

Monday, 8:30-10:00

■ MA-01

Monday, 8:30-10:00
RB-Alfa

Keynote Lecture: Professor Ignacio Grossmann

Stream: Keynote, Tutorial and Plenary Lectures
Keynote session

Chair: *Vincent Mousseau*, LGI, Ecole Centrale Paris, Grande voie des vignes, 92 295, Chatenay Malabry, France, vincent.mousseau@ecp.fr

1 - Challenges in the Application of Mathematical Programming in the Enterprise-wide Optimization of Process Industries

Ignacio Grossmann, Chemical Engineering, Carnegie Mellon University, 5000 Forbes Ave, 15217, Pittsburgh, PA, United States, grossmann@cmu.edu

Enterprise-wide optimization (EWO) is a new emerging area that lies at the interface of chemical engineering and operations research, and has become a major goal in the process industries due to the increasing pressures for remaining competitive in the global marketplace. EWO involves optimizing the operations of supply, production and distribution activities of a company to reduce costs and inventories. A major focus in EWO is the optimization of manufacturing plants as part of the overall optimization of the supply chain. Major operational items include production planning, scheduling, and control. This talk provides an overview of major modeling and computational challenges in the development of deterministic and stochastic linear/nonlinear mixed-integer optimization models for planning and scheduling for the optimization of plants and entire supply chains that are involved in EWO problems. We illustrate the application of these ideas in four major problems: a) integration of planning and scheduling in batch processes that lead to large-scale mixed-integer linear programs, b) optimization of responsive process supply chains that lead to large-scale bicriterion mixed-integer optimization problems, c) optimization of distribution-inventory planning of industrial gases that lead to integration of planning and vehicle-routing models, d) optimization of oilfield infrastructures under uncertainty that lead to multistage stochastic programming problems with endogenous uncertain parameters. We outline the solution methods that have been developed. Also, these problems have been addressed in collaboration with industry, and have led to substantial economic savings.

■ MA-02

Monday, 8:30-10:00
RB-Beta

Scheduling Applications

Stream: Scheduling
Invited session

Chair: *Malgorzata Sterna*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Malgorzata.Sterna@cs.put.poznan.pl

1 - Scheduling chains of divisible computations

Maciej Drozdowski, Dept. of Computer Science, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Maciej.Drozdowski@cs.put.poznan.pl, *Joanna Berlinska*

We analyze scheduling chains of divisible computations. In the chain, one application produces input load for the next one. MapReduce applications are example of 2-stage chains. We propose a divisible load

model and give an algorithm for scheduling multilayer divisible computations. The algorithm is tested experimentally. Structures of the obtained schedules and performance of such applications are studied.

2 - Scheduling malleable tasks with arbitrary processing speed functions

Maciej Machowiak, Poznan University of Technology, Poland, maciej.machowiak@cs.put.poznan.pl, *Mikhail Y. Kovalyov*, *Jan Weglarz*, *Maksim Barketau*

The problem of scheduling n tasks in a system with m processors to minimize the makespan is considered. Task are malleable when can be executed by several processors at a time, its processing speed depends on the number of assigned processors, and a set of processors assigned to the same task can change over time. The processing speed of a task is a strictly increasing function of the number of processors allocated to this task. We present results for arbitrary n and m : polynomial time algorithms for convex and concave functions and an enumerative algorithm for arbitrary functions.

3 - Fast Truck-Packing of 3D boxes

Grzegorz Pawlak, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, grzegorz.pawlak@cs.put.poznan.pl, *Joanna Jozefowska*, *Erwin Pesch*, *Dawid Kowalski*, *Michal Morze*

The practical 3D container packing problem was considered. The problem was formulated for the real packing constrains appearing in the sales and logistics departments of household equipment factory. The formal MIP formulation has been presented and fast heuristic algorithm was proposed. The appropriate computational experiment has been performed. The solution can be implemented in the real container packing problem for the rectangular boxed products.

4 - Genetic Algorithm Supporting Supply Process in Charitable Organizations

Malgorzata Sterna, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Malgorzata.Sterna@cs.put.poznan.pl, *Mateusz Cichenski*, *Mateusz Jarus*, *Michal Miskiewicz*, *Jaroslaw Szymczak*

We study the optimization problem arising in charitable organizations during supply process. Such institutions are especially interested in minimizing the total cost of purchase which consists of the prices at which particular products are bought and the cost of their transportation. We present the formal mathematical model of the problem, which is NP-hard, and propose list heuristics as well as the genetic algorithm solving it. The efficiency of implemented methods was checked in extensive computational experiments.

■ MA-03

Monday, 8:30-10:00
RB-L1

Business Excellence in Logistics: Intelligent and Interactive Routing

Stream: Business Excellence in Logistics
Invited session

Chair: *Martin Josef Geiger*, Logistics Management Department, Helmut-Schmidt-University, Holstenhofweg 85, 22041, Hamburg, Germany, m.j.geiger@hsu-hh.de
Chair: *Murat Koksalan*, koksalan@ie.metu.edu.tr

1 - An Interactive Approach for Multi-objective Route Selection Problem

Diclehan Tezcaner, Industrial Engineering, Middle East Technical University, Endustri Muhendisligi Bolumu, Orta Dogu Teknik Universitesi, 06800, Ankara, Turkey, diclehan@ie.metu.edu.tr, *Murat Koksalan*

Multi-objective (MO) route selection problem is a combination of two combinatorial problems: MO shortest path problem (finding the efficient paths between the nodes to be visited) and MO traveling salesperson problem (finding the efficient tours made up of the efficient paths). We develop an interactive approach that helps in finding the best solution of a decision maker who has a quasiconcave utility function. We demonstrate our approach on the routing problem for unmanned air vehicles with minimization of distance traveled and minimization of radar detection threat objectives.

2 - Delivery Scheduling Using Intelligence

Gulgun Kayakutlu, Industrial Engineering, Istanbul Technical University, Macka, 34367, Istanbul, Turkey, gkayakutlu@gmail.com, *Gokcen Turkel*

Dynamic scheduling is an indispensable need in today's business world. To satisfy the customer, on-time delivery is crucial for the business to continue in spite of continuous change. This study aims to propose a model to predict the optimum time of van deliveries. Factors influencing the delivery process are depicted from various researches. Prediction is modeled as an artificial neural network using Back Propagation. The model is applied in a case study of van deliveries. Achievements of this study will not only contribute to the research, but will also open a new angle in the logistics vision.

3 - A holistic optimization problem for aviation community noise

Daniel Zachary, CRTE, CRP Henri Tudor, 66, rue de Luxembourg, L-4421, Esch sur Alzette, Luxembourg, dan.zachary@tudor.lu, *Ulrich Leopold*

In our presentation, we give an overview of the Luxembourg Aviation community noise situation and discuss a holistic approach to noise abatement and cost sharing. The problem is framed as a multi-indicator assessment and is solved using a minimal cost objective. Recent past results are shown (Luxembourg Aviation Community Noise - LAN project, 2007-2009), a cooperative project with the air freight company Cargolux Airlines International S.A.. New ideas are discussed, including the tuning of the aircraft scheduling, routes, aircraft type, operational procedures and a 3D-trajectory problem.

■ MA-04

Monday, 8:30-10:00

RB-L2

Optimization of shared urban transportation systems

Stream: Optimization in Public Transport
Invited session

Chair: *Gonçalo Correia*, Department of Civil Engineering, University of Coimbra, Faculdade de Ciências e Tecnologia. Dep. Eng. Civil, sala SA 2.8 Rua Luis dos Reis Santos, 3030, Coimbra, Portugal, gcorreia@dec.uc.pt

1 - Strategic design of public bicycle sharing systems with service level constraints

Jenn-rong Lin, Department of Transportation Science, National Taiwan Ocean University, 2, Pei-Ning Road, 20224, Keelung, Taiwan, jrln@mail.ntou.edu.tw, *Ta-hui Yang*

We formulate and analyze a strategic design model for public bicycle sharing systems with service level considerations. In considering the interests of users and investors, the proposed model attempts to determine the number and locations of bike stations, the network structure of bike paths connected between the stations, and the travel paths for users between each pair of origins and destinations. A numerical example is created to illustrate the proposed model. Sensitivity analysis is performed to gain better insights into knowing how important parameters affect the design of the system.

2 - Testing the validity of the MIP approach for locating carsharing stations in one-way systems

Diana Rita Ramos Jorge, Department of Civil Engineering, University of Coimbra, Rua Luis dos Reis Santos, 3030-788, Coimbra, Portugal, diana.jorge@student.dec.uc.pt, *Gonçalo Correia*, *Cynthia Barnhart*

Previous research has proposed using a mixed integer programming (MIP) model for choosing the location of stations in one-way carsharing systems as an approach to solve vehicle stock imbalance. However, MIP models have difficulties including reality-based factors that can have a substantial impact on carsharing. Thus we test the validity of those solutions developing a simulation model including demand variability and relocation operations. The first tentative results show that these factors influence the company profit, affecting significantly the performance of the deterministic solutions.

3 - Assessing the profitability of carsharing fleet distributions based on usage patterns

Mathias Goepfel, GR/PAP, Daimler AG, Building 10, Room 2.3.036, Wilhelm-Runge-Str. 11, 89081, Ulm, Germany, mathias.goepfel@googlemail.com

One-way carsharing as seen with car2go, where vehicle pick-up and drop-off locations are not predefined, challenges the operator. The predominant difficulty lies in matching vehicle locations with customer demand, as well as the development of solutions for fleet maintenance. This article focuses on the formulation of a reliable measure of profitability for the involved vehicles. The measure is based on a time-spatial decomposition of customer data. It enables the operator to decide whether specific areas can be run profitably and allows for advanced scheduling of the service agents.

4 - A shared-taxi agent based model. Testing several market configurations for the Lisbon municipality

Gonçalo Correia, Department of Civil Engineering, University of Coimbra, Faculdade de Ciências e Tecnologia. Dep. Eng. Civil, sala SA 2.8 Rua Luis dos Reis Santos, 3030, Coimbra, Portugal, gcorreia@dec.uc.pt, *Luis Martinez*, *José Viegas*

This paper presents the conceptual design of a new agent-based model to simulate the operation and performance of shared taxi systems. The proposed model incorporates a matching algorithm between the supply and demand, finding the most adequate option, considering multiple objectives, as minimum travel time for passengers and balance in number of services for taxis. The paper will also evaluate the several possible market configurations, measuring the performance of the system from an operator, client and society perspective, finding the most balanced solution in terms of fleet size.

■ MA-05

Monday, 8:30-10:00

RB-L3

Maritime fleet size and mix

Stream: Maritime Transportation
Invited session

Chair: *Trond A. V. Johnsen*, MARINTEK, SINTEF, Otto Nielsen veg 10, 7052, Trondheim, Norway, trond.johnsen@marintek.sintef.no

1 - Containership speed and fleet size optimisation with semi-elastic demand: an application to northern europe-south america trade

Ali Cheaitou, College of Engineering - Industrial Engineering and Management Department, University of Sharjah, Sharjah University City, 27272, Sharjah, United Arab Emirates, ali.cheaitou@graduates.centraliens.net, *Pierre Cariou*

Increasing the number of vessels in a container liner service while reducing speed, known as slow steaming strategy, is modelled in this paper. We focus on the case of optimal speed under semi-elastic demand, for which containerized perishable product transport is sensitive to time. This paper investigates if slow steaming is still optimal when working to maximise the total profit on the cycle. Furthermore, a numerical application is carried out for a direct Northern Europe to East Coast of South America container service, a route selected due to the high volume of perishable products.

2 - On solving the feeder containership network design problem via metaheuristic approaches

Olca Polat, Production Management, TU Berlin, TU Berlin (H95-H9157), Strasse des 19. Juni 135, 10623, Berlin, Berlin, Germany, olcaay@gmail.com, *Hans-Otto Guenther*, *Osman Kulak*

Feeder ports serve as regional hubs from where containers are distributed in the respective region by use of feeder ships. The feeder network design problem (FNDP) determines the smallest ship fleet size with routes to minimize total travelled distance with time, capacity and service frequency restrictions. In this study, a mathematical model is proposed and metaheuristic approaches are developed to solve the FNDP. The developed approaches have been tested using case studies from Turkey. The numerical results of the study show that Turkish ports have great potential as hub ports in its region.

3 - Fleet size and mix in liner shipping

Trond A. V. Johnsen, MARINTEK, SINTEF, Otto Nielsen veg 10, 7052, Trondheim, Norway, trond.johnsen@marintek.sintef.no, *Lars Magne Nonås*, *Kjetil Fagerholt*, *Bjørn Egil Asbjørnslett*

Fleet size and mix is a core decision for all shipping companies. In any given market situation, the number of vessels and the variety of vessel types will determine the profit potential for the company. We present an optimization model for improved support for strategic fleet size and mix decision-making. The model has been implemented and tested in cooperation with a world-leading liner shipping company.

■ MA-06

Monday, 8:30-10:00

RB-Gamma

Matheuristics in Transportation

Stream: Matheuristics
Invited session

Chair: *Fabien Tricoire*, Department of Business Administration, University of Vienna, Chair for Production and Operations Management, Brünner Straße 72, 1210, Vienna, Austria, fabien.tricoire@univie.ac.at

1 - Fresh bovine skin transportation from slaughters to tannery with special time windows and capacity constraints

Giorgio Romanin-Jacur, Management and Engineering, University of Padova, Stradella San Nicola, 3, 36100, Vicenza, Italy, romjac@dei.unipd.it, *Carlo Filippi*

On a road network a tannery, slaughters and truck depots are placed. Different capacity trucks start from depots, load fresh bovine skins supplied by slaughters and unload them at the tannery. Time windows are imposed to truck starting, skins' loading and skins' unloading; skin preservation times and capacity constraints shall be respected. Total cost, due to truck utilization and to paths and times shall be minimized. Quick and easy low cost solution algorithms are required. A mixed integer programming model has been built and both exact and heuristic techniques are suggested and tested.

2 - Freight train composition with minimum shunting operations

Uwe T. Zimmermann, Institute of Mathematical Optimization, TU Braunschweig, Pockelsstrasse 14, 38106, Braunschweig, Germany, u.zimmermann@tu-bs.de, *Ronny Hansmann*

Planning freight train schedules in dense rail networks provides an enormous challenge. Resulting optimization models include a tremendous number of eligible train routes and departure times subject to tight infrastructure requirements. From a BMBF-supported cooperation with Deutsche Bahn, we outline first results focusing on train composition. OD-routed rail cars are assigned to scheduled trains. Optimal locations of rail cars within trains minimize the number of the expensive shunting operations in rail yards. We present MIP-models, heuristics, and some computational experience on DB-data.

3 - Hybrid heuristics for solving a maritime short sea inventory routing problem

Alexandrino Delgado, Matemática, Universidade de Aveiro, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, alexandrino@ua.pt, *Agostinho Agra*, *Marielle Christiansen*, *Luidi Simonetti*

We consider a fuel oil distribution problem where an oil company is responsible for the routing and scheduling of ships between ports such that the demand for various fuel oil products is satisfied during the planning horizon. The objective is to determine distribution policies that minimize the total cost (routing and operations costs), while inventory levels are maintained within their limits. We propose an arc-load flow formulation of the problem. In order to obtain good feasible solutions for several months we propose and compare different hybridization strategies.

■ MA-07

Monday, 8:30-10:00

RB-Eta

Novel and emerging VRPs

Stream: New Trends in Vehicle Routing
Invited session

Chair: *Jorge E. Mendoza*, Institute of Applied Mathematics, Université Catholique de l'Ouest, 3 Place André Leroy, 49008, Angers, France, jorge.mendoza@uco.fr

1 - A Multiple Plan Approach for the Dynamic Technician Routing and Scheduling Problem

Victor Pillac, Automatique - Productique, Ecole des Mines de Nantes, 4 Rue Alfred Kastler, La Chantrerie, 44300, Nantes, France, victor.pillac@gmail.com, *Christelle Gueret*, *Andres Medaglia*

The Dynamic Technician Routing and Scheduling Problem (DTRSP) deals with a crew of technicians that serves dynamically appearing requests. In the DTRSP, each technician has a set of skills, tools, and spare parts, while requests require a subset of each. The problem is then to design a set of tours of minimal total duration such that each request is visited exactly once, within its time window, by a compatible technician, and to dynamically insert new requests into existing tours. We propose a Multiple Plan Approach to solve the DTRSP and illustrate its performance on benchmark instances.

2 - Capacitated Vehicle Routing Problem with Loading Constraints: A Case in the UK

Nasrin Asgari, Mathematics, University of Portsmouth, United Kingdom, Nasrin.Asgari@port.ac.uk, *Xiang Song*, *Dylan Jones*, *Tim Pigden*

Recently it has been raised to solve Capacitated vehicle routing problem (CVRP) considering loading and unloading conditions like sequential loading (Last-In First-Out), vehicle capacity and items fragility. We have dealt with a real case in the UK that distributes consumer items like dairy, food and fruit. Each depot covers 100-150 customers. The case is solved with respect to existing limitations including loading constraints; drivers rule, shift and pattern; and customer time-window. Order splitting is allowed in the case, whilst no split on deliveries has been allowed in the literature.

3 - The Minimum Duration Truck Driver Scheduling Problem

Asvin Goel, Telematique.eu, Germany, goel@telematique.eu

Truck driver scheduling problems are important subproblems of real-life vehicle routing and scheduling problems because rest periods required by government regulations have a significant impact on travel and arrival times. This paper identifies common constraints imposed by hours of service regulations world wide and presents a mixed integer programming formulation for the truck driver scheduling problem. A dynamic programming approach is presented and its effectiveness is demonstrated for working hour regulations in the United States and in the European Union.

4 - A GRASP with heuristic concentration for the vehicle routing problem with stochastic demands

Jorge E. Mendoza, Institute of Applied Mathematics, Université Catholique de l'Ouest, 3 Place André Leroy, 49008, Angers, France, jorge.mendoza@uco.fr, Juan G. Villegas

The vehicle routing problem with stochastic demands consists in designing transportation routes of minimal expected cost to satisfy a set of customers with random demands of known probability distributions. This paper proposes a GRASP that uses randomized route-first, cluster-second heuristics, a variable neighborhood descent, and a post-optimization procedure specially tailored for the problem. Experiments on standard instances show that our approach is competitive with the state-of-the-art method in terms of both accuracy and efficiency

■ MA-08

Monday, 8:30-10:00

RB-Epsilon

Network Optimization 1

Stream: Network Optimization

Invited session

Chair: Ana Bautzer, ISCAL / CIO, Av. Miguel Bombarda, 20, 1069-035, Lisboa, Portugal, aapedro@iscal.ipl.pt

1 - Recent Developments in the Ring Spur Assignment Problem

Paula Carroll, Management Information Systems, UCD, Quinn Business School, Belfield, 4, Dublin, paula.carroll@ucd.ie, Bernard Fortz, Martine Labbé, Seán McGarraghy

We consider the Ring Spur Assignment Problem (RSAP), an NP-hard survivable telecommunications network design problem. It arises in the context of exploiting existing resources efficiently in strategic network development and complements the Sonet Ring Assignment Problem (SRAP) of determining the set of link capacities to install. We propose a complete IP formulation and present recent developments and the results of a cutting plane implementation on benchmark test data.

2 - ILP Models for the PON Access Network Design Problem

Maria João Lopes, Departamento de Métodos Quantitativos, University Institute of Lisbon (ISCTE - IUL) and CIO, Av. das Forças Armadas, 1649-026, Lisboa, Portugal, mjfl@iscte.pt, Luis Gouveia, Amaro de Sousa

A PON is an optical access network connecting a Central Office to a set of terminals using splitters installed on intermediate nodes. In the PON access network design problem, terminals are clustered in a minimum number of PONs and we have to define for each PON where to install splitters and how to connect all elements through fibres. There are costs associated with intermediate nodes, splitter types and fibre connections. We define the minimum cost design problem in the context of densely populated urban areas, proposing different formulations and valid inequalities for this problem.

3 - Robust optimization of optical fiber access networks deployments

Cédric Hervet, Orange Labs/CNAM, France, cedric.hervet@orange.com, Marie-Christine Costa, Faye Alain, Matthieu Chardy, Stanislas Francfort

Due to the recent increase in bandwidth requirements, telecommunication operators have to plan the deployment of optical fiber networks through Gigabit Passive Optical Network technology (FTTH GPON). One great challenge is to design this network while not knowing who and where the future subscribers will be. We focus on the problem of the robust optical fiber network deployment under demand uncertainty. A two-stage robust optimization model is proposed for this problem, as well as two robust solution methods extending classical results from Ben-Tal et al. and Babonneau et al.

4 - Models for a Steiner multi-ring network design problem with revenues

Ana Bautzer, ISCAL / CIO, Av. Miguel Bombarda, 20, 1069-035, Lisboa, Portugal, aapedro@iscal.ipl.pt, Luis Gouveia, Ana Paia, José Pires

The Steiner multi-ring network design problem with revenues is the problem of designing a set of rings that pass through a central depot and through all the customers in a set R and some of the customers in a set S. Besides the usual arcs link costs, revenue profits between each pair of customers in the same ring are also considered. The objective is to minimize the difference between the total routing cost and total profit. We introduced some integer programming formulations for the problem and compared their linear relaxations values. Some valid inequalities are also presented.

■ MA-09

Monday, 8:30-10:00

RB-Zeta

Cutting and Packing 1

Stream: Cutting and Packing

Invited session

Chair: A. Miguel Gomes, INESC TEC, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt

1 - Heuristics for the three-dimensional loading capacitated vehicle routing problem

Leonardo Junqueira, Department of Production Engineering, Federal University of São Carlos, Rua Dona Alexandrina, Num. 2471, Apto. 8, 13566-290, São Carlos, São Paulo, Brazil, leo_junqueira@yahoo.com, Reinaldo Morabito

In this work we present heuristics for the capacitated vehicle routing problem with three-dimensional loading constraints. The problem consists in finding minimum cost delivery routes for a set of identical vehicles that, departing from and returning to the depot, visit all customers only once, while considering constraints related to cargo stability, load bearing and multi-dropping. The routing and loading modules of the method are built on classical heuristics of the vehicle routing and container loading literatures. The results of some computational experiments are presented and discussed.

2 - A heuristic for the vehicle routing problem with backhauls and three-dimensional loading constraints

Andreas Bortfeldt, Dept. of Information Systems, University of Hagen, Profilstrasse 8, 58084 Hagen, Germany, 58084, Hagen, FR Germany, Germany, andreas.bortfeldt@fernuni-hagen.de, Lars Moench

In the vehicle routing problem with backhauls (VRPB) there are delivery and pick up customers. We consider the 3L-VRPB, i.e. a combination of the VRPB and 3D loading. The given vehicles have a 3D loading space and the cargo of a customer consists of 3D boxes. A heuristic is proposed including a variable neighborhood search algorithm for routing and a tree search algorithm for packing boxes. Results are presented for 95 test instances.

3 - Inter-depot transportation planning involving palletisation and truck loading.

Maria Teresa Alonso Martínez, Department of mathematics, University of Castilla-La Mancha, Edificio Infante Don Juan Manuel, Avda.de España s/n, 02071, Albacete, Spain, mariateresa.alonso@uclm.es, Ramon Alvarez-Valdes, Joaquim Gromicho, Francisco Parreno, Gerhard F. Post, Jose Tamarit

In a large logistic company the inter-depot planning problem has to be solved every day. The products are placed on pallets and then the pallets loaded into trucks. The main objective is to send the fewest number of trucks, covering the demand of each depot and satisfying a number of constraints concerning the way in which pallets are built and placed into the truck. Our proposal is to solve the problem using a metaheuristic in two phases, one for building a feasible solution and the other for improving the solution. In both phases palletisation and truck loading are simultaneously considered.

4 - A study on multiobjective rectilinear packing problems

A. Miguel Gomes, INESC TEC, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt, Marisa Oliveira, M^a Eduarda Pinto Ferreira

In many application areas, like in Facility Layout and in VLSI design, one wishes to pack, without overlap, a set of rectilinear polygons while minimizing simultaneously more than one objective, leading to the Multi-objective Rectilinear Packing Problem. The most common objectives are the minimization of the enclosing rectangle area and the minimization of the sum of the distances between a subset of the pieces. The purpose of this work is to study and analyze the relationship between these two objectives, i.e. to study if they really are conflicting objectives.

■ MA-10

Monday, 8:30-10:00

RB-Theta

Applications

Stream: Production and the Link with Supply Chains
Invited session

Chair: Hicham Chehade, ICD- LOSI, University of Technology of Troyes, 12 Rue Marie Curie, 10000, Troyes, France, chehadeh@utt.fr

Chair: Lionel Amodeo, Charles Delaunay Institute, University of Technology of Troyes, 12 Rue Marie Curie BP2060, 10000, Troyes, France, lionel.amodeo@utt.fr

1 - Determining means of serial processors and parameters of lot rectifying inspection plan

Ashraf El-Ga'aly, Systems Engineering, King Fahd University of Petroleum & Minerals, KFUPM P.O. Box 5008, 31261, Dhahran, Eastern, Saudi Arabia, ash.gaaly@yahoo.com, Shokri Selim

We consider determining the optimal means of a set of machines in series. Production is in lots. A lot is processed on each machine sequentially. After each machine, a sample of the lot is examined. If the number of defectives does not exceed a threshold the lot is forwarded to the next machine; otherwise, the lot is rectified and sold. Current solution methods are slow and may not get an optimal solution. We exploit a special structure of the problem that is used to design a fast solution method. We also determine the parameters of the rectification inspection plan for each machine.

2 - High speed methods for volume computation and applications to robust optimization in Supply Chain Management

Rahul Paul, Computer Science, International Institute Of Information Technology, Bangalore, 26/C, Electronic City, Hosur Road, 560100, Bangalore, Karnataka, India, rahul.paul@iiitb.org, G. N. Srinivasa Prasanna, Kundan Kumar, Subhrajit Debnath

Randomized polynomial time polyhedral volume algorithms (Lovasz-Vempala, 2003) are complex and difficult to implement. We extend exact algorithms (Vinci, B. Büeler and K. Fukuda), to introduce a chebyball variant of Direct Monte Carlo with affine transformations, extending their applicability from 9 to 20 dimensions. The volume is used in an information theoretic framework to estimate the information content under uncertainty of a polytope/scenario in a robust optimization framework for Supply Chain Management.

3 - Optimal replenishment policy for deteriorating items with time dependent demand

Shivraj Singh, Mathematics, D.N. College, Shivraj Singh, Dept. of Mathematics, D.N.(P.G.) College, Meerut, U.P., 250001, Meerut, Uttar Pradesh, India, shivrajpundir@gmail.com

This paper considers the impact of learning on set up cost on the Economic Order Quantity model for deteriorating items subject to trapezoidal type consumption rate and shortages. Deterioration models consider gradual reduction in quality and quantity of products over time. In this study the deterioration rate is a Weibull distribution function of time. A model where each cycle begins with shortages and ends without shortages is proposed. The model is developed over an infinite time horizon to determine optimal replenishment policy by minimizing total system running cost.

4 - Optimization of the processing times of cyclically repeated intersecting operation sets

Boris Rozin, Operations research laboratory, United Institute of Informatics Problems of NAS of Belarus, Surganov Str.,6, 220012, Minsk, Belarus, rozin@newman.bas-net.by, Genrikh Levin

A cyclically repeated sequence of intersecting sets of operations is executed in a system and the operations of each set are activated simultaneously. The expenses for each operation decrease with the increase of its processing time, the expenses for the whole cycle are proportional to its time. The problem is to determine the processing times of the operations to minimize the total expenses under the constraint on the cycle time. The proposed method uses decomposition techniques and dynamic programming. Examples of such systems are presented.

■ MA-11

Monday, 8:30-10:00

RB-Iota

Inclusion of foreign transportation resources

Stream: Transportation Planning
Invited session

Chair: Jörn Schönberger, University of Bremen, 28359, Bremen, Germany, jsb@uni-bremen.de

1 - Heuristic Strategies for Bundle Bidding in Transport Auctions

Tobias Buer, Department of Business Studies & Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Str. 5, 28359, Bremen, – Please Select (only U.S. / Can / Aus), Germany, tobias.buer@uni-bremen.de, Herbert Kopfer

The procurement of transport services via a combinatorial auction is considered from a freight carrier's point of view. The freight carrier has to decide on which subsets of the tendered freight requests to place a bid. This problem is denoted as the bid generation problem (BGP). To solve the BGP, we propose heuristic bidding strategies based on synergies between requests. By means of a computational study, the strategies are compared to a brute-force strategy which generates all possible bundle bids. Based on this comparison, trade-offs are discussed.

2 - Benefits of a heterogeneous fleet — the ecological perspective

Herbert Kopfer, Department of Business Studies & Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Strasse 5, 28359, Bremen, Germany, kopfer@uni-bremen.de, Heiko Kopfer, Jörn Schönberger

Road haulers are more and more enforced to integrate emission-related issues in their daily operations planning. We present an innovative approach that aims at exploiting the ecologic benefits of a heterogeneous fleet. Vehicles are classified by their fuel consumption with respect to their dead weight and actual payload. Here, the linearity between travelled distances and cargo weight becomes void. We demonstrate the predominance of a heterogeneous fleet over a homogeneous fleet with respect to the reduction of green house gas emissions.

3 - Collaborative Transportation Operations Planning in a Real-world Scenario - Handling of Backhauls

Andrea Nagel, Information Systems Research Group, FernUniversität - University of Hagen, 58084, Hagen, Germany, andrea.nagel@fernuni-hagen.de, *Giselher Pankratz*, *Hermann Gehring*

In this contribution we examine a cooperation of four producers in the food and beverages industry, which decided to coordinate their distribution activities by inter-organisational transportation planning. We modeled this scenario as a Rich Vehicle Routing Problem. One of the real-world restrictions is the occurrence of backhauls. Different needs for the transportation of the goods induce different backhaul policies that have to be covered by the model. We identify and characterize these policies and propose a strategy for a improved handling of backhauls in a real-world-scenario.

4 - Enrichment of Mobile Freight Auctions with Location Sensitivity: Systemic Design Considerations

Dimitrios Emiris, Industrial Management & Technology, University of Piraeus, 80 Karaoli & Dimitriou Street, 18534, Piraeus, Greece, emiris@unipi.gr, *Charis Marentakis*

The use of the Auction Classification Ecosystem (ACE) recently presented enabled the systemic design of many auction types, including B2B ones that are widely used in trading of freight services. The present proposal secures the systemic design of advanced auctions and capitalizes on the ACE for shaping a progressive and evolutionary approach to implement advanced auctions with mobility and location sensitivity and to incorporate additional sources of information such as participants' behavior. The model parameters are fine tuned using observations from actual or experimental findings.

■ MA-12

Monday, 8:30-10:00

RB-Omicron

Fuzzy Goal Programming and Optimization Methods

Stream: Fuzzy Systems, Neural Networks & Artificial Intelligence

Invited session

Chair: *Mariano Jimenez-Lopez*, Economía Aplicada I, University of the Basque Country, Plaza de Oñati 1, 20018, San Sebastian, Spain, mariano.jimenez@ehu.es

1 - Soft computing applied to portfolio selection with uncertain data

Carlos Cruz Corona, DECSAI, Universidad de Granada, Spain, carloscruz@decsai.ugr.es, *Ricardo Coelho Silva*, *José L. Verdegay*

Nowadays, Soft Computing is employed with great success in the design, construction and utilization of a wide range of products and systems whose functioning is directly based on the human beings reason ways. This is specifically patent in the case of the real-life optimization problems. In this work a novel approach that solves quadratic programming problems under different kind of uncertainties in its data is proposed. As an illustration, a portfolio selection problem with uncertain data is formulated and solved as a fuzzy quadratic programming problem.

2 - Fuzzy goal programming for material requirement planning under uncertainty and integrity conditions

Josefa Mula, Research Centre on Production Management and Engineering, Universitat Politècnica de València, Escuela Politécnica Superior de Alcoy, Plaza Ferrándiz y Carbonell, 2, 03801, Alcoy, Alicante, Spain, fmula@cigip.upv.es, *Manuel Díaz-Madroño*, *Mariano Jimenez-Lopez*

To solve a material requirement planning problem of a first tier supplier in an automobile supply chain a fuzzy goal programming model is proposed. The goals are to minimize production and inventory costs,

idle time and backorder quantities. The epistemic uncertainty is considered in the demand, available and required capacity. The integrity conditions for the main decision variables are considered. To model the relative importance between goals, instead of a crisp weight structure, fuzzy binary relations are used. An example based on modifications of real-world industrial problems is shown.

3 - A Novel Approach for Multiobjective Programming Problems with fuzzy objective functions

Monga K Luhandjula, Decision Sciences, University of South Africa, Muckleneuk Campus, 0003, Pretoria, Gauteng, South Africa, luhanmk@unisa.ac.za

In this paper we propose a novel approach for Multiobjective Programming Problems with fuzzy number coefficients. The main idea behind our approach is to approximate involved fuzzy numbers by their respective nearest interval counterparts. An oracle that associates with a given fuzzy number its nearest interval plays a pivotal role in this regard. Our method contrasts markedly with techniques based on defuzzification operators which replace a fuzzy set by a single real number leading to a lost of too many important information. A numerical example is also provided for the sake of illustration.

4 - Sequential Goal Programming with Fuzzy Hierarchy: Application to Sustainable Investments

Mariano Jimenez-Lopez, Economía Aplicada I, University of the Basque Country, Plaza de Oñati 1, 20018, San Sebastian, Spain, mariano.jimenez@ehu.es, *Amelia Bilbao-Terol*, *Mar Arenas-Parra*, *Verónica Cañal*

A portfolio selection model satisfying Socially Responsible Investment (SRI) criteria is shown. SRI bears in mind financial goals and personal values. To evaluate SRI criteria, social, environmental and ethical indicators are introduced by a fuzzy-MCDM approach. The evaluation of the financial criteria is carried out by the Expected Value at the End and by the Conditional Value at Risk; both are incorporated, along with the SRI criteria into a two-stage GP problem with imprecise sequential hierarchies. Our model optimizes investment and social performance.

■ MA-13

Monday, 8:30-10:00

RB-Tau

Lot-sizing and Related Topics 1

Stream: Lot-sizing and Related Topics

Invited session

Chair: *Bernardo Almada-Lobo*, Industrial Engineering and Management, Faculty of Engineering of Porto University, Rua Dr. Roberto Frias s/n DEIG, 4200-465, Porto, Portugal, almada.lob@fe.up.pt

1 - Integrated scheduling of continuous casters and hot strip mills in the steel industry: a block planning approach

Pedro Amorim, Industrial Engineering and Management, Faculty of Engineering of University of Porto, Rua Doutor Roberto Frias, 4200-465, Porto, Portugal, amorim.pedro@fe.up.pt, *Imke Mattik*, *Hans-Otto Guenther*

This work addresses the joint scheduling of continuous caster and hot strip mill processes in the steel industry. Traditionally, slab yards are used to decouple these two stages. However, the rising importance of energy costs gives motivation for an integrated scheduling. For each of the processes a mixed-integer optimization model based on the block planning principle is presented. This approach develops production schedules that take technological sequences of steel grades and milling programs into account. Instances from a real-world steel plant are solved and the results are discussed.

2 - Lot sizing and scheduling of chemical commodity products: An evolutionary block planning application

Andreas Schöpperl, Production Management, TU Berlin, Strasse des 17. Juni 135, Sekr. H95, 0623, Berlin, Berlin, Germany, andreas.schoepperl@tu-berlin.de, Hans-Otto Guenther

Nowadays companies in many industries are faced with an increased product variety and the need to quickly respond to short-term customer orders. Hence a specific challenge is to continuously adapt production schedules in a cost-efficient way when new customer orders arrive. Evolutionary planning is proposed as a general concept supporting the continuous development of production schedules. Specifically, we adopt the block planning principle as a practical tool for scheduling product variants in a predetermined sequence. As a case study the production of chemical commodities is considered.

3 - Combining column generation and metaheuristics for solving a parallel machine scheduling problem with job splitting

Carina Pimentel, DEGEI, University of Aveiro/Algoritmi Research Center, Campus Universitário de Santiago, Portugal, 3810-193, Aveiro, Aveiro, Portugal, carina@dps.uminho.pt, Filipe Alvelos, Diogo Alves

In this talk we present the problem of scheduling n independent jobs on m identical parallel machines with the objective of minimizing total tardiness, considering jobs release dates, sequence independent setups and lot splitting. A time indexed mixed integer programming compact model and a decomposition model will be presented. The decomposition model is solved by a SearchCol algorithm. SearchCol is a recently proposed general framework for decomposable integer programming/combinatorial optimization problems based on the hybridization of column generation and metaheuristics.

4 - Neighbourhood-based hybrid algorithm for pulp and paper production planning

Gonçalo Figueira, Industrial Engineering and Management, Faculty of Engineering of Porto University, 4200-465, Porto, Portugal, goncalo.figueira@fe.up.pt, Maristela Santos, Bernardo Almada-Lobo

Motivated by a real-world case study in the pulp and paper industry, we tackle the short-term production planning and scheduling in an integrated mill. Our approach combines a Variable Neighborhood Search procedure (which manages the setup variables), a specific heuristic (to determine the discrete production speeds constrained to a maximum variation) and an exact solver for the optimization of production and flow movement decisions. We explore different strategies to speed-up the solution procedure and test alternative variants with instances based on real data from the case study.

or it is related to schedule length. We show that the divisor methods of apportionment may fail in constructing an optimal solution in case of volume oriented product rate.

2 - An Efficient Algorithm for Finding Ideal Schedules

Dariusz Dereniowski, Department of Algorithms and System Modeling, Gdańsk University of Technology, ul. Gabriela Narutowicza 11/12, 80-233, Gdańsk, Poland, deren@eti.pg.gda.pl, Ed Coffman, Wieslaw Kubiak

In this talk we address the problem of scheduling UET jobs with release dates and precedence constraints on two identical processors. We say that a schedule is ideal if it minimizes both maximum and total completion time simultaneously. We give an instance of the problem showing that ideal schedules do not exist in general when preemptions are allowed. If preemptions are not allowed, then ideal schedules do exist for general precedence constraints, and we describe an algorithm for finding ideal schedules in $O(n^3)$ time, where n is the number of jobs.

3 - Coordinating Subcontractor Scheduling with Divisible Jobs and Private Information

Behzad Hezarkhani, Faculty of Business Administration, Memorial University, General Office, Faculty of Business Administration, Memorial University of Newfoundland, A1B 3X5, St. John's, Newfoundland and Labrador, Canada, b.hezarkhani@mun.ca, Wieslaw Kubiak

We consider a decentralized setting with several manufacturer agents and a subcontractor where subcontracting is done to reduce the makespans. We show that the VCG mechanism with Clarke pivot rule gives rise to a simple closed-form formula for payments. Next, we introduce pricing schemes that support the efficient solution, i.e. agents individually choose their allocations in the efficient solution. We show that subcontractor's revenue with such supporting prices are at least as much as that in the VCG mechanism with Clarke pivot rule and can be arbitrarily close to the maximum possible.

4 - Time auction as a tool for solving multiagent scheduling problems

Piotr Modliński, Institute of Control and Computation Engineering, Warsaw University of Technology, ul. Nowowiejska 15/19, 00-665, Warsaw, Poland, p.modlinski@ia.pw.edu.pl

The problem of scheduling disjoint, indivisible tasks takes on a new meaning in a situation when a number of agents have contradictory requirements. Attempts to centralized solving the problem do not produce satisfying results because agents are utilitarian. Bilateral negotiations are not sufficient mechanism in the general case, and multilateral ones are too complex. In the paper we consider usability of the time auction. It bases on multi-commodity auction mechanism. Issues of effectiveness and incentive compatibility are considered.

■ MA-14

Monday, 8:30-10:00

RB-Omega

Scheduling

Stream: Scheduling under Resource Constraints
Invited session

Chair: Wieslaw Kubiak, Faculty of Business Administration, Memorial University, Prince Philip Drive, A1B 3X5, St. John's, NL, Canada, wkubiak@mun.ca

1 - Product Rate Variation problem on parallel machines and divisor methods of apportionment

Joanna Jozefowska, Institute of Computing Science, Poznań University of Technology, Piotrowo 2, 60-965, Poznań, Wielkopolska, Poland, jjozefowska@cs.put.poznan.pl

House monotone methods of apportionment may be successfully applied to solving the PRV problem defined on a single machine. PRV minimization on multiple parallel machines may be defined in two ways: either the product rate is related to the total production volume

■ MA-16

Monday, 8:30-10:00

RB-2103

Advances in Nonsmooth Optimization

Stream: Nonsmooth Optimization
Invited session

Chair: Adilson Elias Xavier, Graduate School of Systems Engineering and Computer Sciences, Federal University of Rio de Janeiro, P.O. Box 68511, Ilha do Fundão - Centro Tecnologia - H319, 21941-972, Rio de Janeiro, RJ, Brazil, adilson@cos.ufrj.br

1 - A Simple Resilient Backpropagation Algorithm for Non-Smooth Optimisation Problems

Apostolos Kotsialos, School of Engineering and Computing Sciences, Durham University, South Road, DH1 3LE, Durham, United Kingdom, apostolos.kotsialos@durham.ac.uk

This paper reports on a non-smooth optimisation algorithm based on non-continuous gradient functions. The resilient backpropagation algorithm is employed. Results from test problems in their unconstrained, bound constrained and non-smooth constrained versions, are presented. The suggested algorithm's performance is compared with those of the more sophisticated bundle methods, that have appeared in the literature; better performance is shown in some cases. Further positive features include the algorithm's scalability and simple implementation requirements.

2 - Solving the Continuous Multiple Allocation p-Hub Median Problem by the Hyperbolic Smoothing Approach: Computational Results

Adilson Elias Xavier, Graduate School of Systems Engineering and Computer Sciences, Federal University of Rio de Janeiro, P.O. Box 68511, Ilha do Fundão - Centro Tecnologia - H319, 21941-972, Rio de Janeiro, RJ, Brazil, adilson@cos.ufrj.br, *Claudio Gesteira*

This paper considers the problem of finding the least expensive hub locations, given demands between pairs of cities. The problem leads to a min-sum-min formulation that is strongly non-differentiable. The proposed method overcomes this difficulty with the hyperbolic smoothing strategy, which has been proven able to solve different non-smooth problems. The most important feature of the methodology is the low dimension of the subproblems. The robustness and the efficiency of the method are shown through a set of computational experiments with large problems with up to 1000 cities.

3 - Solving the Minimum Sum of L1 Distances Clustering Problem by Hyperbolic Smoothing and Partition into Boundary and Gravitational Regions

Sergio B. Villas-Boas, PESC, UFRJ / COPPE, Department of Systems Engineering and Computer Science (PESC), Graduate School of Engineering (COPPE), Federal University of Rio de Janeiro, 21.941-972, Rio de Janeiro, Rio de Janeiro, Brazil, sbvb@sbvb.com.br, *Vinicius Layter Xavier*

It is considered the minimum sum of distances clustering problem, for distances measured using the L1 or Manhattan metric (MSDC-L1). It is a min-sum-min problem, strongly non differentiable.

It is proposed the AHSC-L1 method, by combining 2 techniques that drastically simplify the computational tasks. (1) Use Hyperbolic Smoothing Clustering (HSC), that adopts a smoothing strategy using a special C_∞ completely differentiable function. (2) Partition of the set of observations into two non overlapping groups: "data in frontier" and "data in gravitational regions".

4 - Solving the Fermat-Weber Problem with the Hyperbolic Smoothing Method

Vinicius Layter Xavier, Systems Engineering and Computer Sciences Depart., Federal University of Rio de Janeiro, CT - Bloco H - sala H319, Ilha do Fundao, 21941-972, Rio de Janeiro, RJ, Brazil, viniciuslx@gmail.com, *Felipe França*, *Adilson Elias Xavier*, *Priscila Lima*

The minimization of the sum of the distances of observations to their cluster centroids, a non-differentiable and a non-convex problem with a large number of local minima, is tackled. The hyperbolic smoothing strategy solves a sequence of low dimension differentiable unconstrained optimization sub-problems, which gradually approaches the original problem. The reliability and the efficiency of the method are illustrated via a set of computational experiments. It must be emphasized that the proposed methodology can be analogously applied to the solving of the Fermat-Weber location problem.

1 - On the Feasibility of Establishing a Northern Western Australian Beef Abattoir as a Facility Location Problem

Rodolfo Garcia-Flores, Mathematics, Informatics and Statistics (CMIS), Commonwealth Scientific and Industrial Research Organisation (CSIRO), 71 Normanby Rd., Clayton, 3168, Melbourne, VIC, Australia, Rodolfo.Garcia-Flores@csiro.au, *Andrew Higgins*, *Andreas Ernst*

The trade of livestock from north Western Australia (WA) has recently become more vulnerable to policy changes, whereas the feasibility of building and operating local abattoirs has become highly sensitive to construction costs and prices of slaughtered meat. We formulate a facility location problem that selects segments of the road network to upgrade, and abattoirs from a set of potential sites in the Pilbara region of WA. The model provides insight on the trade off between resource allocation to facilities and links. We present initial results and propose an algorithm based on decomposition.

2 - Design of a pooled distribution network: a case study

Olivier Péton, Automatic Control and Industrial Engineering, LUNAM Université, Ecole des Mines de Nantes, IRCCyN UMR CNRS 6597, 4 rue alfred kastler, 44307, NANTES, France, olivier.peton@mines-nantes.fr, *Fabien Lehuédé*, *Christian Leroux*, *Xavier Perraudin*

We consider a cluster of neighboring competing companies which wish to pool their distribution network. These companies frequently deliver small quantities of goods to hundreds of common retailers spread in a large territory. Their main goal is to reduce transportation cost and environmental footprint thanks to full truckload transportation. We model this problem as a sequence of MILPs with the following steps: location of one consolidation warehouse and several regional cross-docks, design of truckload routes, assignment of retailers to regional warehouses and loading of trucks.

3 - Comparing classical performance measures for a multi-period logistics network design problem

Teresa Melo, Business School, Saarland University of Applied Sciences, Waldhausweg 14, D-66123, Saarbrücken, Germany, teresa.melo@htw-saarland.de, *Isabel Correia*, *Francisco Saldanha-da-Gama*

A two-echelon network design problem is studied. Location and transportation decisions are considered together with the sizing of storage areas for product families. A finite set of capacity levels for each family is available at each potential location. Two mixed-integer linear models are proposed that differ in their objective functions: cost minimization v. profit maximization. Valid inequalities are developed to strengthen the formulations. The impact of these performance measures on network design are investigated through a numerical study. An extension to a bi-objective case is studied.

■ MA-17

Monday, 8:30-10:00
RB-2105

Location and Supply Chain Management

Stream: Applications of Location Analysis
Invited session

Chair: *Teresa Melo*, Business School, Saarland University of Applied Sciences, Waldhausweg 14, D-66123, Saarbrücken, Germany, teresa.melo@htw-saarland.de

■ MA-18

Monday, 8:30-10:00
RB-2107

Financial Crisis Modelling

Stream: Financial Modelling & Risk Management (contributed)

Contributed session

Chair: *Blanka Škrabić Perić*, Department of Quantitative Methods, Faculty of Economics, Matice hrvatske 31, Split, Croatia, bskrabic@efst.hr

1 - Spanish savings banks in the credit crunch: could distress have been predicted before the crisis? A multivariate statistical analysis

Martí Sagarra, Department of Business Economics, Universitat Autònoma de Barcelona, Departament d'Economia de l'Empresa, Facultat d'Economia i Empresa - Edifici B, 08193, Bellaterra (Cerdanyola del Vallès), Spain, Spain, marti.sagarra@uab.cat, *Cecilio Mar-molinero*

Spanish savings Banks (Cajas) have had a long and distinguished history. However, they have been heavily affected by the banking crisis of 2007. Many of them had to merge with other institutions or were rescued. We show that, before the crisis, there were structural differences between successful Cajas and those that had to be rescued. The technical approach is based on Multidimensional Scaling Analysis (MDS). MDS has the advantage that the main characteristics of the study can be presented in a visual form, and thus facilitate communication of the results.

2 - On the transition of Japanese corporate rating structure under the recent credit crises

Motohiro Hagiwara, School of Commerce, Meiji University, 1-1 Kandasurugadai Chiyoda-ku, 101-0062, Tokyo, Japan, motohiro@kisc.meiji.ac.jp, *Yasuhiro Matsushita*, *Katsuaki Tanaka*

The aim of this study is to check the transition of recent bond rating structure under the credit crises based on accounting informations giving Altman Z-score. Japanese corporate bond ratings are transformed to normally distributed variables using published 5 -Year actual default probability, and are modeled as functions by key ratios giving Z-score using ANN. This study found some facts concerning the transition of rating structure in recent several years and time consistency of rating informations under the crises are discussed based on models before crises.

3 - Using assignment problem in financial products' design

Maria Mavri, Business Administration, University of the Aegean, 8 Michalon Street, 82100, Chios, Greece, m.mavri@ba.aegean.gr, *Michail Bekiaris*

Today, the world economic crises are forcing banks to change their operational internal processes. We argue that a service system can effectively be represented as a manufacturing system, and more specifically that any product or service offered by a bank to its clients could be designed following a procedure similar to those used in 'production'. In this study we use the concept of assignment problem in order to distribute tasks and jobs to bank units, that develop new products, suitable for satisfying customers' diverse and different needs.

4 - Recent crisis, credit boom and nonperforming loans in CEE countries-panel data evidence

Blanka Škrabić Perić, Department of Quantitative Methods, Faculty of Economics, Matice hrvatske 31, Split, Croatia, bskrabic@efst.hr, *Josip Arneric*

The paper investigates impact of credit boom during 2000th and recently crisis on nonperforming loans in CEE countries. Namely, the beginning of 2000th was characterized by many features as the foreign capital inflow, entry of foreign banks and economic growth. This has resulted in increased competition in the banking system and rapid credit growth. Dynamic panel data is used to analyze the impact of rapid credit growth on nonperforming loans in 16 CEE countries during period 1994-2010. Empirical analysis is performed on aggregated data for each country.

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Chair: *Rita Deccllesia*, Economic and Social Analysis, Sapienza University of Rome, Piazza Aldo Moro 5, 00185, Rome, Italy, rita.deccllesia@uniroma1.it

Chair: *Bogdan Iftimie*, Applied Mathematics, Academy of Economic Studies of Bucharest, 010374, Bucharest, Romania, Bogdan.Iftimie@csie.ase.ro

1 - Energy commodities:price relationships the key issue

Rita Deccllesia, Economic and Social Analysis, Sapienza University of Rome, Piazza Aldo Moro 5, 00185, Rome, Italy, rita.deccllesia@uniroma1.it

This paper examines the time series econometric relationship between the fossil fuels and electricity in Europe and in US. When data have unit roots as in this case a cointegrating relationship may provide effective results. An optimization framework is also set to get the correct rolling correlation measure which provides hint on short term relationships. Long run and short term relationship represent the key element to set up effective risk management strategies.

2 - A Mixed Integer Linear Programming Approach to Markov Chain Bootstrapping

Roy Cerqueti, Department of Economics and Financial Institutions, University of Macerata, Via Crescimbeni, 20, 62100, Macerata, Italy, roy.cerqueti@unimc.it, *Paolo Falbo*, *Cristian Pelizzari*, *Federica Ricca*, *Andrea Scozzari*

The Markov Chain bootstrap method is one of the most acknowledged tools to make forecasts and study the statistical properties of an evolutive phenomenon. The underlying idea is to replicate the phenomenon on the basis of an available sample, which is assumed to evolve according to a Markov Chain. This paper deals with the relevant problem of reducing the dimension of the transition probability matrix by maintaining the original features of the sample. To this aim, we advance two mixed integer linear programs. We present also some numerical examples based on the electricity market.

3 - Financial Optimization Modeling in R

Ronald Hochreiter, Finance, Accounting and Statistics, WU Vienna University of Economics and Business, Augasse 2-6, 1090, Vienna, Austria, ronald.hochreiter@wu.ac.at

Simplifying the task of modeling financial optimization problems is important. Many commercial products have been created to support the financial modeling process, but none of these products has been adopted by a significantly large number of users. Simplifications are crucial to implement optimization models into business processes successfully. We outline an approach on how to simplify financial optimization modeling using R and external optimization modeling languages as well as by building model generators for specific application problems.

■ MA-19

Monday, 8:30-10:00

RB-2111

Risk management in commodities markets

Stream: Commodities and Financial Modeling
Invited session

Chair: *Massimo Panella*, University of Rome "La Sapienza", Dpt. of Information Engineering, Electronics and Telecommunications

■ MA-20

Monday, 8:30-10:00

RB-2113

Financial Time Series Analysis and Forecasting

Stream: Data Mining in the Financial Sector
Invited session

Chair: *Marcus Hildmann*, Information Technology and Electrical Engineering, ETH Zurich, ETL G 24.2, Physikstrasse 3, 8092, Zürich, Switzerland, hildmann@eeh.ee.ethz.ch

1 - Carbon Price Sensitivity and Sectoral Analysis

Omer Kayhan Seyhun, Banking and Financial Institutions Department, Risk Centralization Division, Central Bank of Turkey, Istiklal Street No 10, Ulus, 06100, Ankara, Turkey, kayhan.seyhun@tcmb.gov.tr

We examine the fundamental drivers of carbon prices and their sensitivity to various sectors; we investigate various related interactions. Multivariate statistical techniques are used to attest the link between carbon prices and sectoral level variables. It is not clear how to price the future damages of the climate change and the increasing natural disaster occurrence. It is expected that the correlation will be a significant tool to observe the sensitivity of carbon prices with energy and agricultural sectors.

2 - Online Financial Data Streams Value at Risk Segmentation Methods

Dima Alberg, Industrial Engineering and Management, SCE Sami Shamoon College of Engineering, Bazel/Bialik Sts, 84100, Beer-Sheva, Israel, albergd@gmail.com

Two novel algorithms FISW and FISWAB for an efficient segmentation of financial data streams are presented. The proposed algorithms implement adaptive sliding window approach whose size recomputed online according to the rate of change observed from the data itself. The main advantages of the algorithms that they are time and memory efficient, use the Value at Risk as a tuning parameter and do not require choosing lot of input parameters. The accuracy and computation time of the proposed algorithms will be compared to real financial stream data.

3 - Modeling the market decision problems for electrical energy balancing systems

Mariusz Kaleta, Institute of Control & Computation Engineering, Warsaw University of Technology, Nowowiejska 15/19, 00-665, Warsaw, Poland, mkaleta@ia.pw.edu.pl

Our work is a step for standardization of balancing problems description (similarly to Kendall's notation in theory of queues) for electrical energy markets, what in effect should facilitate understanding and comparing research works, exchanging data cases and mechanism implementation. We formulate an abstract model of balancing problem, which consists in so called market decision problems and balancing mechanism. We provide a parametrization of the market decision problems space. To prove our concept we apply it to build an expressive market simulation tool.

MA-21

Monday, 8:30-10:00

RB-2115

Financial Mathematics and OR 1

Stream: Financial Mathematics and OR
Invited session

Chair: Tansel Avkar, Department of Mathematics, Middle East Technical University, 06531, Ankara, Turkey, tanselavkar@gmail.com

Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Different approaches for evaluating a Portfolio of R&D Projects

Anabela Costa, Quantitative Methods, CIO/ ISCTE - Instituto Universitário de Lisboa, Av. das Forças Armadas, 1649-026, Lisboa, Portugal, anabela.costa@iscte.pt, José Paixão

We present three approaches to valuing a portfolio of R&D projects with a budget constraint. One approach is based on a dynamic programming model where stages are associated to decisions concerning the progress of the projects. The second one is based on a Monte Carlo simulation approach determining the parallel valuation for the projects. Finally, the third approach consists of a 0-1 integer linear program for finding the optimal decisions in terms of the overall value of the portfolio. We report computational experience concerning the different approaches.

2 - Time series forecasting and optimal stopping problem in market index portfolio

Lukas Pichl, Department of Information Science, International Christian University, Osawa 3-10-2, Mitaka, 181-8585, Tokyo, lukas@icu.ac.jp

Time series forecasting of a single stock title, within an entire market index, and across different markets is an active area of operations research ranging from artificial neural networks across econometric models to information compression methods in symbolic analysis models. We survey the recent developments and present our findings on the correlations in the dynamics of stock index and its individual constituents in Japan, using high frequency tick data aggregated at various time scales, and demonstrating the presence of stylized facts.

3 - Portfolio Optimization with Hybrid Uncertainty

Alexander Yazenin, Applied Mathematics Department, Tver State University, Zhelyabova, 33, 170100, Tver, alexander.yazenin@tversu.ru

In the paper the mathematical model of the minimal risk portfolio with hybrid uncertainty (possibility/probability) is presented and investigated. In the model the profitabilities are explicated with fuzzy random variables. Their second order moments those form the portfolio risk function are non-fuzzy. In the model the expected value level is presented with possibilistic/probabilistic restrictions. The behavior of the investment possibilities set is investigated depending on the level of possibility/necessity and probability. The results are demonstrated on the model example.

4 - Multicriteria decision making in comparison of objective and subjective criteria of companies' success

Branka Marasovic, Faculty of Economics Split, 21000, Split, Croatia, branka.marasovic@efst.hr, Ivana Tadic

Although, financial indicators usually are taken as the most important indicators of success, lately authors argue about the same relevance in usage of subjective indicators. The aim of paper is to research whether the most successful companies regarding financial ratios (objective group of criteria) show the similar results by other groups of criteria, as human resource management evaluation and evaluation of entire companies' success (subjective groups of criteria). Selected companies will be ranked by each group of criteria using multicriteria decision making method PROMETHEE II.

MA-22

Monday, 8:30-10:00

RB-2117

Soft Computing and SCM Applications

Stream: Fuzzy Sets and Soft Computing
Invited session

Chair: Kaj-Mikael Bjork, IAMSR, Abo Akademi University and Arcada, University of Applied Sciences, 20520, Turku, Finland, kaj-mikael.bjork@abo.fi

1 - A tabu search vehicle routing problem

Kaj-Mikael Bjork, IAMSR, Abo Akademi University and Arcada, University of Applied Sciences, 20520, Turku, Finland, kaj-mikael.bjork@abo.fi

Heuristic optimization methods provide a solid platform to solve big sized (realistic) problems even in the application domain of NP-hard problems. Many transportation optimization problems are such that they can be solved with rigorous methods (such as MILP-methods, for instance) for only smaller sized problems. Even if heuristic methods will not provide global convergence, they will be applicable to realistic big-sized problems. In this paper, a Tabu search method is applied to a transportation problem and more specifically a vehicle routing problem relevant for the Finnish forest industry.

2 - A Multi-item Fuzzy Economic Production Quantity Problem with Backorders and Limited Storage Space

Magnus Westerlund, Economics, IT and Media, Arcada, Jan-magnus.jansonsplats 1, 00550, Helsinki, Finland, magnus.westerlund@arcada.fi, Kaj-Mikael Bjork, József Mezei

We extend a fruitful fuzzy EOQ (Economic Order Quantity) track of research with a multi-item model that takes storage limitation and backorders into consideration. In the paper, finite production rate is considered (i.e. the products are produced to stock and not purchased which is a typical situation in process industry). In the model, the order cycle time, the demand and the backorders are represented by triangular fuzzy numbers which allows for taking expert opinion into account when modeling uncertainties. Signomial global optimization (SGO) algorithm is employed to find the optimal solution.

3 - Systems of (max, min)-linear equations and inequalities

Martin Gavalec, Department of Information Technologies FIM, University of Hradec Kralove, Rokitanského 62, 50003, Hradec Kralove, Czech Republic, martin.gavalec@uhk.cz, Karel Zimmermann

By (max, min)-linear equation (inequality) we understand an equation (inequality) between two (max, min)-linear functions of n variables. Properties of the solution sets of finite systems of (max, min)-linear equations and inequalities are investigated in the contribution. The obtained results are then used for solving optimization problems with max-separable objective function and constraints described by a system of (max, min)-linear equations and inequalities. Applications to some multiple fuzzy goal decision problems as well as some generalizations are discussed.

4 - Measuring transitivity of fuzzy pairwise comparison matrix in DM problems

Jaroslav Ramik, Dept. of Math. Methods in Economics, Silesian University, School of Business, University Sq. 1934/3, 73340, Karvina, Czech Republic, ramik@opf.slu.cz, Petr Korviny

A pair-wise comparison matrix is the result of pair-wise comparison a powerful method in multi-criteria optimization. When comparing two elements, DM assigns the value representing the element of the pairwise comparison matrix. The consistency ratio is defined in AHP. In some situations another interpretation is convenient. The DMs preferences can be represented by a fuzzy preference relation. We investigate relations between several types of transitivity of fuzzy relations and multiplicative preference relations. We also define the grade of transitivity.

Exhausters were defined by Demyanov (1999). Then, relationships between exhausters and generalized subdifferentials were given by Demyanov and Roshchina (2007, 2008). In this work, a special class of exhausters is obtained by using weak subdifferentials defined by Azimov and Gasimov (1999). Some examples of positively homogeneous functions whose upper and lower exhausters calculated by weak subdifferential are given. Moreover, some properties of this class of exhausters are examined.

2 - Exhausters, Weak Subdifferentials and Optimality Conditions

Didem Tozkan, Department of Mathematics, Anadolu University, Anadolu Universitesi Yunus Emre Kampusu, Fen Fakültesi Matematik Bölümü, 26470, Eskisehir, Turkey, dtokaslan@anadolu.edu.tr, Mahide Kucuk, Ryszard Urbanski, Jerzy Grzybowski, Yalcin Kucuk, Ilknur Atasever, Mustafa Soyertem

Demyanov defined the concept of exhausters (1999) and then optimality conditions in terms of proper and adjoint exhausters were given by Demyanov and Roshchina (2006, 2008). In this study, we give some examples of evaluating exhausters of positively homogeneous functions via weak subdifferentials defined by Azimov and Gasimov (1999). Furthermore, some optimality conditions are examined by using relationships between exhausters and weak subdifferentials.

3 - Relationships between gw-subdifferentials and radial epiderivatives for nonconvex vector functions

Ilknur Atasever, Department of Mathematics, Anadolu University, Anadolu Universitesi Fen Fakültesi Matematik Bölümü, 26470, Eskisehir, Turkey, iatasever@anadolu.edu.tr, Yalcin Kucuk, Mahide Kucuk

The notion gw-subdifferential for vector valued functions was defined and necessary and sufficient conditions for gw-subdifferentiability of nonconvex vector valued functions were given by Küçük et. al. (2011). In this work, we examine relations between radial epiderivative defined by Kasimbeyli (2009) and gw-subdifferential of vector valued functions. Furthermore, under some assumptions, we proved that the radial epiderivative of a vector valued function is an element of the supremum of the set which is defined by using gw-subgradients of the given function.

4 - Minkowski-Radstrom-Hormander cone and reducing infinite exhausters

Jerzy Grzybowski, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Wieniawskiego 1, 61-712, Poznan, Poland, jgrz@amu.edu.pl, Ryszard Urbanski, Mahide Kucuk, Yalcin Kucuk, Ilknur Atasever, Mustafa Soyertem, Didem Tozkan

We introduce the notion of generalized Minkowski-Radstrom-Hormander cone. We also embed the convex cone $C(X)$ of all nonempty closed convex subsets of real Hausdorff topological vector space X and the convex cone $W(\mathbb{R}^n)$ of all nonempty convex subsets of \mathbb{R}^n into respective Minkowski-Radstrom-Hormander cones. We also present equivalent conditions for reducing infinite exhausters of closed convex sets to a pair of convex sets (an element of Minkowski-Radstrom-Hormander cone).

■ MA-23

Monday, 8:30-10:00

RB-Delta

Generalized Differentiation

Stream: Generalized Differentiation and Optimization
Invited session

Chair: Alexander Kruger, School of Science, Information Technology & Engineering, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au

Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - On Weak Subdifferentials and Exhausters

Mustafa Soyertem, Mathematics, Anadolu University, Anadolu University Yunus Emre Campus Department of Mathematics, 26470, Eskisehir, Turkey, soyertem@gmail.com, Mahide Kucuk, Ryszard Urbanski, Jerzy Grzybowski, Yalcin Kucuk, Ilknur Atasever, Didem Tozkan

■ MA-24

Monday, 8:30-10:00

CC-A11

Cooperation and Logistics

Stream: Game Theory and Logistics
Invited session

Chair: Ignacio García-Jurado, Department of Mathematics, Coruna University, Faculty of Computer Science, Campus de Elvina, 15071, Coruna, Spain, igjurado@udc.es

1 - A polynomial expression for the Owen value in the maintenance cost game

Julian Costa, Faculty of Computer Science, Universidade da Coruña, Campus de Elviña, 15071, A Coruña, Spain, julian.costa@udc.es

The maintenance cost games are a class of cooperative games with transferable utility where the main issue is how to share the maintenance costs of a facility among the agents. We propose the use of the Owen value for the cost allocation problem associated with a game in this class when there is a system of a priori unions. In the general case, the Owen value has exponential complexity. In this paper, we provide a cubic polynomial expression for the Owen value of a maintenance cost game with a priori unions.

2 - Minimum cost Steiner tree problems

Silvia Lorenzo-Freire, Department of Mathematics, Universidade da Coruña, Campus de Elviña, 15071, A Coruña, Spain, slorenzo@udc.es, *Gustavo Bergantinos*, *Leticia Lorenzo*, *Juan Vidal-Puga*

Consider a group of agents located at different geographical places that are interested in some resource provided by a common supplier. Agents can be served directly from the supplier or indirectly through other agents or public switches. The first problem that we need to solve is how to provide all the agents with the resource with a minimal cost. This problem is known as the Steiner tree problem and it is NP-hard. So, in order to find a solution, heuristics need to be applied. In this paper, we allocate the cost of constructing this approximated tree among the agents in a stable way.

3 - Scheduling jobs with a common due date via combinatorial games

Irinel Dragan, Mathematics, University of Texas, 411 S.Nedderman Dr., Pickard Hall, 76019-0408, Arlington, Texas, United States, dragan@uta.edu

Scheduling jobs with a common due date as a sequence that has a minimal total deviation from the due date can be done in the simplest case, by means of J.J.Kanet's algorithm (1981). Assuming that it is known how to do it for a given set of jobs and its subsets, we generate a cooperative cost game with transferable utilities. As recommended by H.P. Young in his paper included in Handbook of Game Theory, vol.2, some efficient values are fair solutions and we discuss the fairness by means of the cost excesses. y_{jr} nucleolus is the most fair solution.

4 - On graphs which can or cannot induce Chinese Postman games with a non-empty core

Daniel Granot, University of British Columbia, Vancouver, Canada, daniel.granot@sauder.ubc.ca

We study the Chinese postman (CP) cooperative game induced by a connected, weighted, undirected graph G , wherein players reside at edges of G and a postman, starting from a post-office location (i.e., vertex of G), needs to traverse all edges before returning to the post-office. We provide a complete characterization of all connected graphs for which there exists a positive edge-cost function such that the induced CP game has a non-empty core, and, consequently, we derive a complete characterization of all connected graphs for which there does not exist a positive edge-cost function which induces a CP game with a non-empty core. Membership in these classes of graphs can be verified in strongly polynomial time.

■ MA-25

Monday, 8:30-10:00

CC-A23

Energy Distribution: Planning and Optimization

Stream: Energy, Environment and Climate 1
Contributed session

Chair: *Carmen Anido*, Economic Analysis: Quantitative Economy, Autonoma University of Madrid, Faculty of Economics, Cantoblanco., 28049, Madrid, Spain, carmen.anido@uam.es

1 - Unit Commitment optimisation through matheuristics

Ana Viana, INESC TEC/ISEP, Campus da FEUP, Rua Dr. Roberto Frias, 4220-465, Porto, Portugal, aviana@inescporto.pt, *Dewan Fayzur Rahman*, *Joao Pedro Pedroso*

Unit Commitment is a classical problem in power production planning, consisting of deciding which electric generators must be committed to production in each period of a given planning horizon, and defining the production level at which each generator should operate. In this work two approaches are explored: one based on "Local Branching" and another where a Particle Swarm Optimisation (PSO) algorithm cooperates with the MIP solver. Thorough computational tests in a well-known set of benchmark instances show the effectiveness of the approaches.

2 - Optimising Distributed Energy Operations in Buildings

Afzal Siddiqui, Statistical Science, University College London, Gower Street, WC1E 6BT, London, United Kingdom, afzal.siddiqui@ucl.ac.uk, *Markus Groissböck*, *Somayeh Heydari*, *Ana Mera Vazquez*, *Eugenio Perea Olabarria*, *Michael Stadler*

Deregulation of the energy sector has created new markets for producers as well as opportunities for consumers to meet their needs in a more customised way. However, to realise economic and energy efficiency gains, small-scale consumers at the building level require more tailored decision support. We model the effect of active equipment control on the zone temperature taking into account the external temperature, solar gains, the building's shell and internal loads. These serve as constraints in a cost-minimisation problem, providing an optimal dispatch for installed equipment.

3 - Compatibility of optimized distributed storage profiles for grid operators and energy traders

Stefan Nykamp, University Twente, NL / RWE Deutschland, Bad Bentheim, Germany, stefannykamp@web.de

The implementation of storage capacities in power grids is seen as an essential element for a successful integration of PV and wind generation. Also on distribution grid level storage capacities are evaluated and installed in pilot projects to overcome massive reinforcement needs. In this talk, the optimal storage profile of a distribution grid operator with real measured energy profiles is presented. This peak shaving scenario is compared to an optimal storage profile of an energy trader with arbitrage purposes. The correlation analysis reveals complementary or supplementary operating modes.

4 - A hybrid genetic algorithm for the optimal allocation of remote controlled switches in radial distribution system

Laura Assis, DENISIS, Universidade Estadual de Campinas, Avenida Albert Einstein n 400 - Cidade Universitária Zeferino Vaz - Barão Geraldo - Campinas - São Paulo - Brasil, 13081-970, Campinas, SP, Brazil, laura.assis@gmail.com, *Fábio Usberti*, *Christiano Lyra*, *Fernando J. Von Zuben*, *José Federico Vizcaino*

Regulatory agencies define target reliability indices to increase the quality of electrical power supply. These indices can be improved with the solution of specific combinatorial optimization problem. This work tackles the problem of finding the best number, location and type of switches to be installed in a radial power distribution network. The objective is to improve system reliability, while minimizing the total cost of the solution. An effective hybrid genetic algorithm that evaluates and optimizes the allocation of remote controlled sectionalizers and tie switches is proposed.

■ MA-26

Monday, 8:30-10:00

CC-A24

OR Applications in Oil and Gas

Stream: OR in the Oil and Gas Sectors
Invited session

Chair: *Krystina Bakhrankova*, Applied economics, SINTEF -

Technology and society, Box 4760 Sluppen, S. P. Andersens veg 5, 7465, Trondheim, Norway, krystsina.bakhrankova@sintef.no

1 - Stochastic MIP modeling of a natural gas-powered industrial park

Gerardo Perez Valdes, IOT, NTNU, Trondheim, Norway, gerardo.valdes@iot.ntnu.no, *Kjetil Midthun*, *Michal Kaut*, *Vibeke Nørstebø*

We present an investment decision model for a natural gas-based industrial park. The model is a stochastic MIP model with random prices of raw materials. The potential plants in the park are modeled from a case study from Norway, whose motivation is to consider the potential for increasing the domestic use of natural gas. Natural gas is abundant in the country, but its domestic use is limited due to both availability of other energy sources and concerns over carbon emissions. Our results have an emphasis on showing model properties in terms of model size and solution times.

2 - Strategic behaviour in the crude oil market - one-stage vs. two-stage oligopoly models

Daniel Huppmann, DIW Berlin, Mohrenstraße 58, 10117, Berlin, Germany, dhuppmann@diw.de, *Clemens Haftendorn*

Oligopoly-fringe models are used to investigate market power in resource markets, combining Cournot and competitive suppliers in a mixed complementarity setting. While computationally convenient, this may lead to results that are not Nash equilibria. We investigate which situations are particularly problematic, and under which circumstances these results are similar to two-stage games. We also revisit tax models of resource extraction as an alternative approach to model oligopoly-fringe markets. Several model setups are then compared using data on the crude oil market over the past decade.

3 - Stochastic mixed integer programming for integrated portfolio planning in the LNG supply chain

Kristin Tolstad Uggem, Applied economics and operations research, SINTEF Technology and society, S.P. Andersens v 5, 7465, Trondheim, Norway, ktu@sintef.no, *Adrian Werner*, *Marte Fodstad*, *Arnt-Gunnar Lium*

We present a model to support strategic planning by global players in the liquefied natural gas market. The model takes an integrated portfolio perspective and addresses uncertainty in future price developments. Decision variables include investments and disinvestments in infrastructure and vessels, chartering of vessels, the timing of LNG and natural gas contracts, and spot market trades. Industry-motivated numerical cases are discussed to provide benchmarks for the potential increases in profits that can be obtained.

4 - Modeling gas infrastructure investments under uncertainty

Ozge Ozdemir, ECN, Netherlands, ozdemir@ecn.nl, *Jeroen de Joode*

A continuous challenge for gas infrastructure companies across Europe is to optimally accommodate the future need for gas infrastructure investments given the uncertainties in gas markets. These uncertainties may originate from the role for gas in the future energy mix, global gas market developments (e.g., shale gas), and the possible cut-offs by a major supplier which threats security of supply. This paper explores how these uncertainties can be tackled and the outcomes can be translated into robust strategies that prevent undesirable gas market outcomes in a range of possible scenarios.

■ MA-27

Monday, 8:30-10:00
CC-A25

Empirical Research on Decision Processes - Methods & Findings

Stream: Decision Processes
Invited session

Chair: *Gilberto Montibeller*, Dept. of Management, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, g.montibeller@lse.ac.uk

1 - Exploring IT project managers' decision making processes in-situ, in-actu, in-toto: an empirical study of day-to-day decision making in medium size software development

Ana Barcus, Management, LSE, 65 Melbourne Ave, M6K 1K6, Toronto, Ontario, Canada, A.Barcus@LSE.ac.uk

This research explores real-time decision-making during the delivery phase of small to medium size software development projects. The empirical research was conducted in two software companies, recording regular day-to-day project meetings. Twelve software projects were tracked, totaling 144 recorded project meetings, resulting in over 94 hours of data. Seventeen decision episodes, spanning over a number of meetings, were identified in-actu. The study examines in more detail how the perception of contextual factors impacts on project team's decision making processes.

2 - The impact of need for closure on model-supported group conflict management

Etiene Rouwette, Nijmegen School of Management, Radboud University Nijmegen, 6500 HK, Nijmegen, Netherlands, e.rouwette@fm.ru.nl, *L. Alberto Franco*

Need for closure, the desire for definite knowledge on some issue, has important impacts on decision making. Decision makers those are high in need for closure seize on information and then freeze on early cues. We focus on the impact of need for closure on conflicts in decision making groups. The groups in our study use Value Focused Thinking to jointly develop a model. We compare groups high and low in need for closure with regard to a) conflicts and how these are resolved; b) how features of the model are used and c) group outcomes such as consensus and satisfaction.

3 - Post-catastrophe decision making

Ian Durbach, Statistical Sciences, University of Cape Town, Department of Statistical Sciences, University of Cape Town Rondebosch, 7701, Cape Town, Western Cape, South Africa, ian.durbach@uct.ac.za, *Gilberto Montibeller*

Unexpected high-impact events present decision makers with dramatic new information but also highlight their previous state of ignorance about the nature of possible outcomes, termed 'sample state ignorance'. We examine post-catastrophe decision making using an experiment based on a simplified decision context. In the experiment, decision makers need to predict share prices and experience, for some series, catastrophic falls in prices. We assess the impact of confronting such events on two dimensions of judgement and decision making: the range of future estimates and attitudes towards risk.

■ MA-28

Monday, 8:30-10:00
CC-A27

OR in Quality Management 1

Stream: OR in Quality Management
Invited session

Chair: *Ipek Deveci Kocakoç*, Econometrics, Dokuz Eylul University Faculty of Economics and Administrative Sciences, Dokuz Eylul Universitesi Ikt.Id.Bil.Fak., Buca, 35160, Izmir, Turkey, ipek.deveci@deu.edu.tr

1 - Dealing with multiple quality characteristics as responses in prediction modeling: An aggregation approach

Leman Esra Dolgun, Industrial Engineering, Anadolu University, 26555, Eskisehir, Turkey, ledolgun@anadolu.edu.tr, *Gulser Koksak*, *Nimetullah Burnak*

This study deals with aggregation of multiple quality characteristics (QCs) into a single measure reflecting the decision maker's expertise. Types of interactions among QCs are identified through structured surveys with quality control experts, designed in this study. Appropriate aggregation models are proposed for the single measure representing the multiple QCs, depending on the identified interactions. Any (single response) prediction model can be used to relate product and process conditions to the resulting measure. Such a model provides valuable feedback for quality improvement.

2 - A supervised learning procedure for monitoring mean and covariance simultaneously

Ipek Deveci Kocakoç, Econometrics, Dokuz Eylul University Faculty of Economics and Administrative Sciences, Dokuz Eylul Universitesi İkt.Id.Bil.Fak., Buca, 35160, Izmir, Turkey, ipek.deveci@deu.edu.tr, *Eralp Dogu*

The signal issued by the simultaneously used mean vector control chart and/or covariance matrix control chart triggers the process professionals to investigate the special cause. This signal does not always indicate that the root cause actually occurred at that particular point in time. Change point methods have been widely used to bridge the gap between monitoring and special cause identification. In this study, a supervised learning approach based on artificial neural networks is proposed to monitor location and dispersion simultaneously in multivariate domain.

3 - Optimization on selection problem of solder paste inspection machines

Gokce Baysal, Econometrics, Dokuz Eylul University, İktisadi ve İdari Bilimler Fakültesi, Ekonometri Bl., Dokuzcesmeler Kampusu, Buca, 35160, İzmir, Turkey, gokce.baysal@gmail.com, *Ipek Deveci Kocakoç*

One of the most important factors to give an inspection automation decision is the rate of false decisions made by the inspection machine. This paper aims to provide help in selection of a solder paste inspection (SPI) machine for a printed circuit board (PCB) production line. For this purpose, two SPI machines have been tested for the same PCBs. After inspection, false "fail" decisions are reviewed by a qualified human inspector and false rejection rate is determined. By utilizing a minimization model, the machine that gives the lowest false decisions is recommended for buying.

4 - An adaptive Bayesian scheme for joint monitoring of process mean and variance

George Nenes, Mechanical Engineering, University of Western Macedonia, Bakola & Sialvera, 50100, Kozani, Greece, gneses@uowm.gr, *Sofia Panagiotidou*

We present a model for the economic optimization of a process operation where two assignable causes may occur, affecting both the process mean and the variance. Thus, the process may operate in control, under the effect of either one of the assignable causes, or under the effect of both of them. The Bayes theorem is used to determine the probabilities of operating under the effect of each assignable cause, at each sampling instance. Based on these probabilities, the parameters of the control scheme are optimized economically. The proposed model is significantly superior to simpler approaches.

2 - Cutting Planes from a Convex Quadratic Relaxation of the Stable Set Problem

Fabrizio Rossi, Ingegneria e scienze dell'Informazione e Matematica, University of L'Aquila, Via Vetoio, I-67010, L'Aquila, Italy, fabrizio.rossi@univaq.it, *Monia Giandomenico*, *Adam Letchford*, *Stefano Smriglio*

A great deal of research has been focused on finding both linear and semidefinite relaxations for the Stable Set problem, but the resulting branch-and-bound algorithms have not been completely successful in practice. We propose an approach based on the construction of an ellipsoid that (i) contains the Stable Set Polytope, and (ii) whose associated upper bound equals the Lovász theta number. This ellipsoid is then exploited to derive strong (linear) cutting planes. Extensive computational results demonstrate that embedding these cutting planes in a branch-and-cut framework can be profitable.

3 - Nonstandard Semidefinite Bounds For Solving Exactly 0-1 Quadratic Problems

Frederic Roupin, LIPN, CNRS-UMR 7030, Université Paris 13, 99 avenue, Jean-Baptiste Clément, 93430, Villetaneuse, France, frederic.roupin@lipn.univ-paris13.fr, *Nathan Krislock*, *Jerome Malick*

We present an improved algorithm for finding exact solutions to Max-Cut and other binary quadratic programming problems. The algorithm uses a branch-(and-cut-)and-bound paradigm, using standard valid inequalities and nonstandard semidefinite bounds. More specifically, we add a quadratic regularization term to the strengthened semidefinite relaxation in order to use a quasi-Newton method. The ratio of the tightness of the bounds to the time required to compute them can be controlled by two real parameters.

4 - On the Gap Inequalities for the Max-Cut Problem

Adam Letchford, Department of Management Science, Lancaster University, Management School, LA1 4YX, Lancaster, United Kingdom, A.N.Letchford@lancaster.ac.uk, *Laura Galli*, *Konstantinos Kaparis*

The gap inequalities, introduced by Laurent and Poljak, form an extremely general class of cutting planes for the max-cut problem. Recently, we have made several advances in the study of these inequalities. First, we have adapted them to general mixed-integer quadratic programs. Second, we have proved various results concerned with the complexity of the inequalities. Third, we have designed and coded the first ever cutting-plane algorithm for the max-cut problem based on gap inequalities. Preliminary computational results are promising. In particular, the upper bounds obtained are very strong.

■ MA-29

Monday, 8:30-10:00

CC-A29

Mixed-Integer Quadratic Problems

Stream: Mixed-Integer Non-Linear Programming
Invited session

Chair: *Adam Letchford*, Department of Management Science, Lancaster University, Management School, LA1 4YX, Lancaster, United Kingdom, A.N.Letchford@lancaster.ac.uk

1 - A New Separation Algorithm for the Boolean Quadratic and Cut Polytopes

Michael Sørensen, Dept. of Economics and Business, Aarhus University, Fuglesangs Alle 4, 8210, Aarhus V, Denmark, mim@asb.dk, *Adam Letchford*

We present separation algorithms for the polytopes associated with zero-one quadratic programming and the max-cut problem. Our approach is based on separation of 0,1/2-cuts. We present a system of weakened linear inequalities for the Boolean quadratic polytope that is closed under switching, and which allows the 0,1/2-separator to run in polynomial time. Using the so-called covariance mapping, we obtain an efficient separation algorithm for the cut polytope as well. The latter algorithm separates all odd bicycle wheel and all (p,2)-circulant inequalities.

■ MA-30

Monday, 8:30-10:00

CC-A31

Fat Tail Models in Finance

Stream: Emerging Applications of Fat Tail Models in Financial Modeling and Engineering
Invited session

Chair: *Audrius Kabasinskas*, Dept. of Mathematical Research in Systems, Kaunas University of Technology, Studentu 50-220, LT - 51368, Kaunas, Lithuania, audrius.kabasinskas@ktu.lt

1 - Application of estimates of alpha-stable distribution to distress forecast

Audrius Kabasinskas, Dept. of Mathematical Research in Systems, Kaunas University of Technology, Studentu 50-220, LT - 51368, Kaunas, Lithuania, audrius.kabasinskas@ktu.lt, *Zivile Kalsyte*

Application of alpha-stable distribution parameters to train a specific neural network is presented. Trained neural network was used to forecast behavior of distress in the US Healthcare sector. Distress value of a company is calculated from financial ratios Gross Margin (GM), Current Ratio (CR) and Total Asset Turnover (TAT). Indicators for prediction of distress value were selected by genetic algorithm. Our results shows that neural network trained with alpha-stable parameters of given indicators has smaller forecast error comparing to trained with 31 financial ratios.

2 - Hurst coefficient and alpha-stable parameter for analysis of financial series

Roman Rodriguez Aguilar, Economy, Instituto Politecnico Nacional, kopoma 523, toltecas 166, C-1013, 14100, Mexico, Distrito Federal, Mexico, roman_econmat@yahoo.com.mx

This paper analyzes the relationship between the parameter alpha of alpha-stable distribution and the Hurst coefficient. It seeks to explore the violation of two major assumptions in the modeling of financial series (assume that the series are normally distributed and that the successive returns are independent) by estimating the Hurst coefficient and the parameter alpha. One of the main results was the presence of fractal features and heavy tails in the serie of exchange rate peso-dollar for some periods in different magnitudes, such differences are accentuated during periods of crisis.

3 - Xpress-Mosel: Modelling support for distributed, remote, and cloud computing with applications in Finance

Susanne Heipcke, Xpress team, FICO, 54 rue Balthazar de Montron, 13004, Marseille, France, susanneheipcke@fico.com, Oliver Bastert, Yves Colombani

Xpress-Mosel is a modelling and programming language that offers advanced functionality for the implementation of optimization algorithms and also for the design of complete applications. Among the prominent features of Mosel figures its support for distributed modeling and problem solving on heterogeneous computing environments (including virtual environments). We shall discuss examples of optimization applications, particularly from the finance sector, that have been deployed using these advanced functionalities of the Mosel environment.

4 - High-Frequency Financial Data: A Mixed-Stable approach

Audrius Kabasinskas, Dept. of Mathematical Research in Systems, Kaunas University of Technology, Studentu 50-220, LT - 51368, Kaunas, Lithuania, audrius.kabasinskas@ktu.lt, Igoris Belovas, Leonidas Sakalauskas

With the introduction of electronic trading an enormous quantity of trading data became available. High-frequency financial data can reveal events and laws that are impossible to identify with monthly, weekly or daily data. We propose a mixed-stable approach to model intra-daily data from German DAX component stocks returns. In practice we often observe a large number of zero returns in high-frequency return data due to the underlying asset price does not change at a given very short time intervals. Our model is designed to capture these unique features observed in high-frequency return data.

2 - Centrality in Weighted Social Networks. A Game Theoretic Approach.

Conrado M. Manuel, Statistics and Operation Research III, Complutense University of Madrid, Avenida Puerta de Hierro s/n, 28040, Madrid, Spain, conrado@estad.ucm.es, Enrique González-Aragüena

We consider the case of networks in which ties are not just either present or absent, but have some weight attached to them, that we will interpret as a function of duration, intimacy or intensity of the relations. Moreover, we will suppose that actors in the network are also players in a cooperative TU game representing the interests that motivate their interactions. We propose as centrality measure for each node its probabilistic Myerson value (Calvo et al., 1999 and Gómez et al., 2008) assuming that the game is a symmetric one and thus, no a priori differences among players exist.

3 - Clustering networks by a new edge betweenness measure: A cooperative game theoretical approach

Daniel Gomez Gonzalez, Estadística e Investigación Operativa III, Complutense University, Av Puerta de Hierro, 28040, Madrid, Spain, dagomez@estad.ucm.es, Javier Castro

The Girvan-Newman algorithm is one of the most used algorithms in clustering networks. This algorithm is based on the edge betweenness measure. In this work we present a new centrality measure based on game theory that fixes the bad performance (in terms of modularity) that presents the classical edge betweenness measure when it is applied to the Girvan-Newman algorithm. We test this new measure in some well-known examples in clustering network as: the Karate Club network, the author network, the dolphin network and Les miserables network.

4 - Computing centralities and the Myerson value in large social networks

Juan Tejada, Estadística e Investigación Operativa I, Complutense University of Madrid, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, jtejada@mat.ucm.es, Javier Castro, Daniel Gomez Gonzalez, Elisenda Molina

We present an approximate, but surprisingly accurate, method for calculating the Myerson value. This value is computable in polynomial time for most of the games used to measure the centrality or importance of a node in a network. The proposed method will be used in known problems in order to measure the error and in real large problems in order to prove its usefulness. The methods presented here can calculate, with the same accuracy, the Myerson value of any type of game. The complexity is polynomial if the calculation of the characteristic function is computable in polynomial time.

■ MA-31

Monday, 8:30-10:00

CC-A33

Game Theory and Social Networks 1

Stream: Game Theory and Social Networks

Invited session

Chair: Juan Tejada, Estadística e Investigación Operativa I, Complutense University of Madrid, Universidad Complutense de Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, jtejada@mat.ucm.es

1 - Analysis of Network Formation with Learning Dynamics

Michiharu Masui, Business Administration, Ishinomaki Senshu University, 1 Shinmito Minamizakai, 9868580, Ishinomaki, Japan, masui@isenshu-u.ac.jp

In a game theoretic context, it is assumed that the decision maker has perfect rationality. However, recently, many studies have restricted the perfect rationality or the structure of the game. These restrictions are called bounded rationality. In this study, we denote bounded rationality by learning dynamics and complex networks. Learning dynamics and complex networks are widely used to describe the real world. The purpose of this study is to examine the behavior of the decision maker with learning dynamics and the formation of networks by the interaction of decision makers.

■ MA-32

Monday, 8:30-10:00

CC-A34

Combining Methods & Multimethodology

Stream: Soft OR and Problem Structuring Methods

Invited session

Chair: Alberto Paucar-Caceres, Business School, Manchester Metropolitan University, Aytoun Building, Aytoun Street, M1 3GH, Manchester, United Kingdom, a.paucar@mmu.ac.uk

1 - Combining hard-soft OR for generative design thinking

Polyxeni Vassilakopoulou, Mechanical Engineering, National Technical University of Athens, Heron Polytechniou 9., Zografou, 15780, Athens, Greece, xvasil@central.ntua.gr, Vassilis Tsagkas, Nicolas Marmaras

We aim to contribute to design research combining hard-soft OR to support circles of convergent-divergent thinking. We build upon system approaches (Churchman 1971; Ackoff 1974; Checkland 1981) and use established OR techniques to nurture explorative, generative design (Martin 2009). We illustrate with a case from banking. Unlike

Mingers et al 2009, we start with DEA modeling to probe questioning of the initial briefing (using different input-output arrangements) bringing to surface different worldviews and continue with SSM to develop purposeful activity models that guide the design process.

2 - Contrasting the 'expected' versus 'realized' benefits of multi-methodology

Felipe Henao, Faculty of Management Science and Economy, Universidad Icesi, Universidad Icesi, Calle 18 # 122 - 135, Pance, 760031, Cali, Valle del cauca, Colombia, jfhenao@icesi.edu.co, *L. Alberto Franco*

Multi-Methodology has been extensively employed by OR/MS scholars to cope with the complexity of real-world situations. The literature has focused on how to design interventions and the challenges faced by OR researchers in deploying MM in practice. However, little attention has been paid to assess MM's impacts from the participants' perspective and there is little understanding of the link between MM's expected and realized benefits. This paper addresses this gap by comparing the intervention's expected versus realized impacts, and relate those to relevant group decision theory.

3 - Applying Soft Systems Methodology and Systems Dynamics to Environmental Management: A boundary critique framework

Alberto Paucar-Caceres, Business School, Manchester Metropolitan University, Aytoun Building, Aytoun Street, M1 3GH, Manchester, United Kingdom, a.paucar@mmu.ac.uk, *Diane Hart*, *Ricardo Rodriguez-Ulloa*

We introduce the use of Ulrich's Critical Systems Heuristics to organize second order critical reflexion in systems practice and action research. The paper draws on critical systems thinking and illustrates its application in the context of an intervention using Soft Systems Methodology (SSM) and Systems Dynamics (SD) to evaluate the environmental impact of mining operations in southern Peru. We sketch the context in which the systemic intervention was carried out reporting on the initial SSM and SD stages to outline a 2nd order boundary critique tool for systemic interventions.

4 - Structuring Community Issues - working with community members to identify and (re)structure local problematic issues

Rebecca Herron, Community Operational Research Unit, University of Lincoln, LN6 7TS, Lincoln, United Kingdom, rherron@lincoln.ac.uk

Problem Structuring Methods often take as their starting point a stakeholder group and an issue requiring exploration. Community OR specifically works with groups of community members — taking as one of its meta-goals the establishment of community-based activities that explore and develop problematic notions such as 'the common good'. We give an example, highlight how workshops can be developed flexibly in community settings, and the issue of how we can measure the impact of our interventions.

■ MA-33

Monday, 8:30-10:00

CC-A37

OR for Business and Industrial Development

Stream: OR for Development and Developing Countries

Invited session

Chair: *Honora Smith*, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, honora.smith@soton.ac.uk

Chair: *Tatjana Staube*, Institute of Civil Construction and Real Estate Economics, Riga Technical university, 1/7 Meza Street; Room 210, LV1048, Riga, Latvia, tatjana.staub@gmail.com

1 - Mining Industrial Transformations and Resource Re-Allocation Using a New MCDM Model – Case of Taiwan and Poland

Mei-Chen Lo, National United University, 360, Miaoli, Taiwan, meichen_lo@yahoo.com, *Gwo-Hshung Tzeng*, *Tian-Jong Hwu*, *Jerzy Michnik*, *Tadeusz Trzaskalik*, *Maciej Nowak*

Technology change dynamically and rapidly, therefore the industrial transformation become an important issues for appropriate resource allocations as well as rearrangement of its usefulness. In this study, the related concerns are discussed, and a hybrid MCDM model based on DANP is used to assess the mining industrial transformation relative performance viewed by different groups of experts from Taiwan and Poland. The procedures find the improvement directions and efficient allocations of resources for the mining industrial transformations to achieve the aspiration levels.

2 - Using DEA to Inform an Integrated Response to Policy Change: The Case of the South African Private Hospital Industry

Shivani Ramjee, Actuarial Science, University of Cape Town, Room 5.40, Robert Leslie Commerce Building, 7700, Cape Town, Western Cape, South Africa, shivani.ramjee@uct.ac.za

The private hospital sector in South Africa has been criticized for their perceived role in rising private medical expenditure and the associated health-system inefficiencies. We use DEA to aid this sector in formulating an integrated response to National Health Insurance policy proposals. Operational, financial and clinical data for 43 hospitals for 2007-2009 was used. It is clear that case-mix and quality of care data are critical to engaging with policymakers. We identify the need for private hospitals to be permitted to employ doctors and highlight the constraint posed by nurse attrition.

3 - Determining the Position of E7 Countries among Developing Countries by Kohonen Networks

Hüseyin Tatlıdil, Statistics, Hacettepe University, Hacettepe Üniversitesi Beytepe Kampusu İstatistik Bölümü, Beytepe, 06532, Ankara, Turkey, tatlidil@hacettepe.edu.tr, *Nurbanu Bursa*

In this study, developing 100 countries, grouped as low-middle and upper-middle income categories on the database of the World Bank, are clustered to their infrastructure investment sizes between the data of years 1990 and 2011 by using Kohonen Networks and it is found in which clusters Brazil, China, India, Indonesia, Mexico, Russia and Turkey known as E7 countries are. As Kohonen Networks cannot form a set of rules, C&RT Decision Tree is applied. Also, it is aimed to find the geometric locations of E7 countries and the countries in the same clusters as them through Multidimensional Scaling.

4 - Does Latvia use its advantageous location?

Tatjana Staube, Institute of Civil Construction and Real Estate Economics, Riga Technical university, 1/7 Meza Street; Room 210, LV1048, Riga, Latvia, tatjana.staub@gmail.com, *Ineta Geipele*

As small scale country with 0.5% from EU population and 70 times larger than Liechtenstein Latvia has economically advantageous geographical location linking large and powerful investors countries like Russia and Scandinavian states block. Latvia could cumulate all its force on servicing these big neighbors, but it does not. For this purpose it must have strong professional specialists and well developed infrastructure. The rating of local specialists has been remarkably rising for the latest decade due to integration into Europe and Latvian inhabitants' natural ambitious leadership.

■ MA-34

Monday, 8:30-10:00

CC-A39

Game Solutions

Stream: Cooperative Game Theory

Invited session

Chair: *Encarnación Algaba*, Applied Mathematics II, Seville University, C/Camino de los Descubrimientos s/n, Isla de la Cartuja., 41092, Sevilla, Spain, ealgaba@us.es

1 - Equilibria in Load Balancing Games

Bo Chen, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, b.chen@warwick.ac.uk

A Nash equilibrium (NE) in a multi-agent game is a strategy profile that is resilient to unilateral deviations. A strong Nash equilibrium (SE) is one that is stable against coordinated deviations of any coalition. We show that, in the load balancing games, NEs approximate SEs well in the sense that the benefit of each member of any coalition from coordinated deviations is quantifiably quite limited. Furthermore, an easily recognizable special subset of NEs exhibit even better approximation of SEs. To establish the above results, we introduce and apply a powerful graph-theoretic tool.

2 - Dealing with time issues in testing revealed preference axioms

Fabrice Talla Nobibon, Decision Sciences and Information Management, KU Leuven, Naamsestraat 69, 3000, Leuven, Belgium, fabrice.tallanobibon@econ.kuleuven.be, *Yves Crama*, *Frits Spieksma*

This paper proposes a graph-coloring approach for dealing with the problem of testing revealed preference axioms while taking into account the timing of the observations. We translate well-known axioms of the revealed preference theory into graph properties leading to a generalized graph coloring problem with an additional vertex ordering constraint. We derive a greedy algorithm for solving the problem when the obtained graph property is hereditary, and a dynamic programming algorithm when the property is not hereditary. In both cases if the property can be verified in polynomial time then these algorithms also run in polynomial time.

3 - Equilibrium, coalitive and computational aspects of Pareto-Nash-Stackelberg Games

Valeriu Ungureanu, Department of Applied Mathematics, State University of Moldova, Gh. Asachi str., 58, ap.38, MD-2009, Chisinau, Moldova, Republic Of, v.a.ungureanu@gmail.com

Equilibrium Principles for Hierarchical and Mixture of Hierarchical and Simultaneous Games are defined and examined by the means reaction sets, efficient reaction sets and its intersection. The set of equilibria normally consists by more than one element and may have the cardinality of the continuum. If all players form a coalition, they apply usually the criterion of Pareto optimality. Otherwise, there are a lot of other possibilities. So, equilibrium, coalitive and computational aspects of Pareto-Nash-Stackelberg Games are treated.

4 - Harsanyi power solutions for union stable systems

Encarnación Algaba, Applied Mathematics II, Seville University, C/Camino de los Descubrimientos s/n, Isla de la Cartuja., 41092, Sevilla, Spain, ealgaba@us.es, *Jesus-Mario Bilbao*, *Rene van den Brink*

This paper analyzes solutions for games in which partial cooperation is based on union stable systems. In this context, we provide axiomatic characterizations of the Harsanyi power solutions which distribute the Harsanyi dividends proportional to weights determined by a power measure for union stable systems. Moreover, the Myerson value is the Harsanyi solution for the equal power measure and on a special subclass the position value coincides with the Harsanyi solution obtained for the influence power measure.

■ MA-35

Monday, 8:30-10:00

CC-A41

OR Industry; OR Software

Stream: OR in Industry and Software for OR (contributed)

Contributed session

Chair: *Belarmino Adenso-Diaz*, Engineering School at Gijón, Universidad de Oviedo, Campus de Viesques, 33204, Gijón, Spain, adenso@epsiv.uniovi.es

1 - High-performance local search for TV media planning on TF1

Frédéric Gardi, e-lab, Bouygues SA, 40 rue Washington, 75008, PARIS, France, fgardi@bouygues.com

In 2012, the leading French TV Channel TF1 launched a new offer consisting in selling some packages of commercials, and not only commercials individually. In this offer, TF1 is responsible for planning the advertising campaigns of its clients while satisfying some audience and budget constraints, in others. Having outlined the resulting combinatorial optimization problem, we present the high-performance local-search heuristic developed by the Bouygues e-lab to solve it. This algorithm is daily used by TF1 to automate and optimize the sale of nearly 100,000 commercials per year.

2 - Cost optimization in planning the dubbing of a film

M^a Luisa Carpena, Matemáticas, Universidade da Coruña, Facultade de Informática. Campus de Elviña, 15071, A Coruña, Spain, luisacar@udc.es, *Ana Cerdeira-Pena*, *Silvia Lorenzo-Freire*

In this paper we propose a binary programming model for optimizing costs in a dubbing studio. This cost is directly related to the planning of the dubbing of a film. The model, programmed using the package AIMMS, can always obtain optimal schemes for a wide range of films. Despite this, the time for obtaining many of the solutions is not entirely satisfactory for practical handling in the production. That is why we have designed an alternative algorithm that obtains optimal schemes in few seconds.

3 - Multistage Multiproduct Advertising Budgeting

Cesar Beltran-Royo, Estadística e Investigación Operativa, Universidad Rey Juan Carlos, Calle Tulipán, s/n, 28933, Móstoles, Madrid, Spain, cesar.beltran@urjc.es, *Huizhen Zhang*, *Luis Blanco*, *Jose Almagro*

In this paper we present a market optimization model to allocate the annual advertising budget in a multisage setting. Market response models allow to estimate the effect that marketing mix variables have on performance measures, such as sales or market share. Market optimization models combine utility functions with market response models in order to find an optimal marketing mix. We analyze the concavity properties of this (non-linear optimization) model and present some numerical examples that show its effectiveness in order to be used in the advertising industry.

■ MA-36

Monday, 8:30-10:00

CC-A43

DEA and Performance Measurement: Methodology 1

Stream: DEA and Performance Measurement

Invited session

Chair: *Timo Kuosmanen*, Aalto University School of Economics, 00100, Helsinki, Finland, timo.kuosmanen@aalto.fi

1 - Aggregation in cross-efficiency evaluations with induced ordered weighted averaging (IOWA) operators

Inmaculada Sirvent, Centro de Investigación Operativa, Universidad Miguel Hernández, Avd. de la Universidad, s/n, 03202, Elche, Alicante, Spain, isirvent@umh.es, *Teresa Leon*, *Nuria Ramón*, *José L. Ruiz*

We propose an enhancement of the cross-efficiency evaluation through the aggregation of cross-efficiencies by using induced ordered weighted averaging (IOWA) operators. To be specific, an ordering is to be induced in the rows of the matrix of cross-efficiencies, so the IOWA operator weights can be attached accordingly. Both the choice of the criterion that induces such ordering and the specification of the orness degree allow the DM to incorporate his/her preferences on the relative importance that should be attached to the cross-efficiencies provided by the different DMUs.

2 - Performance Measurement Tools for HR Management related Processes based on System Identity Analysis

Jitka Civinova, Department of Informatics and Telecommunications, Czech Technical University, Czech Republic, Jitka.Civinova@seznam.cz

System identity method is a tool enabling the identification of operation critical subjects and parameters. The aim of this paper is to design a set of measurement techniques to control these potential weak points in the process related to the knowledge management and to provide the best solution to stabilize them. The term stable system defines a system that can be for its reliability and objectivity applied repeatedly without scattering resulting values. By monitoring individual elements of the process, the optimization of complex process is achieved.

3 - One-stage and two-stage DEA estimation of the effects of contextual variables

Timo Kuosmanen, Aalto University School of Economics, 00100, Helsinki, Finland, timo.kuosmanen@aalto.fi, *Andrew Johnson*

In two-stage data envelopment analysis (2-DEA) efficiency scores are regressed on z-variables representing operational conditions. We show consistency of 2-DEA under more general conditions than earlier studies. However, the finite sample bias of DEA carries over to the second stage, causing bias in the regression coefficients. Using the fact that DEA is a special case of convex nonparametric least squares, a new one-stage estimator (1-DEA) is developed to directly incorporate z-variables to standard DEA. Monte Carlo simulations show that 1-DEA performs systematically better than 2-DEA.

4 - Estimation Efficiency of Teachers through Data Envelopment Analysis

Venkata Hrd, Business Management, C/O. Prof. Ramana, S.V. University, TIRUPATI, School of Commerce, Management and Computers, 2H/3B, Mayura Apartments, V.V. Plaza, Reddy & Reddy Colony, TIRUPATI, 517501, TIRUPATI, Andhra Pradesh, India, professorhrd@yahoo.com

Data Envelopment Analysis to evaluate the efficiency of faculty based on various faculty attributes and outputs at the student and institute level. The inputs are research grants, feed-back forms, IT, infrastructure, staff assistance, incentives for case, book writings, number of hours spent on seminars or conferences. Outputs are consistency of ranking of institute or teacher, number of books, research papers, case studies published, number of presentations in conferences and seminars and fund development. DMUs are faculty members.

■ MA-37

Monday, 8:30-10:00

CC-Act

Bioinformatics I

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Jacek Blazewicz*, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

Chair: *Metin Turkay*, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr

1 - A data mining case study on brain cancer patients

Fadime Uney-Yuksektepe, Industrial Engineering, Istanbul Kultur University, E5 Karayolu Londra Asfalti Uzeri, Atakoy Kampusu, 34156, Istanbul, Turkey, f.yuksektepe@iku.edu.tr

A data mining study is carried out in order to analyze the brain cancer patients. Previous brain cancer patients' data is taken from an oncologist who works in a neurosurgery department of a private hospital. The aim of the study is to find out useful information that will help the doctors to predict the survival status and survival length of patients. The data set on hand is studied by different data classification algorithms. The most suitable and efficient method is determined and useful rules and models that will help the doctors are obtained.

2 - Markov models of voltage gating of gap junction channels

Henrikas Pranevicius, Business Informatics, Kaunas University of Technology, Studentu 50, Kaunas, Lithuania, henrikas.pranevicius@ktu.lt, *Feliksas Bukauskas*, *Mindaugas Pranevicius*, *Osvaldas Pranevicius*, *Saulius Vaiceliunas*

The major goal of this study was to create a continuous time Markov models of voltage gating of gap junction (GJ) channels formed of connexin protein. This goal was achieved using the piece linear aggregate (PLA) formalism to describe function of GJs and transforming PLA into Markov process. Proposed method was implemented to creating models of voltage gating of GJ channels containing in each hemichannel of the GJ channel fast and slow gating mechanisms, operating between open and closed states.

3 - Inferring two-generation kinship (or genealogy) from microsatellite samples

Tanya Berger-Wolf, University of Illinois at Chicago, 60607, Chicago, United States, tanyabw@uic.edu, *Daehan Won*, *Chun An Chou*, *W. Art Chaovalitwongse*, *Bhaskar Dasgupta*, *Ashfaq Khokhar*, *Mary V. Ashley*

We propose a combinatorial optimization framework for parental reconstruction of a single-generation population using microsatellite data. Without prior information about the population, our optimization framework uses the combinatorial concepts of the Mendelian laws to reconstruct sibling groups and in turn identify the associated parental genotypes. The proposed framework was tested on real and simulated data sets with different mating patterns: monogamy, semi-polygamy, and polygamy. The results show that our framework can efficiently and accurately infer the real parental genotypes.

■ MA-38

Monday, 8:30-10:00

HH-Colombus

Integer Linear and Linear Multiobjective Optimization

Stream: Multiobjective Optimization

Invited session

Chair: *Walter Habenicht*, Business Administration, University of Hohenheim, Lst. fuer IBL(580 B), 70593, Stuttgart, Germany, walter.habenicht@uni-hohenheim.de

1 - Enumerative Cuts in Integer Linear Vector Optimization

Walter Habenicht, Business Administration, University of Hohenheim, Lst. fuer IBL(580 B), 70593, Stuttgart, Germany, walter.habenicht@uni-hohenheim.de

This paper deals with a conceptual framework of a hybrid method for solving linear integer vector optimization problems. It combines cutting planes with an enumeration approach. The concept is based on enumerative cuts, which is well established approach in (single criterion) integer linear optimization. In this paper we show how enumerative cuts can be integrated in an interactive procedure for solving integer linear vector optimization problems.

2 - Graphical exploration of the weight space in multiobjective integer linear programming

Maria João Alves, Faculty of Economics, University of Coimbra / INESC-Coimbra, Av. Dias da Silva, 165, 3004-512, Coimbra, Portugal, mjalves@fe.uc.pt, *João Paulo Costa*

We present an approach that determines, at each time, a subset of the indifference region in the weight space associated with an efficient solution of a multiobjective integer linear programming (MOILP) problem. Based on the graphical exploration of these regions, we propose an algorithm to compute all supported efficient solutions "around" an already known solution, or even all the supported efficient solutions, of a tri-objective problem. We also show a computer implementation of the algorithm.

3 - A multicriteria linear programming model for measuring efficiency in productive processes

David Alcaide Lopez de Pablo, Estadística, Investigación Operativa y C., Universidad de La Laguna, Avda. Astrofísico Francisco Sanchez, 38206, La Laguna, Tenerife, Spain, dalcaide@ull.es, *Rafaela Dios-Palomares, Angel M. Prieto*

The efficiency in production has been usually analysed with the production frontier function. Efficiency scores are based on distances to the frontier. Improvements regard to the total consumption of each input. However, in many cases, each input is detached in its stages and trade-off among them is possible. Such analysis provides the total optimal consumption of each input, as data envelopment analysis does, and the most efficient assignment in each stage. This paper studies technical efficiency with this perspective. A non-parametrical methodology and a multicriteria model are proposed.

4 - Factoraggregation and its application for solving bilevel linear programming problems.

Pavels Orlovs, Department of Mathematics, University of Latvia, Zellu street 8, LV-1002, Riga, Latvia, pavels.orlovs@gmail.com, *Olga Montvida*

We introduce the notion of a factoraggregation, which is a special construction of a general aggregation operator, based on an ordinary aggregation operator. We apply the factoraggregation for analysis of optimal solution of bilevel linear programming problems. The aggregation observes lower level objective functions considering the classes of equivalence generated by an objective function at the upper level. The proposed method is illustrated with numerical and graphical examples.

■ MA-39

Monday, 8:30-10:00

HH-Cousteau

MADM Applications I

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration, Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District,, 11111, Taipei, Taiwan, ctlin@mail.mcu.edu.tw

Chair: *Chie-bein Chen*, International Business, National Dong Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien, Taiwan, cbchen@mail.ndhu.edu.tw

1 - A storage location assignment problem for a pick-and-pass warehousing system with multiple pickers and congestion considerations

Jason Chao-Hsien Pan, Department of Business Administration, Takming University of Science and Technology, No.56, Sec.1, Huanshan Rd., Neihu District, Taipei City, Taiwan 11451, R.O.C., Taiwan, jpanbox@gmail.com, *MingHung Wu*

This paper develops a performance evaluation method for a pick-and-pass system by describing the operation of a picker as a GI/G/1 open queueing network to estimate the expected response time of the picker in a picking zone. Based on the proposed method, this study provide storage assignment algorithm to balance the workload of each zone so that the performance of the system can be improved. A simulation model is used to implement the proposed algorithm and to compare the throughput for different policies as well. The results indicate that the proposed algorithm outperforms existing policies.

2 - The Effects of Individualism/Collectivism Orientations

Kuo-chung Chang, International Business, National Dong Hwa University, Taiwan, kcchang@mail.ndhu.edu.tw

The purpose of study was to examine the relationship between individualism/collectivism orientations, self-construals, and quality motivation. Participants were chosen from three Industrial Parks in Taiwan. The findings indicated that collectivism orientation not only had significant effect on the technological dimension of quality motivation, but

also had indirect effect through the individuals' interdependent self-construal. The study also found that independent self-construal mediated the relationship between individualism orientation and the humanistic dimension of quality motivation.

3 - An EOQ Model with Defective Items and Imperfect Inspection Process

Chia-Huei Ho, Business Administration, Ming Chuan University, 250 Zhong Shan N. Rd., Sec. 5., 111, Taipei, Taiwan, chiahueiho@gmail.com, *Liang-yuh Ouyang, Chia-hsien Su*

This paper considers an EOQ model with defective goods in inward purchases and imperfect inspection process. We assume that screening errors (including type I and type II) may occur due to imperfect inspection quality, and retailer invests capital to improve inspection quality. The objective is to find the optimum order quantity and the power of the test such that total cost per unit time is minimized. Mathematical analysis is used to find the optimal solution. Numerical examples and sensitivity analysis will be presented as well to demonstrate the results of the proposed model.

4 - Market Effectiveness and Reinstatement of Top Managers

Chin-Tsai Lin, Department of Business Administration, Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District,, 11111, Taipei, Taiwan, ctlin@mail.mcu.edu.tw, *Yi-Hsien Wang, Jung-Ho Lu, Hwa-Rong Shen, Yang-Sheng Wang*

This study investigated the impact of the reinstatement of former CEO on the stock market reaction of listed corporations in Taiwan. Therefore, corporate decision often to reinstate former CEO, because expected former CEO with experience in managerial practices can improve corporate performance. The aim of this study is to provide practical guidelines to companies for decision making, and helpful information for adjust expectations of investors to alter portfolio allocation.

■ MA-40

Monday, 8:30-10:00

HH-Livingstone

MADM Applications V

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration, Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District,, 11111, Taipei, Taiwan, ctlin@mail.mcu.edu.tw

Chair: *Chie-bein Chen*, International Business, National Dong Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien, Taiwan, cbchen@mail.ndhu.edu.tw

1 - The study on the festival event experience benefit structure relationship model — a case of Kaohsiung Zuoying Wannian Folklore Festival

Tang-Chung Kan, Department of Travel Management, National Kaohsiung University of Hospitality and Tourism, 1, Sung-ho Rd. Hsia-Kang, 81267, Kaohsiung, Taiwan, kan@mail.nkuht.edu.tw, *Hung-ju Chien, Vivien Y.C. Chen*

Event's place attachment and tourist's experience quality, are the important key factors of festival event success and event benefits. The purpose of this research is to investigate the relationships among the place attachment, experience quality and events benefits of the Kaohsiung Zuoying Wannian Folklore Festival. Use LISREL analysis system to investigate linear structure relation model. The result can be develop the relationship model among place attachment, experience quality and event benefits's aspect.

2 - Dealer selection for an automotive company using ELECTRE I and TOPSIS methodologies

Elif Maç, Industrial Engineering, Kocaeli University / Natural and Applied Sciences, Turkey, ellyfkaraca@gmail.com, *Zerrin Aladag*

Sales & Aftersales network is of vital importance for customer satisfaction with automotive companies. New technologies, competitive price and charming design increase new customer potential and of course customer satisfaction; but these are not enough to sustain long term satisfaction and loyalty. Companies have to select accurate contacts for dealer role. Multicriteria analysis is meaningful to integrate various aspects into a uniform evaluation process. We propose to use ELECTRE I and TOPSIS to choose one dealer among 6 dealership applicants for an automotive company in Turkey.

3 - An empirical analysis between Japanese Government and NPOs in the New Period

Kuo Tzu-hsuan, Department of Applied Japanese,, National Kaohsiung University Of Hospitality And Tourism, Taiwan, NO,311 sonchung street Kaohsiung, NO, 807, Kaohsiung, Taiwan, Taiwan, kaku322@gmail.com, *Vivien Y.C. Chen*, *Tang-Chung Kan*

After the 1990s, Japan has been deeply influenced by international trends as well as its own political and economic development. This dissertation constructs a society-centered theory to explore and to analyze the relationship between the Japanese government and NPOs during the new period. I examine the change and the development by dividing the progress into "traditional period" and "new period" with after the cold war in the 1990s. This study is emphasized on showing how important Japanese government and NPOs cooperative partnership.

4 - A multi-objective strategy for Pareto set refinement

Adriano Lisboa, ENACOM - Handcrafted Technologies, 31255530, belo horizonte, minas gerais, Brazil, *adriano.lisboa@enacom.com.br*, *Fellipe Santos*, *Douglas Vieira*, *Rodney Saldanha*, *Marcus Lobato*

This paper introduces a strategy for Pareto set refinement in order to allow where there will be more samples of the Pareto set. The fundamental idea is to find the Pareto set vertices and then use refinement criteria in order to generate new seeds for extra Pareto set samples. The strategy is especially efficient when coupled to intrinsic multi-objective optimization algorithms. The strategy is tested in analytical benchmarking problems and real world applications.

■ MA-41

Monday, 8:30-10:00

HH-Heyerdahl

Evolutionary Multiobjective Optimization

Stream: Multiobjective Optimization

Invited session

Chair: *Juergen Branke*, Warwick Business School, University of Warwick, CV4 7AL, Coventry, United Kingdom, *juergen.branke@wbs.ac.uk*

Chair: *Arnaud Liefooghe*, LIFL - CNRS - INRIA, Université Lille 1, Lille, France, *arnaud.liefooghe@lifl.fr*

1 - Preference-based Evolutionary Algorithm for Many Objective Optimization Problems

Ankur Sinha, Department of Information and Service Economy, Aalto University School of Economics, 4.13 Chydenia, Runeberginkatu 22-24, 00100, Helsinki, Finland, *ankur.sinha@aalto.fi*, *Kalyanmoy Deb*, *Pekka Korhonen*, *Jyrki Wallenius*

Recent contributions towards handling many objective optimization problems propose to seamlessly integrate the decision maker with the execution of an evolutionary algorithm. Preference elicitation from the decision maker is performed at the intermediate steps of the algorithm to direct the search in preferred regions. In this study, we discuss one such technique where an interactive evolutionary algorithm based on implicitly defined value functions is used to find the most preferred solution in a fixed number of interactions with the decision maker.

2 - Automatic Design of Multi-Objective Optimizaton Metaheuristics

Manuel López-Ibáñez, IRIDIA, Université Libre de Bruxelles, Av. F. Roosevelt 50, CP 194/6, 1050, Bruxelles, Belgium, *manuel.lopez-ibanez@ulb.ac.be*, *Thomas Stützle*

We propose to automatically instantiate multi-objective ant colony optimization (MOACO) algorithms from a flexible framework that encapsulates most of the design alternatives found in the literature. This approach allows us to generate, with little effort, new MOACO algorithms that are designed for specific multi-objective problems. The automatically generated MOACO algorithms are able to outperform the MOACO algorithms from the literature. The proposed approach can be easily extended to other multi-objective metaheuristics, such as multi-objective evolutionary algorithms.

3 - Anytime Local-Search Algorithms for Multi-Objective Optimization

Jérémie Dubois-Lacoste, IRIDIA, Université Libre de Bruxelles, 50, av. F. Roosevelt, 1050, Bruxelles, Belgium, *jeremie.dubois-lacoste@ulb.ac.be*, *Manuel López-Ibáñez*, *Thomas Stützle*

Many optimization algorithms are designed to deliver the best possible outcome after a given computation time. However in many real-life situations, the available computation time may be unknown a priori. "Anytime" algorithms, on the other hand, are designed to obtain the best possible results whenever the algorithm is stopped. In this work we present anytime variants of two algorithms for multi-objective optimization, Two-Phase Local Search and Pareto Local Search, which are essential components of state-of-the-art algorithms for well-known bi-objective problems.

4 - Multi-objective combinatorial benchmark problems and search space structure

Arnaud Liefooghe, LIFL - CNRS - INRIA, Université Lille 1, Lille, France, *arnaud.liefooghe@lifl.fr*

We first discuss the issues of designing and analyzing multi-objective combinatorial optimization problem instances, and we identify existing attempts of defining such benchmark for different domains. Next, we propose a possible alternative in the form of a multi-objective variant of NK-landscapes with objective correlation. We define and analyze a number of problem features that impact the search space characteristics, and we give guidelines for the design of evolutionary multi-objective optimization algorithms and other metaheuristics, based on the main search space features.

■ MA-42

Monday, 8:30-10:00

BW-Amber

Simulation 1

Stream: Simulation

Invited session

Chair: *Michael Manitz*, Technology and Operations Management, Chair of Production and Supply Chain Management, University of Duisburg/Essen, Mercator School of Management, Lotharstr. 65, 47057, Duisburg, Germany, *michael.manitz@uni-due.de*

1 - A research of computer network systems' productivity and efficiency with simulation modeling

Sultan Ceren Salkin, Industrial Engineering, Istanbul Technical University, Kenan Evren Bulvarı Esencan Sitesi A blok 2/5, Çukurova, 01170, ÇUKUROVA, ADANA, Turkey, *cerensalkin@hotmail.com*

Computer networks are the most prevalent systems with many applications-like internet sales. Internet commands are working with complex algorithms that cause communication troubles. With this study, it is proposed to show the usage efficiency of the computer network systems by describing system topology with ARENA simulation model. First, web system working principle was analyzed; data was suited to probability distributions. System variables, attributes, entities were defined and after results, system resource usage ratios were criticized to make suggestions.

2 - The impact of a waiting-time threshold in overflow systems with impatient customers

Michael Manitz, Technology and Operations Management, Chair of Production and Supply Chain Management, University of Duisburg/Essen, Mercator School of Management, Lotharstr. 65, 47057, Duisburg, Germany, michael.manitz@uni-due.de, *Raik Stolletz*

We analyze the performance of call centers with impatient customers, two levels of support, and an overflow mechanism. Waiting calls from the front-office queue, if not, renege are sent to the back office if at least one back-office agent is available and if a certain threshold on the waiting time is reached. We approximate such systems via a continuous-time Markov chain that allows for overflow immediately upon arrival. Two different approaches for the derivation of the respective probability of an overflow are developed the reliability of which is shown by numerical experiments.

3 - Value analysis of healthcare asset tracking systems using simulation

Ece Arzu Demircan, Industrial Engineering, TOBB University of Economics and Technology, 06560, Ankara, Turkey, eademircan@etu.edu.tr, *Nilgun Fescioglu-Unver*

Healthcare systems try to improve the quality of patient care and safety, and reduce their costs by use of new technologies such as Radio Frequency Identification (RFID) based asset tracking systems. Some hospitals abstain from using this technology because they are not sure how much value the system will bring. The aim of this research is to generate a value analysis framework for healthcare asset tracking systems, and develop a simulation model which can measure the benefits of asset tracking in hospitals of different scales and patient arrival-rates.

multistage stochastic formulation. We show that theorems proved for two stage case are valid also in the multistage case. Numerical results on a case study illustrate the relationships.

3 - Stochastic programming formulations of coherent multiperiod risk measurement

Martin Denzinger, Energy Economics, PSI, Paul Scherrer Institut, 5232, Villigen, Switzerland, martin.denzinger@psi.ch

Coherent risk measurement is related to stochastic optimization. An example is the single-period risk measure Conditional-Value-at-Risk (CVaR) that can be formulated as a stochastic linear program. The favorable properties of CVaR led to recent interest in multi-period extensions. We consider the case of coherent multi-period risk measurement for a value process. We discuss an extension of CVaR to the product space of state and time, and a time-consistent recursive definition. In a finite setting on a scenario tree, we consider duality relations, and integration in mean-risk optimization.

4 - Decomposition of Risk Measures

Alois Pichler, Statistics and Operations Research, University of Vienna, Universitätsstraße 5, 1010, Wien-Vienna, Vienna, Austria, alois.pichler@univie.ac.at

We provide a new identity for the multistage Average Value-at-Risk and selected, other risk measures.

The identity is based on the conditional Average Value-at-Risk at random level, which is introduced. It is of interest in situations, where the information available increases over time, so it is – among other applications – customized to multistage optimization. The identity relates to dynamic programming. We elaborate further dynamic programming equations for specific multistage optimization problems and derive a characterizing martingale property for the value function.

■ MA-43

Monday, 8:30-10:00

BW-Granite

Multistage Stochastic Programming

Stream: Stochastic Programming
Invited session

Chair: *Alois Pichler*, Statistics and Operations Research, University of Vienna, Universitätsstraße 5, 1010, Wien-Vienna, Vienna, Austria, alois.pichler@univie.ac.at

1 - Ambiguity in multistage stochastic programming and worst case trees

Georg Pflug, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

We consider the multistage ambiguity problem, i.e. a multistage decision model, where the governing probability is only known to lie in a set of models. These ambiguous models are defined through balls w.r.t. the nested distance of tree processes.

The ambiguity problem is formulated and solved as a minimax problem. A subproblem is to find tree processes, which belong to the ambiguity set, but give worst values for the optimization problem. We give some algorithm to identify this worst case tree process and show some illustrative examples.

2 - Measures of information in multistage stochastic programming

Marida Bertocchi, Department of Mathematics, Statistics, Computer Science and Applications, University of Bergamo, Via dei Caniana 2, 24127, Bergamo, BG, Italy, marida.bertocchi@unibg.it, *Francesca Maggioni*, *Elisabetta Allevi*

Multistage stochastic programs are usually hard to solve in realistically sized problems. Providing bounds for their optimal solution, may help in evaluating whether it is worth the additional computation for the stochastic program versus simplified approaches. In this talk we generalize the value of information gained from deterministic, pair solutions and rolling-horizon approximation in the two-stage case to the

■ MA-44

Monday, 8:30-10:00

BW-Marble

Airline Revenue Management

Stream: Revenue Management
Invited session

Chair: *Tatsiana Levina*, School of Business, Queen's University, 143 Union str, K7L 3N6, Kingston, Ontario, Canada, tlevin@business.queensu.ca
Chair: *Yuri Levin*, School of Business, Queen's University, 143 Union str, K7L 3N6, Kingston, Ontario, Canada, ylevin@business.queensu.ca

1 - Uncertainty in air cargo revenue management

Emily Cookson, Management Science, Lancaster University, LA1 4YX, Lancaster, United Kingdom, e.cookson@lancaster.ac.uk, *Kevin Glazebrook*, *Joern Meissner*

The air cargo industry faces some unique challenges including highly volatile demand and variable tendering. In the case of mixed carriers, the prioritisation of passengers and their baggage complicates belly space allocation. A new dynamic programming formulation has been developed to maximise a carrier's expected profit from cargo. Capacity and demand uncertainty is modelled using probability distributions. Ad hoc acceptance decisions are made using dynamic prices computed using various numerical analysis techniques. The sales problem of long-term versus short-term contracts is discussed.

2 - Airline product design based on consumer preference for ticketing restrictions

Dong Myong Lee, Business Administration, Korea Aerospace University, Hwajun-dong, 412-791, Goyang, Gyunggi, Korea, Republic Of, dmllee@kau.ac.kr, *Do Hee Han*, *Meghana Dhungana*

Ticketing restrictions are important factors for designing airline products. With various types of ticketing restrictions, airlines have offered many airline tickets to differentiate their customers. This paper focuses on the product design problem for airlines based on customer

preference values. For measuring the values, we apply a choice based conjoint analysis model. With empirical analysis on the survey data for air travelers in Korea, we will show airlines can offer various kinds of air ticket products with a high selecting possibility.

3 - A continuous-time dynamic pricing model knowing the competitor's pricing strategy

Kimitoshi Sato, Graduate School of Finance, Accounting and Law, Waseda University, 103-0027, Tokyo, Japan, k-sato@aoni.waseda.jp, *Katsushige Sawaki*

We consider a dynamic pricing model for a firm knowing that a competitor adopts a static pricing strategy. We establish a continuous time model to analyze the effect of the dynamic pricing on the improvement of revenue. Customers arrive to purchase tickets in accordance with a geometric Brownian motion. We derive an explicit closed-form expression for optimal pricing policy to maximize the expected revenue. It is shown that when the competitor adopts a flat rate pricing policy, a dynamic pricing is not always effective in terms of the expected revenue compared to the fixed pricing strategy.

4 - Dynamic pricing of flight passes

Yuri Levin, School of Business, Queen's University, 143 Union str, K7L 3N6, Kingston, Ontario, Canada, ylevin@business.queensu.ca, *Mikhail Nediak*, *Huseyin Topaloglu*

Many airlines have recently introduced a "flight pass" which targets customers in a frequent traveler segment. This product permits its holder to obtain a seat on a specified number of flights at a fixed price. Dynamic pricing of passes is contingent upon pricing of individual flights and how customers choose between passes and individual bookings. Customers in this setting are inherently forward-looking. We present a stochastic dynamic programming formulation for this problem and analyze the properties of the pricing policy.

3 - Optimal Sequence of play for channels with cooperative advertising programs

Salma Karray, Faculty of business & IT, UOIT, 2000 Simcoe Street North, L1H7K4, Oshawa, Ontario, Canada, salma.karray@uoit.ca

Most research about cooperative advertising programs in channels relies on the assumption that manufacturers and retailers decide of pricing and marketing efforts simultaneously. This paper evaluates this central assumption and investigates the optimal periodicity (sequence of play) of pricing and marketing efforts (ME) decisions for a distribution channel using a game theoretic analysis.

■ MA-45

Monday, 8:30-10:00

BW-Water

Advertising decisions in the supply chain

Stream: Revenue Management

Invited session

Chair: *Salma Karray*, Faculty of business & IT, UOIT, 2000 Simcoe Street North, L1H7K4, Oshawa, Ontario, Canada, salma.karray@uoit.ca

1 - Bilateral Cooperative Advertising

Marcus Kunter, Faculty of Business & Economics, Aachen University, Kackertstr. 7, D-52064, Aachen, Germany, mk@lum.rwth-aachen.de

We study channel coordination in a manufacturer-retailer channel with bilateral moral hazard. We argue that existing approaches involve assumptions that contradict reality or require instruments that are often not adopted by managers (ex-post bargaining, per-unit cost sharing, introduction of a third party). As an alternative, we show that channel coordination is achieved by contracting on bilateral cooperative advertising and wholesale pricing. However, the channel may not be coordinated by this contract since it is dominated by other contracts from channel members' individual perspectives.

2 - Cooperative Advertising in a Dynamic Retail Market Duopoly

Suresh Sethi, School of Management, SM30, University of Texas at Dallas, 800 W. Campbell Rd., 75080, Richardson, TX, United States, sethi@utdallas.edu, *Anshuman Chutani*

Cooperative advertising is a key incentive offered by a manufacturer to influence retailers' promotional decisions. We study cooperative advertising in a dynamic retail duopoly where a manufacturer sells his product through two competing retailers. We model the problem as a Stackelberg differential game in which the manufacturer announces his shares of advertising costs of the two retailers or his subsidy rates, and the retailers in response play a Nash differential game in choosing their optimal advertising efforts over time.

Monday, 10:30-12h00

■ MB-01

Monday, 10:30-12h00

RB-Alfa

IFORS Invited Tutorial: Professor Erhan Erkut

Stream: Keynote, Tutorial and Plenary Lectures
Tutorial session

Chair: *Elena Fernandez*, Universitat Politecnica de Catalunya, Barcelona, Spain, e.fernandez@upc.es

1 - How to Make OR the Most Liked Course in the Curriculum?

Erhan Erkut, Rector, Ozyegin University, Kusbakisi Cad. No:2, Istanbul, Turkey, erhan.erkut@ozyegin.edu.tr

As teachers of OR, many of us would like to think that OR is one of the most valuable topics in university education. However, past experience shows that some of the students in our classrooms may not agree with this. How do we close this perception gap, and attract the best students to OR? This is just another problem, and if we think we are the best-trained problem solvers in the world, we should be able to overcome it easily. Unfortunately, while we may have exceptional training in analytical thinking and quantitative analysis, many of us lack the tools necessary for strategic planning, brand creation, and reputation management. Furthermore, most of us lack formal training in teaching, which makes matters worse.

My colleagues at the University of Alberta and I have experimented with various methods and tools over two decades, and we established that an OR curriculum can be very successful even in a business school— a considerably more challenging environment than an engineering school. The winning recipe includes ingredients such as spreadsheets, real-time modeling ("slow learning"), course management system, web tools, on-line communication, large classes, labs, student assistants, videos, guest speakers, on-line exams, and group projects; all delivered with a heavy emphasis on applications, and with a student-centered pedagogical approach. The results have been very positive; the reputation of the introductory course became "most useful," many of the best students took our electives, all members of our team won teaching awards, and through our collaboration with the industry we established a know-how transfer unit called Centre for Excellence in Operations.

In this tutorial, I will describe the problem we faced, and our attempts to solve it with examples of what worked and what did not, with an emphasis on what audience members could transfer to their institutions. The focus is not only on making one course popular, but on managing the entire student supply chain, complete with a student club, competitions, conferences, internships, and graduate programs. If you are interested in improving the perception and image of OR in your institution through teaching (and strategic planning), you are welcome to attend this session.

■ MB-02

Monday, 10:30-12h00

RB-Beta

New scheduling models and algorithms

Stream: Scheduling
Invited session

Chair: *Dirk Briskorn*, University of Siegen, Germany, dirk.briskorn@uni-siegen.de

1 - A tactical approach to skill management

Murat Firat, Mathematics and Computer Science, Eindhoven University of Technology, Postbus 513, 5600 MB, Eindhoven, Netherlands, m.firat@tue.nl, *Cor Hurkens*, *Alexandre Laugier*

In multi-skill workforce planning, employees are specialized in different fields. We consider a time horizon in which several projects, each with a target makespan, are to be completed. If a makespan is not achievable with available skills, an option is outsourcing some jobs by using a fixed budget. We investigate another option of increasing the available amount of skills with the aim of saving some near-future outsourcing costs. This study addresses a center question: "how to evaluate the value of a skill?".

2 - Integrated planning of jobs and maintenance activities on a single machine

Dirk Briskorn, University of Siegen, Germany, dirk.briskorn@uni-siegen.de, *Stefan Bock*, *Andrei Horbach*

We focus on single machine scheduling subject to machine deterioration. The maintenance level specifies the machine's current maintenance state. While jobs are processed the maintenance level drops by a certain - possibly job-dependent - amount. A maintenance level of less than zero is associated with the machine failure. Consequently, scheduling maintenance activities that raise the maintenance level may become necessary in order to prevent maintenance level being becoming negative. We present complexity results and approaches considering two types of maintenance activities.

3 - A labeling algorithm for scheduling deliveries with e-vehicles

Sleman Saliba, Corporate Research Germany, ABB AG, Wallstadter Str. 59, 68526, Ladenburg, Germany, sleman.saliba@de.abb.com, *Sven Krumke*, *André Chassein*

In this presentation, we solve a real-world scheduling problem occurring for courier services employing electrical vehicles. E-vehicles are requested to make deliveries during given time windows while they need to be flexibly re-charged at certain re-charging points during the delivery trips. The objective is to make as many deliveries as possible while minimizing the travel cost. This problem can be formulated as a Resource Constraint Shortest Path Problem (RCSPP). Since the RCSPP is NP-hard, we present a fast Labeling Algorithm that can be employed in real-world scheduling systems.

4 - Hybrid method for minimizing earliness and tardiness penalties in a single-machine problem with a common due date

Christophe Wilbaut, LAMIH, University of Valenciennes, Le Mont Houy, ISTV2, 59313, Valenciennes, France, christophe.wilbaut@univ-valenciennes.fr, *Said Hanafi*, *Rachid Benmansour*, *Mustapha Ratli*, *Rita Macedo*

In this paper we deal with the single machine earliness and tardiness scheduling problem against common due dates. We propose a hybrid method mixing heuristics and mathematical programming to solve it. The approach reaches strong upper bounds and lower bounds using: relaxation techniques; a temporary setting of variables to generate and solve reduced problems; the generation of pseudo-cuts to strengthen the problem formulation. Heuristics can be integrated at different levels to enhance the approach. The efficiency of the method is shown through its results on a set of available instances.

■ MB-03

Monday, 10:30-12h00

RB-L1

Business Excellence in Logistics: Future Transport and Production

Stream: Business Excellence in Logistics
Invited session

Chair: *Martin Josef Geiger*, Logistics Management Department, Helmut-Schmidt-University, Holstenhofweg 85, 22041, Hamburg, Germany, m.j.geiger@hsu-hh.de

1 - A Scheduling heuristic for surface treatment process of steel coils and its application

Ozlem Uzun Araz, Industrial Engineering Dept., Celal Bayar University, Turkey, ozlem.araz@cbu.edu.tr, *Ozgur Eski*, *Ceyhan Araz*, *Levent Bayoglu*

The paper deals with the sequencing problem for the surface treatment process of steel coils in a Turkish Fastener Company. Our problem is to sequence the steel coils waiting for surface treatment process and schedule a single crane which performs material handling within stages for minimizing the total tardiness of jobs. A scheduling heuristic is proposed that is capable of handling special constraints about material types and material handling requirements. The performance of the heuristic has been tested by an application on the surface treatment line in Norm Fasteners Co., Turkey.

2 - Future Transport Demand Analysis for Turkey

Fusun Ulengin, Industrial Engineering, Dogus University, Dogus Universitesi, Muhendislik Fak. Endustri Muh. Bol, Acibadem, Kadikoy, 34722, Istanbul, Turkey, fulengin@dogus.edu.tr, *Sule Onsel*, *Burc Ulengin*, *Ozay Ozaydin*, *Özgür Kabak*

The main objective of this study is to conduct a demand analysis to identify whether the capacity expansion plans will be in line with the likely development of transport demand, given expected trends of the drivers of transport demand. An integration of multiple regression and the Bayesian Net (BN) is used for this purpose. Scenario analysis is also conducted in order to see the impact of different investment strategies to reach different target in transport mode demand. The time horizon is in line with planned durations of concession contracts for transport infrastructure.

3 - Multi-criteria analysis of transport policy targets with the help of telematic services

Gideon Mbiydzennyuy, Computing, Blekinge Institute of Technology, Biblioteksgatan 4, 374 24, Karlshamn, Sweden, gmb@bth.se

The aim of this paper is to assess how the choices of telematic systems through service offers can enable our understanding of different possibly competing transport policy goals in the context of road freight. Since such goals are aimed at different targets, we consider the achievement of different transport policy goals using different telematic systems as a multi-criteria decision analysis problem. Further, the paper uses a constraint-based approach to determine a satisfactory solution. The results suggest the contribution of different telematic services to different transport policies.

4 - Measuring Cost Effects of Supply Chain Stockouts: An Interactive Approach with Fast Cost Function Convergence

Sebastian Langton, Logistics Management Department, Helmut-Schmidt-University, 22041, Hamburg, Germany, langton@hsu-hh.de, *Martin Josef Geiger*

Measuring cost effects of stockouts is a crucial aspect in Supply Chain Management. In our talk, we present an interactive approach for obtaining cost function estimations from a decision maker/planner. First, a questioning strategy for the fast convergence of the computed cost functions is implemented in the interactive phase (similar techniques are known from Robust Ordinal Regression). Second, function approximations are derived by employing Genetic Programming, a modern metaheuristic. A decision support system integrating both aspects is presented, and numerical results are discussed.

■ MB-04

Monday, 10:30-12h00

RB-L2

Public Transport Perspectives within a Changing Mobility Environment

Stream: Optimization in Public Transport
Invited session

Chair: *Claus Doll*, Sustainability and Infrastructures, Fraunhofer-Institut für Systems and Innovation Research ISI, Breslauer Str. 48, 76139, Karlsruhe, Germany, claus.doll@isi.fraunhofer.de

1 - USEmobility: Why do people switch to environmentally friendly modes of transport?

Jolanta Skalska, EU projects, Allianz pro Schiene e.V., Reinhardtstr. 18, 10117, Berlin, Germany, Germany, jolanta.skalska@allianz-pro-schiene.de

The EU project USEmobility applies a novel approach that directly identifies the reasons for behavioural change of European citizens in local and regional transport where rail is the backbone of the mobility chain. In 6 European countries and 10 regions people who changed their individual mobility-mix were interviewed to find out factors that influence the choice of transport mode. Recommendations for political decision makers and transportation companies will be made on how to achieve the change towards eco-friendly mobility and better adapt the transport services to what the customers want.

2 - Social Costs and Benefits of Sustainable and Healthy Mobility Patterns

Claus Doll, Sustainability and Infrastructures, Fraunhofer-Institut für Systems and Innovation Research ISI, Breslauer Str. 48, 76139, Karlsruhe, Germany, claus.doll@isi.fraunhofer.de

As many other Industrialised world regions, Europe is facing an aging and declining population, more tight public households and changes in peoples' concerns on lifestyles and sustainability. However, more eco-friendly mobility must pay off for the individual user as well as for local authorities and public transport providers. In this paper we thus look at direct costs, time budgets, health impacts, safety, environmental indicators, GDP and employment of alternative forms of mobility patterns from the individual's perspective as well as for the economy in total.

■ MB-05

Monday, 10:30-12h00

RB-L3

Maritime Transportation 1

Stream: Maritime Transportation
Invited session

Chair: *Harilaos Psaraftis*, National Technical University of Athens, Evrota 20, 15451, Neo Psychico, Greece, hnpasar@mail.ntua.gr

1 - An Integrated Model for Ship Routing with Transshipment and Berth Allocation

Jiyin Liu, School of Business and Economics, Loughborough University, Ashby Road, LE11 3TU, Loughborough, Leicestershire, United Kingdom, j.y.liu@lboro.ac.uk, *King-Wah Pang*

We consider the operation of shipping companies that operate container vessels and company-owned terminals. An integrated model is developed to make coordinated decisions on container ship routing, berthing time allocation at the terminals, as well as transshipment of containers so that the overall cost can be minimized. To obtain a solution efficiently, we propose a decomposition-based heuristic approach. Computation experiment results show that significant benefit can be achieved by integrating the decisions on ship routing, berthing time allocation, and transshipment of containers.

2 - Stochastic Optimal Positioning of Tramp Vessels: A Markovian Approach

Evangelos Magirou, Informatics, Athens University of Economics, Patission 76, N/A, Athens, Greece, efm@aueb.gr

Determining the optimal sequence of ports that maximizes the time average profit of a tramp vessel dates back to Dantzig who solves it for constant rates. The model was extended to periodic charter rates and then to rates being random variables independent in time using DP. We relax this assumption by introducing a state of the charter market Markov chain, specific rates depending stochastically on the state. The formulation differs from the traditional MDP models; solution methods are developed and illustrated. The charter selection rules are intuitive and appealing to practitioners.

3 - A taxonomy and survey of speed models in maritime transport

Harilaos Psaraftis, National Technical University of Athens, Evrota 20, 15451, Neo Psychico, Greece, hnpasar@mail.ntua.gr

Ship speed is important for economic reasons, as it is a key determinant of fuel cost, a significant component of the operating cost of ships. Moreover, speed is an important parameter of the overall supply chain. However, as emissions are directly proportional to fuel consumed, speed is also very much connected with the environmental dimension of shipping. This paper presents a taxonomy and survey of speed models in maritime transport, that is, models in which speed is one of the decision variables.

4 - Maritime transport as an important link in the global supply chain

Algirdas Šakalys, Competence Centre of Intermodal Transport and Logistics, Vilnius Gediminas Technical University, Plytins st. 27, LT-10105, Vilnius, Lithuania, algirdas.sakalys@vgtu.lt

The East West Transport Corridor, connecting northern Europe with Russia and Far East is an excellent platform to develop an innovative pilot testing ground where modern technology and information systems contribute to increased efficiency, traffic safety and security as well as reduced environment impact in the corridor. The corridor stands out as green transport corridor which will reflect an integrated transport concept where Short Sea Shipping, rail, inland water ways and road complement each other to enable the choice of environmentally friendly transport.

3 - Probabilistic stopping rules for GRASP heuristics

Celso Ribeiro, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso.ribeiro@gmail.com, *Isabel Rosseti, Reinaldo Souza*

A drawback of most metaheuristics is the absence of effective stopping rules. We show experimentally that the solution values obtained by GRASP fit a truncated Normal distribution. We use this approximation to obtain an estimation of the number of iterations needed to improve the best known solution. This estimation is used to propose and implement effective stopping rules based on the trade off between solution quality and the time needed to find a solution. This strategy is validated by a computational study reporting results obtained for some GRASP heuristics.

4 - A solution clustering based guidance mechanism for parallel metaheuristic algorithm

Jianyong Jin, Molde University College, Britvegen 2, N-6411, Molde, Norway, jianyong.jin@himolde.no, *Arne Løkketangen, Teodor Gabriel Crainic*

We present a solution clustering based guidance mechanism for a parallel metaheuristic which solves the capacitated vehicle routing problem. The solutions are clustered according to their similarities. The knowledge extracted from the solution clusters is applied to guide the intensification and diversification of the parallel algorithm. The computational experiments show that the proposed guidance mechanism is effective. The presented algorithm has generated solutions to the benchmark instances that are very competitive or better than the best solutions previously reported in the literature.

■ MB-06

Monday, 10:30-12h00

RB-Gamma

Design and parameter tuning of metaheuristics

Stream: Metaheuristics

Invited session

Chair: *Mike Wright*, The Management School, Lancaster University, Dept. Of Management Science, LA1 5AG, Lancaster, Lancashire, United Kingdom, m.wright@lancaster.ac.uk

1 - Scheduling cricket umpires using neighbourhood search — The dramatic impact of a simple change in neighbourhood definition

Mike Wright, The Management School, Lancaster University, Dept. Of Management Science, LA1 5AG, Lancaster, Lancashire, United Kingdom, m.wright@lancaster.ac.uk

This paper reports on the dramatic effect of a relatively simple change in definition of neighbourhoods for a cricket umpire scheduling system used in practice for amateur leagues in England. After further analysis of the results, the neighbourhood definition was changed, with dramatically improved effect. Results will be presented for data from both leagues. These results serve to emphasise the value of good neighbourhood definition for neighbourhood search methods — probably much more important than the specific choice of metaheuristic technique.

2 - Online Parameter Tuning: Another Aspect of Learning for Metaheuristics

Arif Arin, Engineering Management & Systems Engineering, Old Dominion University, 241 Kaufman Hall, 23529, Norfolk, VA, United States, aarin@odu.edu, *Ghaith Rabadi*

Metaheuristics are effective approaches in solving large scale optimization problems. However, most metaheuristics have several parameters that need to be tuned before they can reach good results. In this study an online parameter tuning method where parameters are changed during search process is proposed. The method memorizes and stores the information about the search process to determine the probability of selecting each parameter setting for future iterations. To evaluate the proposed algorithm it will be applied to Meta-RaPS in solving 0-1 multidimensional knapsack problem.

■ MB-07

Monday, 10:30-12h00

RB-Eta

Neighborhood reduction strategies for vehicle routing

Stream: Vehicle Routing and Logistics Optimization

Invited session

Chair: *Wout Dullaert*, Faculty of Economics and Business Administration, VU University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, Netherlands, wout.dullaert@vu.nl

1 - A Simple Parameter-free Heuristic for the Fleet Size and Mix Problem with Time Windows

Olli Bräysy, Procomp Solutions Ltd, Kiviharjuntie 11, FI-90220, Oulu, Finland, olli.braysy@procomp.fi, *Wout Dullaert*

We suggest a new metaheuristic for the fleet size and mix vehicle routing problem with time windows. The suggested metaheuristic is based on simple random-sized jumps. The key idea is to set a random maximum percentual limit for each move and a random limit to the number of accepted moves that worsen the solution. The actual search is based on known segment relocation operations. Computational testing on the benchmark problems show that suggested new metaheuristic is competitive to previous best approaches, providing a significant number of new best-known solutions.

2 - Efficient local search methods for the large-scale Vehicle Routing Problem.

Onne Beek, Mgt Information Science & Operations Mgt, Ghent University, Tweeckerkenstraat 2, 9000, Gent, Belgium, Onne.Beek@ugent.be, *Birger Raa, Wout Dullaert*

Even after 60 years of research, state-of-the-art (meta)heuristics often perform poorly for solving very large instances of the Vehicle Routing Problem. This paper therefore deals with analyzing, redesigning and testing local search methods that are the building blocks of these metaheuristics. It focuses on efficient data structures and parallel algorithms suited for modern multicore systems, with an emphasis on simplicity and scalability, aiming to create new "best practices" for more efficiently solving large-scale VRP instances.

3 - Incorporating constraint preservation in GA operators for VRPTW problem

Gintaras Vaira, Vilnius University, Institute of Mathematics and Informatics, Akademijos St. 4, 08663, Vilnius, Lithuania, gintaras@vaira.net, *Olga Kurasova*

In this research we investigate the constraint handling approaches used in genetic algorithm for VRPTW problem. The investigation deals with feasibility preservation operators in GA. These operators are responsible to identify feasible parts in chromosome and reuse them in the offspring. Possible chromosome encoding approaches are investigated to reduce the complexity of GA operators while identifying and reusing feasible parts. Results of this research are compared to other GA feasibility handling approaches used in VRPTW including penalty based and repair based techniques.

■ MB-08

Monday, 10:30-12h00

RB-Epsilon

Network Optimization 2

Stream: Network Optimization
Invited session

Chair: *Dimitri Papadimitriou*, Bell Labs, Alcatel-Lucent, Copernicuslaan 50, 2018, Antwerp, Antwerp, Belgium, dimitri.papadimitriou@alcatel-lucent.com

1 - Single Source Tree Network Design Under Convex Costs

Henrique Luna, Instituto de Computação, Universidade Federal de Alagoas, Rua Eng. Mario de Gusmao 1230/1202, Ponta Verde, 57035000, Maceio, Alagoas, Brazil, hpluna@gmail.com, *Gilberto Miranda*, *Ricardo Camargo*

The single source tree network design problem under convex costs is a referential problem in networks for materials, energy or data transportation. The model is a hard large scale mixed-integer nonlinear program. In order to overcome the difficulties, two methods are deployed: Generalized Benders Decomposition and a combination of Outer Approximation with Benders Decomposition. The new scheme is effective on solving instances up to 702 edges in a few seconds. Properties of price unicity and differentiability are also studied to cope with the continuous relaxation of the problem.

2 - SearchCol algorithms for unsplitable multicommodity flow problems

Filipe Alvelos, Departamento de Produção e Sistemas, Universidade do Minho, Campus de Gualtar, 4710-057, Braga, Portugal, falvelos@dps.uminho.pt, *Amaro de Sousa*, *Dorabella Santos*

SearchCol, short for "metaheuristic search by column generation", is an algorithmic framework for approximately solving integer programming / combinatorial optimization problems with a decomposable structure. We apply SearchCol algorithms to two multicommodity flow problems. In the problems addressed, the commodities, associated with origin/destination pairs, must be routed through a single path. We consider two different objectives: (i) minimize the total cost and (ii) minimize the maximum load of an arc. We present computational results for different variants of the SearchCol algorithms.

3 - Ultra-fast meta-heuristic for the spectrum re-allocation problem in flexgrid optical networks

Marc Ruiz, Computer Architecture, Universitat Politècnica de Catalunya, c/ Jordi Girona 1-3, 08034, Barcelona, Spain, mruiz@ac.upc.edu, *Alberto Castro*, *Luis Velasco*, *Jaume Comellas*

The performance of future flexgrid optical networks can be improved reducing spectrum fragmentation. To improve capacity performance, spectrum re-allocation of already established traffic is performed in very short running time (e.g., 1 second), thus minimizing their impact over network operation. To produce near-optimal solutions within that stringent time period, we propose a randomized multi-constructive procedure followed by a path-relinking intensification. Its benefits against single-constructive procedures are evaluated. This research was funded by the TEC2011-27310 ELASTIC project.

4 - Exploiting geometry of large-scale topologies for routing operations

Dimitri Papadimitriou, Bell Labs, Alcatel-Lucent, Copernicuslaan 50, 2018, Antwerp, Antwerp, Belgium, dimitri.papadimitriou@alcatel-lucent.com

Geometric routing aims at providing a competitive tradeoff between the memory space required to store the routing tables, the computational complexity and the stretch of the routing paths it produces. This paper proposes a distributed procedure to characterize the graph curvature and to assign node coordinates for geometric routing to properly operate. Indeed, existing procedures for verifying sufficient conditions holds globally results in computational challenges, in particular if we assume that global topology information is not available at each node and central processing is inapplicable.

■ MB-09

Monday, 10:30-12h00

RB-Zeta

Cutting and Packing 2

Stream: Cutting and Packing
Invited session

Chair: *Maria Antónia Carravilla*, INESC TEC, Faculty of Engineering, University of Porto, R. Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, mac@fe.up.pt

1 - A hybrid metaheuristic for the nesting problem

José Fernando Oliveira, INESC TEC, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt, *Ramon Alvarez-Valdes*, *Antonio Martinez Sykora*, *Maria Antónia Carravilla*, *A. Miguel Gomes*, *Jose Tamarit*

The 2-dimensional nesting problem involves the placement of a given set of polygons, not necessarily convex, into a container. In our problem, the container is a strip of fixed width and the objective is minimizing the required length. In this work we develop a metaheuristic scheme in which local search and other heuristic tools are combined with the use of an exact procedure for solving some specific subproblems. The efficiency of the proposed procedure is assessed by solving a set of instances from literature and comparing the results with the most recent and successful heuristic approaches.

2 - Optimisation Containment Problem of Arbitrary Shaped Objects into a Circular Container

Alexander Pankratov, Department of Mathematical Modeling and Optimal Design, Institute for Mechanical Engineering Problems of the National Academy of Sciences of Ukraine, 61046, Kharkov, Ukraine, impankratov@mail.ru, *Yuri Stoyan*, *Tatiana Romanova*

We consider a containment problem for irregular shapes into a circular container of minimal radius. Each shape is formed by circular arcs and line segments and may be free translated and rotated. As an efficient tool of mathematical modeling of non-overlapping, containment and distance constraints we use phi-functions. We provide a mathematical model as a nonlinear constraint optimization problem. Each terminal node of the solution tree corresponds to a system of inequalities involving infinity-differentiable functions. A solution algorithm is outlined.

3 - Tetris-like Item Packing with Balancing and Additional Conditions: an MIP-based Heuristic Approach

Giorgio Fasano, Space Infrastructures & Transportation, Thales Alenia Space Italia, Str. Antica di Collegno 253, 10146, Turin, Italy, giorgio.fasano@thalesalieniaspace.com

This work focuses on the orthogonal packing of tetris-like items inside a convex domain. Additional conditions, such as the presence of separation planes, are taken into account and particular attention is given to the balancing issue, in the presence of filling material. A Mixed Integer Programming formulation and a heuristic approach are considered to tackle real-world instances efficiently. Some case studies are looked into to provide significant insights. In spite of this work originating within the context of space engineering, it can be extended to a number of different implementations.

4 - The Dotted-Board Model, a promising MIP model for the Nesting Problem

Maria Antónia Carravilla, INESC TEC, Faculty of Engineering, University of Porto, R. Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, mac@fe.up.pt, *Franklina Toledo*, *Cristina Ribeiro*, *José Fernando Oliveira*, *A. Miguel Gomes*

In the Nesting Problem the aim is to position, without overlap, a set of 2-dimensional small pieces of different shapes over a rectangular piece of material with a known width and infinite length. The objective is to minimize the used length of the rectangular piece. The decision variables in the Dotted-Board model are the dots of the board. The 1-dimensionality of the dots in the Dotted-Board allows a straightforward use, in the MIP model, of the constraint programming concepts of "domain of a variable" and of "domain reduction".

■ MB-10

Monday, 10:30-12h00

RB-Theta

Performance Analysis and Inventory

Stream: Production and the Link with Supply Chains
Invited session

Chair: *Frédéric Dugardin*, LOSI, University of Technology of Troyes, 12, rue Marie Curie, 10010, Troyes, France, frederic.dugardin@utt.fr

Chair: *Christophe Duhamel*, ICD - LOSI, CNRS, 12 rue Marie Curie, BP 2060, 10010, Troyes, France, christophe.duhamel@utt.fr

Chair: *Olga Nazarenko*, NTUU "KPI", Mayakovskogo avenue 17c, fl.72, 02225, Kiev, Ukraine, onazzaro@gmail.com

1 - Performance evaluation of a merge system: A distribution centre with multiple random suppliers

Michael Vidalis, Business Administration, University of Aegean, Sachtouri 19 Agios Dimitrios, 17341, Athens, Greece, mvid@ath.forthnet.gr, *Stelios Koukoumialos*

A two echelon discrete flow merge supply network consists of a number of non identical reliable suppliers that feed a distribution center (DC) with a shared buffer. The active lead times and service time at DC are exponential distributed. The supply network is modeled as a continuous time Markov process with discrete states. The transition matrices of these specific systems are explored and a computational algorithm is developed to generate performance measures for different values of system characteristics. The algorithm is used as a design tool to optimize system's behavior.

2 - Does greater company size lead to better performance? Evidence from Greek food supply chain

Emel Aktas, Brunel Business School, Brunel University, UB8 3PH, Uxbridge, United Kingdom, Emel.Aktas@brunel.ac.uk, *Michael Bourlakis*, *George Maglaras*, *Christos Fotopoulos*

We analyze performance differences within the food supply chain (SC) by examining its key members (growers, manufacturers, wholesalers and retailers) with respect to company size (micro, small, medium and large). Greek food companies evaluated their food SC performance based on key indicators (efficiency, flexibility, responsiveness, product quality and total supply chain performance). The findings suggest that Greek food SC cannot be characterized as agile since the results indicate low performance in flexibility indicators. Manufacturers are chain champions in terms of total SC performance.

3 - Inventory management optimisation in multi-echelon enterprise

Olga Nazarenko, NTUU "KPI", Mayakovskogo avenue 17c, fl.72, 02225, Kiev, Ukraine, onazzaro@gmail.com, *Yuriy Pasenchenko*

The optimal inventory management is vital for production or trading enterprise. Distribution network is based on the principle of hierarchical structure. Its elements are independent companies operating in their own interests, trying to optimize their own stocks. It is more

effective to optimize inventory in such multi-echelon distribution network as integral system through application of VMI approach. Results of simulation show behavior strategies of the center, resellers, and retailers that lead to an optimal level of inventory in the system as a whole and each of elements in particular.

■ MB-11

Monday, 10:30-12h00

RB-Iota

Transport Modelling

Stream: Transportation and Logistics
Invited session

Chair: *Jaume Barcelo*, Statistics and Operations Research, Tecnical University of Catalonia, Edifici Omega, Jordi Girona, 1-3, 8034, Barcelona, Catalonia, Spain, jaume.barcelo@upc.es

1 - Logit models incorporating driving styles variables for representing gap-acceptance behavior

Riccardo Rossi, Department of Civil, Architectural and Environmental Engineering, University of Padova, Via Marzolo, 9, I35131, Padova, -, Italy, riccardo.rossi@unipd.it, *Massimiliano Gastaldi*, *Claudio Meneguzzo*

The paper proposes an analysis of Logit models for representing gap-acceptance behavior at priority intersection. Differently from other studies, in this work gap-acceptance data were collected from driving simulator tests. The effectiveness of the data collected from experiments with driving simulators is highlighted: the use of driving styles variables not detectable from direct observations (on site) in driver gap-acceptance models can positively affect the accuracy of operational analysis (micro simulation, maneuver capacity and LOS assessment).

2 - An integrated fleet assignment model with supply-demand interactions

Bilge Atasoy, Transport and Mobility Laboratory, École Polytechnique Fédérale de Lausanne (EPFL), CH-1015, Lausanne, Switzerland, bilge.kucuk@epfl.ch, *Michel Bierlaire*, *Matteo Salani*

We integrate an itinerary choice model into a fleet assignment model so that price and demand interaction is endogenously included in the model. The decisions of the integrated model are the fleet assignment, seat allocation for each cabin class, schedule design and the pricing of the itineraries. We analyze the impact of including the demand model on the profits and transportation capacity from the airlines point of view. To deal with the complexity of the resulting mixed integer nonlinear problem, we build a heuristic method based on Lagrangian relaxation and subgradient optimization.

3 - Ship route modelling for traffic pattern analysis

Ronald Pelot, Industrial Engineering, Dalhousie University, 5269 Morris St., PO Box 15000, B3H 4R2, Halifax, Nova Scotia, Canada, Ronald.Pelot@Dal.ca, *Dong Lin*, *Casey Hilliard*

Ship movement tracking is improving due to various satellite and ground-based systems. This point data is sufficient for individual ship tracking or visual traffic patterns. But there are applications where maritime traffic analysis requires vector information on typical shipping routes and densities along each segment of these routes. We developed a method for aggregating the individual vessel trajectory data into routes and paths, that can be used to identify outliers in real-time, whether due to deliberate deviance from normal routes or for some accidental or nefarious purposes.

4 - The sensor location problem

Jaume Barceló, Statistics and Operations Research, Universitat Politècnica de Catalunya, Jordi Girona salgado 1-3, Campus Nord, Edifici C5, Office 215, 08034, Barcelona, Spain, jaume.barcelo@upc.edu

The main input for traffic models are Origin-Destination matrices, describing traffic patterns across the network, critical in Traffic Management supported by Dynamic Traffic Assignment models. OD matrices

are not directly observable, a seed matrix is adjusted from link flow counts provided by traffic counting stations. The adequacy of the detection layout strongly determines the quality of the adjusted OD. We present two alternative formulations as set covering models with side constraints exploiting the advantages of new technologies, and propose a tabu search heuristic to solve it.

■ MB-12

Monday, 10:30-12h00

RB-Omicron

Fuzzy Relations & Neural Networks

Stream: Fuzzy Systems, Neural Networks & Artificial Intelligence

Invited session

Chair: *Martin Gavalec*, Department of Information Technologies FIM, University of Hradec Kralove, Rokitanského 62, 50003, Hradec Kralove, Czech Republic, martin.gavalec@uhk.cz

1 - Eigenproblem of Circulant and Toeplitz matrices in extremal algebra

Hana Tomaskova, Information Technologies, Faculty of Informatics and Management, University of Hradec Králové, Rokitanského 62, 50003, Hradec Kralove, Czech Republic, hana.tomaskova@uhk.cz, *Martin Gavalec*

Eigenproblem of circulant and Toeplitz matrices in extremal algebra are studied. Both types of matrices have a special form. Toeplitz matrix is determined by vector of inputs in the first row and first column. Circulant matrix is special case of Toeplitz matrix and is determined by vector of inputs in the first row. Investigation of eigenvectors in max-min algebra is important for applications connected with reliability of complex systems or with fuzzy relations. For special types of matrices the computation of the eigenproblem can often be performed in a simpler way than in the general case.

2 - Learning Effect Approach for Scheduling Problem with Fuzzy Processing Time and Fuzzy Due Date

Merve Kayaci Çodur, Industrial Engineering, Ataturk University, Ataturk University Engineering Faculty, Industrial Engineering, 25200, Erzurum, Turkey, mkayaci@atauni.edu.tr, *Vecihi Yigit*

In scheduling problems, by considering the imprecise of the durations in the reality of manufacturing, processing times and due dates are introduced as fuzzy numbers. In most studies, fuzzy processing times of a job are assumed fixed. However in many realistic settings, the actual processing time of a job maybe more or less than its normal processing time when it is scheduled later. This phenomenon is known as the "Learning Effect" So we indicate study in which the uncertainty of a job processing time not only defines fuzzy numbers, but also defines its scheduled position. According to the complex property of the problem, a heuristic approach of Genetic Algorithm is applied to solve this NP-hard problem.

3 - Mean-Partial moments models for portfolio selection with fuzzy returns

Mbairadjim Moussa Alfred, Université Montpellier 1 - Lameta, France, moussa_alf@yahoo.fr, *Sadefo Kamdem Jules, Terraza Michel*

Since financial risk relates only to loss, lower partial moment is a more suitable risk measure compared to variance. In order to measure the risk of fuzzy portfolio return, a concept of partial moment for fuzzy variable, is defined in this paper. As extensions of the fuzzy mean-semivariance model, some mean-partial moments models are presented and the corresponding variations are discussed. In order to solve the proposed models, PSO algorithm integrating fuzzy simulation is designed. Finally, several numerical examples are given in order to illustrate the effectiveness of our modeling idea.

4 - Simulation of Stochastic Linear Queuing Systems

Richard Cimler, Information Technologies, University of Hradec Králové, Rokitanského 62, 500 02, Hradec Králové, Czech Republic, Czech Republic, richard.cimler@uhk.cz, *Martin Gavalec*

Cost optimization in stochastic linear queuing systems is considered in the contribution. Simulation approach is used because the exact prediction is not possible in stochastic systems. The simulated system is linear, i.e. it consists of a series of servers. The aim of simulation is to find the best way of controlling the server capacities due to system setup. The optimization is oriented to minimizing the total costs, which are divided into four parts: working costs, idle costs, queuing costs and change costs.

■ MB-13

Monday, 10:30-12h00

RB-Tau

Lot-sizing and Related Topics 2

Stream: Lot-sizing and Related Topics

Invited session

Chair: *Christian Almeder*, Chair for Supply Chain Management, European University Viadrina, Große Scharrnstr. 59, 15230, Frankfurt (Oder), Germany, Almeder@europa-uni.de

1 - The impact of major factors in food processing industry on the capacitated lot-sizing and scheduling problem

G.D.H. (Frits) Claassen, Operations Research and Logistics, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, frits.claassen@wur.nl, *J.c. Gerdessen, M.t. Patek*

Traditional lot sizing and scheduling models violate crucial issues in food processing industry. We develop models that relax all assumptions regarding changeover matrices including the triangular setup conditions; take into account effects of deterioration due to perish ability of inventory; have the flexibility to take issues for physical distribution into consideration. Optimal production schemes become significantly different when these issues are considered. We apply a time-based decomposition heuristic and show that near-optimal solutions can be found in reasonable time.

2 - A multicommodity lotscheduling model for the soft drink production process

Socorro Rangel, UNESP - Sao Paulo State University, Rua Cristovão Colombo, 2265, 15054000, S.J. do Rio Preto, São Paulo, Brazil, socorro@ibilce.unesp.br, *Michelli Maldonado*

The production of soft drinks involves two main stages: syrup preparation and bottling. Two main approaches have been used in the literature to model the scheduling decisions of the bottling stage. The first one is a small bucket approach in which each period is divided into subperiods. The second is a big bucket one. The objective of this work is to discuss the use of a multicommodity formulation for the asymmetric traveling salesman problem to model the scheduling decisions in the big bucket approach. The proposed model is studied and compared to others presented in the literature.

3 - Modeling the multi-level lot-sizing and scheduling problem - a comparison

Renate Traxler, European University Viadrina Frankfurt (Oder), Germany, traxler@europa-uni.de, *Christian Almeder*

In this work we compare different models from the literature for integrating the lot-sizing and the scheduling decisions in multi-stage systems. For that purpose, we show their abilities and limitations in describing relevant aspects of a production environment. Furthermore, we show the computational behavior of the models by applying them to benchmark instances. The structural and numerical comparisons show that there are considerable differences between the approaches. They allow us to provide a guideline for selecting the right modeling approach for different planning situations.

■ MB-14

Monday, 10:30-12h00

RB-Omega

Discrete-continuous scheduling

Stream: Scheduling under Resource Constraints
Invited session

Chair: *Jan Weglarz*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, jan.weglarz@cs.put.poznan.pl

1 - Metaheuristics for discrete-continuous project scheduling with discounted cash flows and various payment models

Grzegorz Waligora, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Wielkopolska, Poland, grzegorz.waligora@cs.put.poznan.pl

Discrete-continuous project scheduling problems with discounted cash flows are considered, in which the number of discrete resources is arbitrary, and there is one continuous, renewable and limited resource. The processing rate of each nonpreemptable activity is a continuous, increasing function of the amount of the continuous resource allotted to the activity at a time. A positive cash flow is associated with each activity, and the objective is to maximize the net present value (NPV). Metaheuristic approach to the considered problems is proposed under various payment models.

2 - Metaheuristic approaches for power-aware scheduling problem

Rafal Rozycki, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, rafal.rozycki@cs.put.poznan.pl

We consider the problem of scheduling power driven jobs on parallel identical processors. Jobs are preemptive and related. Each job is characterized by the size and the processing speed function. Power and energy limits have to be respected in a feasible schedule. The problem is to find both: a sequence of jobs on processors as well as an allocation of power to jobs that minimize the schedule length. We propose some metaheuristic approaches that produce suboptimal solutions of the problem in a reasonable time. The effectiveness of the approaches has been compared experimentally.

3 - Multimode resource-constrained project scheduling problem with setup costs

Marek Mika, Institute of Computing Science, Poznan University of Technology, ul Piotrowo 2, 60-965, Poznan, Poland, Marek.Mika@cs.put.poznan.pl

In the multimode resource-constrained project scheduling problem a set of activities has to be scheduled in such a way that precedence and resource constraints are met. Each activity can be performed in one of several execution modes differing between themselves in resource requirements and processing times. Some of the resources required by an activity have to be set up before the execution of this activity. Both the setup time and the setup cost depend on the execution mode. The objective is to minimize the total cost of all setups. A heuristic approach is proposed to solve the problem.

4 - Optimal resource allocation in virtual datacenters — a multidimensional continuous bin packing approach

Holger Schrödl, Otto-von-Guericke University Magdeburg, Germany, holger.schroedl@ovgu.de

The optimized used of resources in IT datacenters is of vital interest for IT service providers. Abundance of resource is cost-intensive, reducing IT resources leads to bottlenecks. Resource factors in datacenters are processor schedules, storage space and computing time. Existing approaches are limited how these resource factors are considered. First, the authors study multidimensional bin packing models to describe resource allocation in IT datacenters. Second, resource factors are described through general continuous functions which represent the behavior of certain resource classes.

■ MB-15

Monday, 10:30-12h00

RB-2101

Nonlinear Optimization and Applications 1

Stream: Nonlinear Programming
Invited session

Chair: *Simone Göttlich*, School of Business Informatics and Mathematics, University of Mannheim, A 5, 6, Mannheim, 68131, Germany, goettlich@uni-mannheim.de

1 - Range Approximation of Multivariate Polynomials for Global Optimization

Martin Stöcker, Fakultät Mathematik, Professur Wirtschaftsmathematik, Technische Universität Chemnitz, Reichenhainer Str. 41, Zimmer 727, 09107, Chemnitz, Germany, martin.stoecker@mathematik.tu-chemnitz.de

We consider polynomials in an arbitrary number of variables which frequently occur in optimization problems. A common challenge is to find bounds for the range of polynomials. We introduce two approaches which generate lower and upper bounds of multivariate polynomials over an n-dimensional box. The first method is based on the estimation of the contribution of the polynomial's summands, while the second one uses an expansion into Bernstein polynomials to obtain the desired bounds. We apply the methods to a real-world problem which occurs in the development process of vehicle transmissions.

2 - Linear least squares with different types of constraints: effectiveness of methods.

Arnaud Vandaele, Mathematics and Operations Research, University of Mons, rue de Houdain, 9, 7000, Mons, Belgium, arnaud.vandaele@gmail.com

In this work, we study different approaches used to solve the well-known Linear Least Squares problem, used in many fields of OR. Specifically, we focus on this problem with two types of constraints on the variables: either they must be positive, or they must be located between bounds. Different technics exist to solve these problems. In this work, we compare these methods on different points of view, paying a particular attention to their effectiveness of determining the optimal active set, which is the set of variables reaching one of their bounds at the optimal solution.

3 - Optimization Techniques: Combinatorial Optimization and Adjoint Calculus

Simone Göttlich, School of Business Informatics and Mathematics, University of Mannheim, A 5, 6, Mannheim, 68131, Germany, goettlich@uni-mannheim.de

The focus is on optimization problems arising in the continuous modeling of network applications such as production systems and traffic flow. We present an adjoint calculus for solving the optimality system and discuss suitable discretizations of this system. For particular discretizations the resulting problem is in fact a mixed-integer program. To speed up the solution procedure, we introduce presolve techniques that are inspired by the continuous dynamics.

4 - An improved approach to subset selection for parameter estimation in online applications

Diana López, Chair of Process Dynamics and Operation, Berlin Institute of Technology, Sekr. KWT-9, Str. Des 17, Juni 135, 10623, Berlin, Germany, diana.lopez@mailbox.tu-berlin.de, *Tilman Barz*, *Harvey Arellano-Garcia*, *Günter Wozny*

Subset selection is a systematic approach to system identification in nonlinear least squares parameter estimation. Ill-conditioned parameters are fixed at prior estimates and a well-conditioned parameter estimation problem is solved to determine the active parameters. The procedure permits to determine the parameters whose effects are unique and have a strong effect on the output measurements. The experimental results correspond to a biological system (ion-exchange high performance liquid chromatography column for protein separation) where transport and adsorption parameters are determined.

■ MB-16

Monday, 10:30-12h00

RB-2103

Hybrid Algorithms & Nonsmooth Optimization

Stream: Nonsmooth Optimization

Invited session

Chair: *Angel A. Juan*, Computer Science, Open University of Catalonia, Rambla Poblenou, 156, 08018, Barcelona, Spain, ajuanp@gmail.com

Chair: *Albert Ferrer*, Dpt. of Applied Mathematics I, Technological University of Catalonia, Av. Doctor Marañon, 44-50, 08028, Barcelona, Catalunya, Spain, alberto.ferrer@upc.edu

1 - Successive Approximations of the SimuRoute Procedure to solve the Heterogeneous Vehicle Routing Problem

Javier Faulin, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building. First floor, Campus Arrosadia, 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, *Angel, A. Juan, Alba Agustín, Miguel Angel Llorente*

We propose a Successive Approximations Method (SAM) for solving the Heterogeneous Vehicle Routing Problem (HVRP) in real scenarios. Our approach solves, in each iteration, the Capacitated Vehicle Routing Problem (CVRP) for the non-served nodes and the maximum capacity of unused vehicles. We used the so-called SimuRoute Procedure via Generalized Clarke and Wright (SR-GCW) to solve the associated CVRP. Thus, the largest routes which are generated from the CVRP solution are saved as a partial solution for the HVRP. Finally, competitive results have been obtained in reasonable computing times.

2 - Solving non-smooth problems through biased randomization of heuristics

Angel A. Juan, Computer Science, Open University of Catalonia, Rambla Poblenou, 156, 08018, Barcelona, Spain, ajuanp@gmail.com, *Albert Ferrer, Javier Faulin, Helena Ramalhinho Lourenço*

We discuss the use of probabilistic algorithms for solving combinatorial optimization problems with non-smooth objective functions. Our approach employs non-uniform probability distributions to add a biased random behavior to well-known heuristics. By doing so, a large set of alternative good solutions can be quickly obtained in a natural way and without complex configuration processes. This approach does not need to assume any particular property of the objective function. The procedure can be especially useful in problems where properties such as non-smoothness or non-convexity lead to a highly irregular solution space.

3 - A Randomized Algorithm for the Heterogeneous Fixed Fleet Vehicle Routing Problem

Jose Caceres Cruz, IN3 - Computer Science, Open University of Catalonia, Roc Boronat, 117, 7th floor, Mediativ, 08018, Barcelona, Spain, Spain, jcaceresc@uoc.edu, *Angel, A. Juan, Daniel Riera, Helena Ramalhinho Lourenço*

The academic point of view for the Vehicle Routing Problem (VRP) has undergone significant theoretical advances. Several techniques are enabling for solving real-world scenarios like the heterogeneous fixed fleet VRP. In this study, we present an approach for the HFFVRP using a hybrid algorithm combining a randomized Clarke & Wright heuristic, a memory, and a random policy for preassignment of vehicles. The Java implementation is compared over classical datasets against other saving heuristic implementation. So far, the obtained results are promising and other policies are being considered.

4 - Solving a real application of the Time-Constraint Capacitated Open Vehicle Routing Problem

Helena Ramalhinho Lourenço, Department of Economics and Business Q-5850017D, Universitat Pompeu Fabra, R. Trias Fargas 25-27, 08005, Barcelona, Spain, helena.ramalhinho@upf.edu, *Luciana Pessoa, Alex Grasas, Angel A. Juan, Mauricio Resende*

This work considers a real application of the Capacitated Time-constrained Open Vehicle Routing Problem in the health care sector, the blood sampling collection problem. The problem is COVRP with an additional constraint: the time between the first collecting point and the laboratory must be smaller or equal that a maximum time. The main objective is to minimize the number of vehicles used. We propose a Bias Random Key-Genetic Algorithm, and present results for real instances and classical ones. For the real instances, we could reduce significantly the number vehicle significantly.

■ MB-17

Monday, 10:30-12h00

RB-2105

Location and GIS

Stream: Applications of Location Analysis

Invited session

Chair: *Burcin Bozkaya*, Sabanci School of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, bbozkaya@sabanciuniv.edu

1 - A fast spatial query algorithm for location analysis

Honora Smith, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, honora.smith@soton.ac.uk

The use of new spatial query capabilities in relational databases combined with specific heuristics has allowed us to create an algorithm that can process very large location modeling problems at high speed. The program was developed to tackle a healthcare modeling problem in South Africa that had over 3,200 demand points and 220 possible service locations. Using a version of Microsoft® SQL Server, possible solutions for this problem have been found in a few minutes. Visualization of travel to nearest service locations is facilitated by Google Maps route finding capabilities.

2 - Location Survey and GIS (Geographic Information System) for Shopping Centers Across the Country (Turkey)

Ceren Erdin Gundogdu, Business Administration, Yildiz Technical University, Barboros Bulvari Besiktas, 34349, Istanbul, Turkey, ceren_erdin@yahoo.com

Being a part of social life, Shopping Centers (SCs) become more popular and represent the environments where consumption comes into prominence. In this study a model based on geographical information system was created and decision making process was analyzed with the purpose of location survey of SCs to be opened across the country by taking population, economic and social data, geographical and spatial data. In analysis, ESRI, ArcGIS software pack, ArcCatalog, ArcMap, ArcToolbox tool boxes and software required for topology development, data conversion and geographical analysis were used.

3 - Locating Temporary Shelter Areas After a Large-Scale Disaster

Burcin Bozkaya, Sabanci School of Management, Sabanci University, Orhanli, Tuzla, 34956, Istanbul, Turkey, bbozkaya@sabanciuniv.edu, *Firat Kilci, Bahar Yetis Kara*

In this study, we develop a mathematical model that decides on the location of shelter areas and the population assignment to these areas. Our formulation is based on Turkish Red Crescent's criteria on shelter area selection. We employ a GIS-based decision support system to implement our model. The system retrieves the distance data from ArcGIS and obtains a solution with the help of Gurobi optimization software. The resulting solutions are visualized on a map that is generated by ArcGIS. We perform a case study on Kartal, a district of Istanbul, Turkey, using our decision support system.

■ MB-18

Monday, 10:30-12h00
RB-2107

Risk Analysis and Options

Stream: Financial Modelling & Risk Management (contributed)

Contributed session

Chair: *Susanne Griebisch*, School of Finance and Economics, University of Technology Sydney, PO Box 123 Broadway, 2007, Sydney, NSW, Australia, susanne.griebisch@uts.edu.au

1 - Designing a combinatorial auction for real estate

Dries Goossens, Operations Research and Business Statistics (ORSTAT), KU Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Dries.Goossens@econ.kuleuven.be, *Frits Spijksma*, *Onderstal Sander*

Real estate auctions are not uncommon, but typically involve a sequential and individual auctioning of properties, with bidders facing the exposure problem. Further, in a real estate setting, there may be various constraints on the allocation, and bidders are often inexperienced. Taking this into account, we discuss the design of a combinatorial auction (choices with respect to e.g. pricing, feedback, and activity rules), resulting from a simulation with students. We also present complexity results for the winner determination problem.

2 - A Stochastic Volatility Cointegration Model in Continuous Time

Susanne Griebisch, School of Finance and Economics, University of Technology Sydney, PO Box 123 Broadway, 2007, Sydney, NSW, Australia, susanne.griebisch@uts.edu.au, *Kay Pilz*

We investigate the valuation of spread options written on futures contracts which exhibit co-movement over large time periods. In general, co-moving futures display certain characteristics when deviating from their normal spread level due to changes from usual market conditions, e.g. the mean-reversion of spreads. However, we detect a new property between co-moving futures in the empirical data and propose a model that allows for a representation of this property. In a second step, we derive pricing formulas for European and spread options. We conclude with a discussion of numerical results.

■ MB-19

Monday, 10:30-12h00
RB-2111

Energy and Environmental markets

Stream: Commodities and Financial Modeling

Invited session

Chair: *Silvana Stefani*, Quantitative Methods for Economics and Business Sciences, Università Milano Bicocca, Piazza Ateneo Nuovo 1 U7-4023, I-20126, Milano, Italy, silvana.stefani@unimib.it

1 - The impact of grandfathering on emission certificates for the electricity sector

Paolo Falbo, Department of Quantitative Methods, University of Brescia, Contrada Santa Chiara, 50, 25122, BRESCIA BS, Italy, falbo@eco.unibs.it, *Daniele Felletti*, *Silvana Stefani*

We focus on the impact of EUAs on the optimal policy of a competitive electricity producer. The effect of grandfathering is consistently shown to introduce significant distortions to the system. It is theoretically shown that there is a threshold value of carbon price so that, for prices above this, the EUA becomes an incentive for reduced production rather than a penalty for inefficient producers. These theoretical results are supported by the data of one producer from Italy and one from Germany.

2 - An inspection of Energy and Agricultural Markets after Fukushima

Angelica Gianfreda, Florence School of Regulation, EUI, Italy, angelica.gianfreda@eui.eu, *Giacomo Scandolo*

After the earthquake occurred in Fukushima in March 2011, the hypothesis of replacing nuclear generation with alternative sources has been explored. Then considering the need to mitigate climate change and reduce carbon emissions, renewable sources have attracted an increasing interest. However, wind, solar and wave energy show serious limitations, hence biofuels are becoming an interesting issue with implications on agricultural commodities and consequently on world population. Therefore, this contribution is aimed to understand the impact of Fukushima on energy and agricultural markets.

3 - Forecasting Volatility with Interday or Intraday Data: A Case Study on Istanbul Stock Exchange 30 National Index

Alper Inkaya, Middle East Technical University, Institute of Applied Mathematics, METU Üniversiteler Mah. Dumlupınar Blv. No:1, Çankaya, 06800, Ankara, Turkey, ainkaya@metu.edu.tr

Finding a proper volatility model that forecasts true volatility accurately lies in the heart of risk management and asset valuation. We compare forecasting performance of time series models, such as ARCH type models and ARFIMA model, by estimating one-day ahead daily volatility of the Istanbul Stock Exchange 30 National Stock Index using historical and realized volatility measurements. We control whether ISE 30 daily close series has long memory, and compare the forecasting ability of long memory models by several penalty criteria with traditional models.

■ MB-20

Monday, 10:30-12h00
RB-2113

Data Mining and Risk Analysis

Stream: Data Mining in the Financial Sector

Invited session

Chair: *Marcus Hildmann*, Information Technology and Electrical Engineering, ETH Zurich, ETL G 24.2, Physikstrasse 3, 8092, Zürich, Switzerland, hildmann@eeh.ee.ethz.ch

1 - Estimation of Stochastic Volatility Models for Commodities with few Options

Gonzalo Cortazar, Ingenieria Industrial y de Sistemas, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, Santiago, Chile, gcortaza@ing.puc.cl, *Federico Alonso*

Stochastic volatility specifications are required to adequately model the dynamics of commodity prices. To obtain good parameter estimates, prices for non-linear derivatives with different maturities are necessary, but some commodities trade only futures and short-term options. This paper proposes a three-factor multicommodity model with stochastic volatility and shows how to use long-term options written on one commodity to help estimate the dynamics of another. The model is implemented for Brent and WTI commodities with excellent results.

2 - Data cleansing of implied volatility surfaces

Dejan Stokic, tbd, 60386, Frankfurt, Germany, sdeyan@gmail.com

Data cleansing of implied volatility surfaces is one of the most important topics in managing the risk of options portfolios. We set the focus on the static arbitrage checks and assume that implied volatility surfaces are already cleaned of outliers and missing data points. We present a non-parametric method for correcting the surface, so that resulting surface is convex in moneyness dimension and monotonic in time to expiry dimension, while at the same time keeping the distribution of implied volatility returns of the surface points minimally changed.

3 - A Linear Programming Model for Enhanced Indexation based on Strong Stochastic Dominance

Renato Bruni, Dip. Ingegneria Informatica, Automatica e Gestionale, University of Roma "Sapienza", Via Ariosto 25, 00185, Roma, Italy, renato.bruni@dis.uniroma1.it, Francesco Cesarone, Andrea Scozzari, Fabio Tardella

In the field of Portfolio Optimization, Enhanced Indexation is the problem of selecting a portfolio that generates excess return with respect to a benchmark index. In this work, we propose a linear programming model for Enhanced Indexation that selects an optimal portfolio according to a generalization of strong stochastic dominance. Since our model has an exponential number of constraints, we solve it through a constraint generation procedure. Some experimental results are presented for well-known financial data sets showing good out-of-sample performance of our model.

4 - Pump Storage Hydro Plant Valuation under Risk Constraints

Marcus Hildmann, Information Technology and Electrical Engineering, ETH Zurich, ETL G 24.2, Physikstrasse 3, 8092, Zürich, Switzerland, hildmann@eeh.ee.ethz.ch, Florian Herzog, Sebastiano Rossi

For power producers, the valuation of pump storage hydro plants becomes an important task for investment decisions, capacity market participation and operation planning. We propose a scenario based linear programming approach, which maximizes the profit by calculating the optimal power plant operation schedule on hourly basis with cVaR as risk constraint. In addition, capacity markets, such as control energy markets can be taken into account. The presented method allows valuing pumped storage hydro plants, including risk and control energy reserves in a computational efficient way.

■ MB-21

Monday, 10:30-12h00

RB-2115

Financial Mathematics and OR 2

Stream: Financial Mathematics and OR
Invited session

Chair: Tansel Avkar, Department of Mathematics, Middle East Technical University, 06531, Ankara, Turkey, tanselavkar@gmail.com

1 - Recently crisis, credit boom and nonperforming loans in CEE countries-panel data evidence

Blanka Škrabić Perić, Department of Quantitative Methods, Faculty of Economics, Matice hrvatske 31, Split, Croatia, bskrabic@efst.hr, Josip Arneric

The paper investigates impact of credit boom during 2000th and recently crisis on nonperforming loans in CEE counties. Namely, the beginning of 2000th was characterized by many features as the foreign capital inflow, entry of foreign banks and economic growth. The rapid credit growth and lenient credit standard in the period before the crisis have caused an increase in nonperforming loans during the crisis. Dynamic panel data is used to analyze the impact of rapid credit growth on nonperforming loans in 16 CEE countries during period 1994-2010 on aggregated data for each country.

2 - A Technology Credit-Scoring Model for Service Industry

So Young Sohn, ISE, Yonsei university, Shinchon-dong, 134, Sudaemoon-gu, 137-049, Seoul, Korea, Republic Of, sohns@yonsei.ac.kr, Mooyeob Lee

A technology credit guarantee fund is established to support the growth and innovation of small and medium enterprises (SMEs) based on their technology. A technology credit-scoring model has been introduced to select applicants in a manner intended to reduce their loan default rate. However, this model was heavily influenced by the manufacturing industry, although the role of the service industry has been growing. In this paper, we propose a new technology credit-scoring model for the service industry by applying a logistic regression model to empirical data.

3 - Properties and Calculation of MVaR and MCVaR

Jinwook Lee, RUTCOR, Rutgers University, 640 Bartholomew Rd., 08854, Piscataway, New Jersey, United States, Jinwook@rci.rutgers.edu, Andras Prekopa

In a recent paper by A. Prekopa (2010) a survey is presented in connection with Multivariate Value-at-Risk (MVaR) that has been known for some time under the name of p-Level Efficient Point (pLEP) and a new multivariate risk measure, called Multivariate Conditional Value-at-Risk (MCVaR), was introduced. The purpose of this paper is to further develop properties of MVaR and MCVaR. This includes the presentation of a new methodology to numerically calculate MCVaR, by the use of the discrete moment problem. Numerical examples are presented.

4 - A bank's attractiveness as described by a cusp catastrophe model

Vassilis Angelis, Business Administration, University of the Aegean, Michalon 8, 82100, Chios, Greece, v.angelis@aegean.gr, Katerina Dimaki

In the present paper we introduce a bank's Image as a measure giving the true picture of its current state of development and future prospects. This picture when received and perceived by its customers will determine their attitude. Based on this Image existing/potential customers will decide to stay/cooperate or not with the given bank. However, the perception and reaction times to any changes of a bank's Image are different for the various groups of its customers. Our objective is to define a bank's Image, build a model for it and apply it to a real case.

■ MB-22

Monday, 10:30-12h00

RB-2117

Multiple-criteria evaluation and decision-making under fuzziness: theory and applications

Stream: Fuzzy Sets and Soft Computing
Invited session

Chair: Jana Talasova, Dept. of Mathematical Analysis and Applications of Mathematics, Faculty of Science, Palacky University Olomouc, tr. 17. listopadu 1192/12, 771 46, Olomouc, Czech Republic, jana.talasova@seznam.cz

1 - A multi-agent multiple-criteria approach to fraud detection under fuzziness

Mario Fedrizzi, Department of Computer and Management Sciences, Universita di Trento, Via Inama 5, 38122, Trento, Italy, mario.fedrizzi@unitn.it, Alessandro Buoni, Alessandro Buoni

We introduce a multi-agent system (FIDES) aiming at offering to a team of auditors an innovative way to manage fraud schemes, assuming that the judgments of auditors are represented by fuzzy preference relations. First we introduce a dynamical group decision model to achieve a consensual design of the attack tree, the basic component of the system. Then, starting from a linguistic valuation of the nodes of the attack tree, we show how to propagate the values up the tree through an aggregation process based on multiple-criteria techniques.

2 - Multiple criteria evaluation of creative work outcomes

Jana Talasova, Dept. of Mathematical Analysis and Applications of Mathematics, Faculty of Science, Palacky University Olomouc, tr. 17. listopadu 1192/12, 771 46, Olomouc, Czech Republic, jana.talasova@seznam.cz, Jan Stoklasa

The Register of Artistic Performances is currently being developed in the Czech Republic that contains information on works of art originating from creative activities of art colleges. Outcomes in various fields of artistic production are divided into 36 categories. The abstract categories are scored according to the significance, size, and international

reception of corresponding works of art. The Saaty's matrix of pairwise comparisons is applied to determine the scores of categories. A new view to the scores calculation and a notion of week consistency of the Saaty's matrix were introduced.

3 - Linguistically oriented model for academic staff performance evaluation

Jan Stoklasa, Dept. of Mathematical Analysis and Applications of Mathematics, Faculty of Science, Palacky University Olomouc, tr. 17. listopadu 1192/12, 771 46, Olomouc, Czech Republic, jan.stoklasa@upol.cz, *Jana Talasova*, *Pavel Holeček*

The information system for academic staff performance evaluation (IS HAP) currently used at Palacky University in Olomouc will be presented. The core of IS HAP is a multiple criteria evaluation model based on linguistic fuzzy rule bases. The apparatus of linguistic fuzzy modelling enables us to describe complex aggregation functions in a way comprehensible to the evaluators and academic staff members that are being evaluated. Innovative ways of interpreting the outputs of the evaluation and using them for classification purposes will also be presented.

4 - Multicriteria analysis of teacher's managerial competencies

Helena Brozova, Dept. of Systems Engineering, Czech University of Life Sciences, Kamýcka 129, 165 21, Prague 6 - Suchbát, Czech Republic, brozova@pef.czu.cz

This article deals with identification and evaluation of the students' expectance of teacher's competencies at the Faculty of Economics, Czech University of Life Sciences in Prague. In this research we do not intend to evaluate the teacher's scientific ability which can't be subject of students' evaluation. The key characteristics of the managerial competencies of teachers are set according to the Casselmann typology of teacher's roles. Than the students pairwise comparisons of various teacher's characteristics and competencies were analysed using the Analytic Hierarchy Process.

■ MB-23

Monday, 10:30-12h00

RB-Delta

Optimality Conditions and Stability

Stream: Generalized Differentiation and Optimization
Invited session

Chair: *Alexander Kruger*, School of Science, Information Technology & Engineering, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, weber@metu.edu.tr

1 - First and Second Order Optimality Conditions for Vector Optimization Problems with Non-solid Positive Cone

Valentin Gorokhovich, Institute of Mathematics, National Academy of Sciences of Belarus, ul. Surganova, 11, 220072, Minsk, Belarus, gorokh@im.bas-net.by

The talk deals with a nonlinear vector optimization problem with non-solid ordering cone. The main purpose is to present a unified approach to deriving first and second order optimality conditions, both necessary and sufficient, for solutions of this problem. Our approach includes two stages. At first, we reduce the vector optimization problem to the variational system consisting of the scalar inequality and the operator equality, and then, analyzing this system with variational (convex and nonsmooth) methods, we obtain optimality conditions.

2 - Risk-Sensitive Average Optimality in Finite and Denumerable Markov Decision Chains

Karel Sladky, Department of Econometrics, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, Pod Vodarenskou vezi 4, 18208, Prague 8, Czech Republic, sladky@utia.cas.cz

The contribution is devoted to the risk-sensitive optimality criteria in finite or denumerable state Markov Decision Chains, where expectation of the stream of one-stage rewards generated by a Markov chain is evaluated by exponential utility function. Then even for unichain models risk-sensitive average optimality may depend on the starting state and be optimal only if the process starts in transient state. Explicit formulae and optimality conditions for the growth rates of expected utility as well as for mean value of the corresponding certainty equivalent will be discussed.

■ MB-24

Monday, 10:30-12h00

CC-A11

Centralized Inventory and Production

Stream: Game Theory and Logistics

Invited session

Chair: *Ana Meca*, Operations Research Center, Universidad Miguel Hernández, Avda. Universidad s/n, Edificio Torretamarit, 03202, Elche, Alicante, Spain, ana.meca@umh.es

1 - Cooperation in Assembly Systems: the Role of Knowledge Sharing Networks

Fernando Bernstein, The Fuqua School of Business, Duke University, 100 Fuqua Drive, 27708, Durham, NC, United States, fernando@duke.edu, *Gurhan Kok*, *Ana Meca*

We consider an assembly system with a buyer purchasing components from several first-tier suppliers. Suppliers incur variable inventory costs and fixed setup production costs, and invest in process improvement activities which have a direct impact on their fixed costs. The assembler establishes a knowledge sharing network, modeled as a cooperative game among suppliers. As a result of cooperation, all suppliers achieve a level of cost reduction equal to that of the most efficient supplier. We investigate the resulting impact on the investment process and cost structure for the assembly system.

2 - Cost allocation in inventory transportation systems

Ignacio García-Jurado, Department of Mathematics, Coruna University, Faculty of Computer Science, Campus de Elvina, 15071, Coruna, Spain, igjurado@udc.es, *M^a Gloria Fiestras-Janeiro*, *Ana Meca*, *Manuel Alfredo Mosquera Rodríguez*

We deal with the cost allocation problem arising in an inventory transportation system with a single item and multiple agents that place joint orders using an EOQ policy. The fixed order cost of each agent is defined and the assumptions are stated. For these inventory transportation systems we introduce and characterize a rule which allows us to allocate the costs generated by the joint order. We show that our rule has good properties from the point of view of stability.

3 - Capacity sharing: capacity or labor division? A cooperative game approach

Shoshana Anily, Faculty of Management, Tel Aviv University, 69978, Tel Aviv, Israel, anily@post.tau.ac.il

In this talk we discuss two types of capacity sharing approaches to model various service/production systems as cooperative games with transferrable utility, and we analyze their core. The literature on cooperative games usually assumes that total capacity is divisible and allocable additively. This premise is reasonable in some settings, but in others it may yield unacceptable solutions. We suggest another approach, which is aligned with the concept of division of labor, where total processing time, rather than total capacity over all resources, is allocated additively.

4 - k-norm Cost Games with Critical Players

Ana Meca, Operations Research Center, Universidad Miguel Hernández, Avda. Universidad s/n, Edificio Torretamarit, 03202, Elche, Alicante, Spain, ana.meca@umh.es, Greys Sosc

In this talk, we present some special classes of cost games that satisfy k-norm property and possess players who contribute to cost reduction of all members of the alliance that they belong to (which we call critical players). This type of games can be found in knowledge-sharing games, inventory games, holding cost games, etc. While papers analyzing these games study specific examples of k-norm cost functions and analyze how players can reduce their cost through cooperation, our goal is to provide an analysis of stability for more general classes of k-norm games with critical players.

■ MB-25

Monday, 10:30-12h00
CC-A23

Practical Issues of Environmental Management

Stream: Energy, Environment and Climate 1
Contributed session

Chair: *Carmen Anido*, Economic Analysis: Quantitative Economy, Autonoma University of Madrid, Faculty of Economics, Cantoblanco., 28049, Madrid, Spain, carmen.anido@uam.es

1 - Dynamic Modelling of Climate Change Adaptation Pathways: The Case of Surf Life Saving Australia

Oz Sahin, School of Engineering, Griffith University, Gold Coast Campus, 4222, Griffith University, Qld, Australia, o.sahin@griffith.edu.au, *Marcello Sano*, *Russell Richards*, *Shauna Sherker*

Surf Life Saving Australia (SLSA) is Australia's major water safety and rescue authority whose assets and operations are threatened by extreme events and sea level rise. This research aims to explore adaptation pathways and enhance the capacity of SLSA to tackle these threats. To achieve this aim, systems dynamics is used to test conceptual models developed by stakeholders. These models are designed to connect climatic drivers, impacts on assets, operations and communities, and strategies to improve adaptive capacity. The initial outcomes of 4 case studies across Australia will be presented.

2 - Materials and Technologies for Industrial Heritage Sustainability

Michal Ganobjak, Institute of History and Theory of Architecture and Monument Restoration, Slovak university of technology, Faculty of architecture, Námetie slobody 19, 812 45, Bratislava, Slovakia, Slovakia, ganobjakm@gmail.com, *Eva Kralova*

We study the efficient use of brownfield sites, buildings of manufacturing process converting to the new alive features. The adaptation of the industrial heritage to the new features while maintaining the values must be chosen thoughtfully. Our study shows the optimization of intervention choices through simulation and visualization of local resources and their interactions. It comprehensively sees the issue of social sustainability, ecology of abandoned industrial environment and its economic aspect.

3 - Impacts of Climate Change on the Slovak Economy

Tomas Domonkos, Institute of Economic research, Slovak Academy of Sciences, Sancova 56, 81105, Bratislava, Slovakia, tomas.domonkos@savba.sk, *Ivan Lichner*

Climate change represent one of the most challenging issues humanity has to face, because they could critically affect all areas of our life. We aim to analyze and determine the impact of climate change on the Slovak economy. Integrated Assessment Model which comprise of three sub-models was designed. Basic principles of the AD-DICE model developed by de Bruin, Dellink and Tol (2007) are incorporated into a recursive-dynamic CGE model which analyzes the impact of climate change under various adaptation intensive policies.

■ MB-26

Monday, 10:30-12h00
CC-A24

Recent Research Advances in the Oil Sector

Stream: OR in the Oil and Gas Sectors
Invited session

Chair: *Irina Dolgoplova*, Economics and Administrative Sciences, Middle East Technical University, Odu Kent, Konuk Evi 1, B Block, 108, Ankara, Turkey, 06420, Ankara, Turkey, irina.dolgoplova@gmail.com

1 - From a decoupled to an integrated planning approach in the supply chain of specialty oils

Mario Guajardo, Finance and Management Science, NHH Norwegian School of Economics, NHH, Institutt for Foretaksøkonomi, Helleveien 30, 5045, Bergen, Norway, Mario.Guajardo@nhh.no, *Martin Kylinger*, *Mikael Rönnqvist*

We propose linear models for decoupled and integrated planning in a divergent supply chain for specialty oils. The optimization problem involves decisions on production, inventory, transportation, sales and distribution. The integrated objective is to maximize contribution. In the decoupled approach, an internal price system pursues to align sellers with this objective. While the total contribution is higher in the integrated solution, the sellers' contribution may be lower. We suggest contribution sharing rules to make both the company and sellers better off under the integrated planning.

2 - Dynamic pricing application in the energy market

Gamze Oğcu, Industrial engineering, Fatih University, Büyükcckmece, 34500, İstanbul, Turkey, gamzeogcu@gmail.com, *Ozlem Cosgun*

The recent rise in world oil prices and the consequent run-up in gasoline prices provide a useful analog for illustrating the role of dynamic pricing in electricity markets. In this study, we consider a dynamic pricing problem in one of the private energy companies in Turkey. In the competitive market electricity prices change very frequently, so pricing is the most important tool to response demand. We resort stochastic dynamic programming to decide on the optimal policy. The results show that the dynamic pricing policy provides more revenue than the policy applied currently.

3 - Revenue management and pricing: A case study for a natural gas supplier

Ozlem Cosgun, Industrial Engineering, Fatih University, Fatih Universitesi endustri muhendisligi bolumu, Hadımkoş Kampüs Buyukcekmece, 34500, buyukcekmece, İstanbul, Turkey, ozlem_ince@hotmail.com, *Emre Meterelliyoz*, *Abdulkadir Kıvrak*, *Yunus Sartık*, *Seniye Ümit Oktay Fırat*

In this study, the dynamic pricing problem of a natural gas supplier in İstanbul is considered. The natural gas consumption is varied according to the months and cities since the weather condition and revenue levels of the people in these cities are important factors in consumption amount. Clustering analysis is used for determining clusters which show similar consumption behavior. Our goal is to find optimal prices for each cluster by using stochastic dynamic programming. We try to search whether the revenue levels increase by applying dynamic pricing policy instead of fixed pricing or not.

■ MB-27

Monday, 10:30-12h00
CC-A25

MCDA and Decision Processes

Stream: Decision Processes
Invited session

Chair: *K. Nadia Papamichail*, Manchester Business School, University of Manchester, Booth Street East, M15 6PB, Manchester, United Kingdom, nadia.papamichail@mbs.ac.uk

1 - Design and evaluation of MCDA interventions

K. Nadia Papamichail, Manchester Business School, University of Manchester, Booth Street East, M15 6PB, Manchester, United Kingdom, nadia.papamichail@mbs.ac.uk, *Theodor Stewart*

This paper presents a framework for analyzing and evaluating multi-criteria decision analysis (MCDA) interventions. The framework is applied to two case studies to illustrate the process of designing and implementing such interventions. We reflect on the process, the way it was managed, the composition of the decision body, the tools employed, the information exchanged between actors and the duration of the process. We discuss the outcomes and impact of the two MCDA interventions and provide lessons learned.

2 - Criteria definition and weight assignment in MCDA: a review on environmental problems

Miguel Morgado, INESC Coimbra and Faculty of Economics - University of Coimbra, Portugal, miguel.morgado@sapo.pt, *Luis C. Dias*

Environmental decisions processes involve usually a large number of stakeholders with conflicting interests. Multi-Criteria Decision Aiding (MCDA) methods have demonstrated to provide more insight and increase the transparency of the decision process. We present a literature review to analyze and understand how social actors are being involved in such decision processes, the roles of the experts and the roles of the researchers involved. We focus on two questions: who and how defines the criteria to evaluate the alternatives, and who and how assigns the weights to each criterion.

3 - Introduction to a new evidential reasoning rule for decision analysis

Jian-Bo Yang, Manchester Business School, The University of Manchester, Booth Street East, M15 6PB, Manchester, United Kingdom, jian-bo.yang@manchester.ac.uk

In the paper, a recently discovered ER rule is reported that provides a general process to combine multiple pieces of independent evidence in the form of belief distribution under the common condition that every piece of evidence plays a limited role equal to its relative weight. It generates total belief from combination of any two pieces of evidence as the addition of the bounded average of individual support from each of them and the orthogonal sum of joint support from both of them. A numerical example is examined and its significance for decision analysis and processes are discussed.

4 - Supporting the restoration of historical portable organ with a new hybrid MCDM model

Tian-Jong Hwu, Business Management, National United University, 36003, Miaoli, Taiwan, tjhwu@nuu.edu.tw, *Mei-Chen Lo*, *Jerzy Michnik*, *Tadeusz Trzaskalik*, *Maciej Nowak*, *Gwo-Hshing Tzeng*

The physical state of any historical object exacerbates with time. An impression it makes on the public becomes effete and its value decreases. To counteract the influence of time, the conservation and restoration of historical objects are undertaken. Before starting conservation, the research to determine its range and to choose the best method should be undertaken. An aim of this study is to apply the new hybrid MCDM model DANP (DEMATEL-based ANP) to assessing the relative values of the historical portable organ and to rank the potential methods and range of conservation and restoration.

■ MB-28

Monday, 10:30-12h00
CC-A27

OR in Quality Management 2

Stream: OR in Quality Management
Invited session

Chair: *Gulser Koksak*, Industrial Engineering, Middle East Technical University, Inonu Blvd., 06800, Ankara, Turkey, koksak@ie.metu.edu.tr

1 - Optimum 2k-p factorial experiment sequencing: A bi-objective mathematical model

Vitoria Pureza, Production Engineering, Universidade Federal de Sao Carlos, Via Washington Luiz, km 235, 13564-090, Sao Carlos, Sao Paulo, vpureza@dep.ufscar.br, *Pedro Oprime*, *Antonio Branco Costa*

Sequencing experiments with good statistical properties and low costs is a key challenge for both researchers and practitioners. We address the problem by proposing a mathematical programming formulation that aims to generate minimum cost run orders with the best statistical properties for 2k full-factorial and fractional-factorial designs. Results for designs of up to 64 experiments indicate that the approach is capable of producing optimal or sub-optimal solutions regarding the objectives addressed for a given design matrix.

2 - Observer scheduling for quality monitoring

Satyaveer S. Chauhan, John Molson School of Business, Concordia University, MB 11-317, 1455 de Maissonneuve, Blvd. west, H3G 1M8, Montreal, Quebec, Canada, sschauha@alcor.concordia.ca, *Anjali Awasthi*, *Anna Guinzbourg*

We propose a decision tool for scheduling observers to access the service quality in the field. The location of service professional changes dynamically but known. An observer should spend a predefined time with the service professionals. Services are provided 24 hrs basis but the observers are scheduled during the daytime. The goal is to observer every staff for a given number of times during the planning horizon. The overall problem is similar to travelling salesman problem and we develop a heuristic approach and tested on the real data set. The experimentation results will be presented.

3 - A two-stage stochastic programming model for p-chart design

Elif Elcin Gunay, Industrial Engineering, Sakarya University, Sakarya, Sakarya, Turkey, eekabeloglu@gmail.com, *Ufuk Kula*, *Tülin Aktin*

Car manufacturing is performed in three shops called body, paint and assembly. To control the painting operations it is common to use an attributes (p-chart). Determination of chart parameters affects the paint shop objectives (minimizing the color-changeover, or maximizing the capacity). Therefore, it is important to consider paint shop constraints and objectives in the design of a p-control chart. Problem formulated as a two-stage stochastic programming problem, and solved by using sample approximation algorithm. We provide managerial insights on the problem by performing a numerical study.

■ MB-29

Monday, 10:30-12h00
CC-A29

Robust Optimization and Non-Convex Integer Programming

Stream: Mixed-Integer Non-Linear Programming
Invited session

Chair: *Emiliano Traversi*, Fakultät für Mathematik, Technische Universität Dortmund, Germany, emiliano.traversi@gmail.com

1 - Cutting Planes for the Network Loading Problem with Stochastic Demands

Konstantinos Kaparis, Management Science, Lancaster, United Kingdom, k.kaparis@lancs.ac.uk, *Adam Letchford*, *Stein W. Wallace*

We consider a stochastic variation of the Network Loading Problem. The demand is uncertain and its realisation depends on a finite number of scenarios. We model this problem as a 2-stage stochastic mixed-integer program with complete recourse. We introduce the new class of probabilistic metric inequalities and we describe a heuristic separation algorithm. Finally, we report our computational results from the application of the proposed scheme on a set of test instances.

2 - Robust Integer Non-Linear Optimization

Ruth Hübner, Institut für Numerische und Angewandte Mathematik, Georg-August-Universität Göttingen, Lotzestraße 16-18, 37083, Göttingen, Germany, r.huebner@math.uni-goettingen.de, *Anita Schöbel*

Finding robust solutions of an optimization problem is relevant for applications since for most practical problems the input data is not known exactly but depends on some unknown scenario. The concept of strict robustness asks for the best solution which is feasible for every scenario. This is in particular hard for integer optimization problems. We investigate the level sets of the robust problem and identify which properties of the original problem still hold for its robust counterpart. In particular, we show in which cases an optimal integer solution can be obtained by rounding techniques.

3 - A concave programming approach for Sparse Principal Component Analysis and Sparse representation of signals

Francesco Rinaldi, Dipartimento Informatica e Sistemistica, Sapienza, via Ariosto, 25 Roma, 00185, Rome, Italy, rinaldi@dis.uniroma1.it, *Giampaolo Liuzzi*

We consider Sparse Principal Component Analysis (SPCA) and sparse representation of signals. SPCA is important for data analysis and compression and has applications in science and engineering. The goal is obtaining principal components with only a few nonzero coefficients, which are usually easier to interpret. The second problem is studied in signal analysis and consists in finding a sparse representation of a signal in terms of a given dictionary. We propose an algorithm based on concave programming formulations of the problems and present numerical results on test problems and real data.

4 - Separable underestimators for Quadratic Combinatorial Optimization.

Emiliano Traversi, Fakultät für Mathematik, Technische Universität Dortmund, Germany, emiliano.traversi@gmail.com, *Christoph Buchheim*

We propose a method to obtain separable underestimators for Quadratic Combinatorial Optimization Problems. By exploiting separability we can provide lower bounds by solving an Integer Linear Problem and use them in a Branch and Bound scheme. This is useful in practice when the underlying linear counterpart is easy to solve. We investigate the tightness of the bounds and their effect on the running time of the algorithm. Computational results are provided concerning the Quadratic Binary Unconstrained Problem and the Quadratic Spanning Tree Problem.

■ MB-30

Monday, 10:30-12h00
CC-A31

Emerging Applications in Finance

Stream: Emerging Applications in Finance and Logistics

Invited session

Chair: *Amparo Soler-Dominguez*, Universitat Jaume I, Spain, amparo.soler@uji.es

1 - Assessing the role of managers as determinants of mutual fund efficiency: a nonparametric approach

Amparo Soler-Dominguez, Universitat Jaume I, Spain, amparo.soler@uji.es, *Emili Tortosa-Ausina*, *Juan Carlos Matallin-Saez*

This study contributes to an incessant intent of achieving conclusions from the manager decision-making and its implications for the portfolio efficiency. We apply non-parametric techniques for measuring mutual fund's performance and we extend the methodology in order to isolate the manager's influence on the degree of efficiency reached. Results shed light both on investors and practitioners' concerns because differences among managers do actually arise. This work provides a guide for evaluating managers' forecasting ability and how they perform covering ex ante investors' expectations.

2 - Optimal stopping rules for the random horizon duration problems

Mitsushi Tamaki, Business Administration, Aichi University, 370 Kurozasa Miyoshi, 470-0296, Nishikamo, Aichi, Japan, tamaki@vega.aichi-u.ac.jp

As a variation of the secretary problem, Ferguson et al. considered a problem called duration problem whose objective is to maximize the time of possession of a relatively best object when a known number of objects appear. We here generalize this problem into two directions by allowing the number N (of objects) to be a random variable with a known upper bound n and also allowing the objects to appear in accordance with Bernoulli trials. We give a sufficient condition for the optimal rule to be a threshold rule.

3 - The Effects of Topology and Behavioral Canon on Network Equilibria

Abhijit Deshmukh, School of Industrial Engineering, Purdue University, 241 Grissom Hall, 47907, West Lafayette, IN, United States, abhi@purdue.edu, *Brandon Pope*

Network topology has far ranging implications on the presence of contagion effects and existence of equilibria in networks of agents. Behavioral canon, which determines how decisions are made and the evolution of states in the network, is defined by the interaction mechanism between agents through the network topology. This presentation considers two behavioral canon paradigms, bargaining and diffusion. We study the impact of each paradigm on the speed and quality of the equilibria reached on networks. Specifically, we study hybrid networks of Poisson random graphs and scale-free networks.

■ MB-31

Monday, 10:30-12h00
CC-A33

Game Theory and Social Networks 2

Stream: Game Theory and Social Networks

Invited session

Chair: *Elisenda Molina*, Statistics, Universidad Carlos III de Madrid, Madrid, Spain, elisenda.molina@uc3m.es

1 - Social Capital. A Game Theoretic Approach.

Enrique González-Arangüena, Statistics and Operation Research III, Complutense University of Madrid, Avda. Puerta de Hierro s/n, 28040, Madrid, Madrid, Spain, egaran@estad.ucm.es, *Anna Khmel'nitskaya*, *Conrado M. Manuel*

The notion of social capital appeared initially to highlight the importance of social networks relations as a valuable resource for social and/or economic affairs. We define an index of social capital using game-theoretical concepts. We assume that interests of individuals are presented by means of a cooperative game which take into account possibly different players abilities. The network of players relations is modeled by a (undirected) graph. The social capital of each actor is then measured as the difference between his Myerson value and his Shapley value.

2 - A Game-theoretic Approach to Networks

Martha Saboya, Análisis Económico: Economía Cuantitativa, Universidad Autónoma de Madrid, Paseo de la Chopera 206, 1º-B, 28100, Alcobendas (Madrid), Madrid, Spain, martha.saboya@uam.es, *Guillermo Owen*, *Susana Lopez*

We consider teams whose members are represented as nodes of a graph. By cooperation, the several members can accomplish much more than by acting individually. This collaboration is however only possible if the several members can communicate, and this requires links in the graph. The links can be more or less effective; being effective links generally more costly. We use the Myerson approach to games on graphs to represent the amount of work that can be done, and the method of multilinear extensions to represent more or less efficient links. This allows us to look for optimal links.

3 - Average Forest Value for Directed Graph Restricted Games

Elisenda Molina, Statistics, Universidad Carlos III de Madrid, Madrid, Spain, elisenda.molina@uc3m.es, *Ramon Flores*, *Anna Khmel'nitskaya*, *Juan Tejada*

We propose a value for cooperative TU games with partial action, when influence relations are directional: the Average Forest Value. Based on this concept, we also propose an index of global Social Network Efficiency which measures the ability of the network to promote efficient coalition structures to form. We analyze their properties and show their behavior by means of some illustrative applications (hierarchies, symmetric games, ...).

■ MB-32

Monday, 10:30-12h00

CC-A34

Understanding the Practice of Soft OR Interventions I

Stream: Soft OR and Problem Structuring Methods
Invited session

Chair: *L. Alberto Franco*, Hull University Business School, University of Hull, Management Systems, Cottingham Road, HU6 7RX, Hull, United Kingdom, alberto.franco@hull.ac.uk

1 - The emergence of agreements within facilitated modelling workshops

Thanos Papadopoulos, Hull University Business School, University of Hull, HU6 7RX, Hull, United Kingdom, a.papadopoulos@hull.ac.uk, *L. Alberto Franco*

The paper focuses on the emergence of agreements in facilitated modelling workshops. We address the literature gap concerning the dynamics and mechanisms that underpin trajectories and outputs of soft OR interventions using Actor-Network Theory (ANT). Our analysis suggests that the trajectories and outcomes of such interventions are socially constructed, emerging from associations of humans and non-humans. We also argue that in practice ANT offers 'translation' to explain the emergence of agreement in the workshop, whereas the workshop offers models and space for translation to occur.

2 - Exploring dialogue in problem structuring workshops

Elena Tavella, Institute of Food and Resource Economics, University of Copenhagen, Denmark, eta@foi.dk

The use of Problem structuring methods (PSMs) is claimed to have positive effects on the quality of dialogue. In this presentation I explore this by examining the dialogue from a PSM workshop held with members of a local food network in the UK. Drawing on Tsoukas' (2009) Dialogical Model of Organizational Knowledge Creation, I discuss the characteristics of productive dialogue, and assess the extent to which they were present in the workshop and how they related to the outputs. Implications of the use of a dialogue lens for research into and practice of PSM workshops will also be discussed.

3 - Exploring the communicative impact of Problem Structuring Methods: Results of an interaction-analysis based research.

Orestis Afordakos, Warwick Business School, University of Warwick, CV4 7AL, Coventry, United Kingdom, orestis.afordakos@gmail.com

This paper presents the results of an interaction analysis based research, examining non-experimental groups engaging in strategic conversations, while employing a facilitated PSM. The different elements of the research framework will be examined with particular emphasis on the methodological aspects of interaction analysis. Results in the areas of conflict management and model appropriations will be presented. The presentation will conclude with a discussion on the interpretation of the results.

4 - On the roles, uses, and effects of models in Soft OR workshops

L. Alberto Franco, Hull University Business School, University of Hull, Management Systems, Cottingham Road, HU6 7RX, Hull, United Kingdom, alberto.franco@hull.ac.uk

This presentation pays attention to how groups use models within the context of soft OR interventions. Models are conceptualised as artefacts with specific roles, uses and effects according to the relative complexity of different 'boundaries' faced by workshop participants during interaction. This conceptualisation is then illustrated via a series of case vignettes drawn from an ongoing research programme studying the impact of soft OR interventions in multi-organisational settings. The conceptual and prescriptive value of the conceptual framework is then discussed, as well as its implications for research into the evaluation of soft OR interventions.

■ MB-33

Monday, 10:30-12h00

CC-A37

OR and Modelling for Sustainable Development

Stream: OR for Development and Developing Countries
Invited session

Invited session

Chair: *Subhash Datta*, Institute of Management Technology, 35 Km Milestone, Katol Road, 441502, NAGPUR, Maharashtra, India, subhash.datta@gmail.com

1 - OR/MS Models for Sustainable Development in India

Subhash Datta, Institute of Management Technology, 35 Km Milestone, Katol Road, 441502, NAGPUR, Maharashtra, India, subhash.datta@gmail.com

The problems of sustainability can be resolved through OR/MS methods. However, there are major constraints like corruption, infrastructure inadequacies, bureaucratic deficiencies and long gestation periods in implementation. We discuss the possibility of future transformation of the society through continuous interactions and result oriented methodologies based on DSS, simulation and connectivity. Once the common people are ensured about the benefits in terms of more production, distribution and employment they have no hesitations in implementation of the OR/MS models.

2 - Multicriteria decision making in comparison of objective and subjective criteria of companies' success

Branka Marasovic, Faculty of Economics Split, 21000, Split, Croatia, branka.marasovic@efst.hr, *Ivana Tadic*

Although financial indicators usually are taken as the most important indicators of success, lately authors argue about the same relevance in usage of subjective indicators. The aim of this paper is to research whether the most successful companies regarding financial ratios (objective group of criteria) show similar results by other groups of criteria, as human resource management evaluation and evaluation of entire companies' success (subjective groups of criteria). Selected companies will be ranked by each group of criteria using multicriteria decision making method PROMETHEE II.

3 - Revised ICI as a leading indicator of Croatian industrial production during a recession

Mirjana Cizmesija, Faculty of Economics, Dept. of Statistics, University of Zagreb, J.F.Kennedy Square 6, 10000, Zagreb, Croatia, mcizmesija@efzg.hr, *Natasa Erjavec*, *Vlasta Bahovec*

With the aim to improve its forecasting properties, especially during a recession, we modified a standard composite leading indicator (ICI) in Croatia. Two revised ICIs are proposed and their predictive powers were analysed on the bases of several econometric models with variables: standard ICI, two revised ICIs and Croatian industrial production (y-o-y growth rate). As for a Croatian industrial production during the recession it is recommended to forecast only one quarter ahead and revised leading indicator, calculated with negative manager's answers, showed the best forecasting properties.

4 - Flexible approach in planning of infrastructure development

Jerzy Paslowski, Civil and Environmental Eng., Poznan University of Technology, Instytut Konstrukcji Budowlanych, ul. Piotrowo 5, PL 60-965, Poznan, Poland, jerzy.paslowski@put.poznan.pl

Flexible approach seems very useful in planning and design when environment is very difficult to predict and forecast. A special attention must be paid in design and planning of infrastructure in developing countries. Analysis of different types of infrastructure (highways, airports, bridges) demonstrates high potential to expand but real demand (traffic) is very difficult to forecast in typical time periods (years). The sudden development of low cost airline carriers is an example of this problem. In countries in transition a special attention must be paid on investment decision.

■ MB-34

Monday, 10:30-12h00

CC-A39

Cooperative games: dynamics, robustness and related topics

Stream: Cooperative Game Theory

Invited session

Chair: *Ehud Lehrer*, Tel Aviv University, 69978, Tel Aviv, Israel, lehrer@post.tau.ac.il

■ MB-35

Monday, 10:30-12h00

CC-A41

Assortment and Replenishment Planning

Stream: Demand and Supply in Consumer Goods and Retailing

Invited session

Chair: *Michael Sternbeck*, Supply Chain Management and Operations, Catholic University of Eichstaett-Ingolstadt, Auf der Schanz 49, 85049, Ingolstadt/Donau, Germany, Michael.Sternbeck@ku-eichstaett.de

1 - Joint product assortment, inventory and price optimization

Argyro Katsifou, TOM, École Polytechnique Fédérale de Lausanne (EPFL), Odyssea 1.16 - Station 5, 1015 Lausanne, Switzerland, 1015, Lausanne, Switzerland, argyro.katsifou@epfl.ch, *Ralf W. Seifert*, *Jean-Sébastien Tancrez*

We study a retailer's joint problem of product assortment, pricing and inventory management optimization given limited shelf space. The product assortment is composed of "standard" and "variable" products. We propose an iterative heuristic to find the combined product assortment as well as the inventory level and the price for each product that maximize retailer's overall profit. The results of our study are illustrated by numerical examples.

2 - Selecting order packaging units for store delivery in grocery retailing

Michael Sternbeck, Supply Chain Management and Operations, Catholic University of Eichstaett-Ingolstadt, Auf der Schanz 49, 85049, Ingolstadt/Donau, Germany, Michael.Sternbeck@ku-eichstaett.de, *Heinrich Kuhn*

In store operations are responsible for the highest share of operational costs within the internal retail network. The order packaging unit (OPU) per stock keeping unit is regarded as one driver of in store efficiency. This is the number of consumer units that are combined to

one order and distribution unit for supplying the individual stores. We consider a replenishment cycle system that is used by grocery retailers for non-perishable, non-seasonal and non-promotional items. For that setting, we present an approach with which appropriate OPUs can be selected to support packaging decisions.

3 - Scheduling in-store replenishments under service-level and capacity constraints

Rob Broekmeulen, OPAC, TU Eindhoven, P.O. Box 516, Pav. E10, 5600 MB, Eindhoven, -, Netherlands, r.a.c.m.broekmeulen@tue.nl

Almost half of the shelf allocations in planograms of retail stores are insufficient, resulting in overflow stocks in the backroom and frequent additional replenishments after the order delivery from the outside supplier. We propose a procedure to reduce the number of additional replenishment trips by clustering the products in schedules for joint in-store replenishment based on the service level target, the allocated store space on the shelves and the available handling capacity. The procedure can also assist planogramming decisions from a cost perspective.

■ MB-36

Monday, 10:30-12h00

CC-A43

DEA and Performance Measurement: Methodology 2

Stream: DEA and Performance Measurement

Invited session

Chair: *Dimitris Despotis*, Department of Informatics, University of Piraeus, 80, Karaoli & Dimitriou Street, 18534, Piraeus, Greece, despotis@unipi.gr

1 - Two-stage data envelopment analysis: A slack-based measure procedure for the upper bound performance

Fuh-Hwa Liu, Industrial Engineering & Management, National Chiao Tung University, 1001 Ta Shueh Road, Dept. IE&M, 300, Hsin Chu City, Taiwan, Taiwan, fliu@mail.nctu.edu.tw, *Yu-Cheng Liu*

We introduce a three-phase procedure to measure upper performance bound of 2-stage DEA problems. Phase I uses a slack-based measure (SBM) model to assess the process of converting inputs into outputs, and treats the intermediate items as non-discretionary. The intermediate items are then classified as to-be-decreased (TBD), not-to-be-changed (NC), and to-be-increased (TBI). Phase II employs another SBM model to assess the process of converting of inputs and outputs. Phase II repeats until no NCs are identified. Phase III is a SBM model, similar to Phase II but without NCs.

2 - Cost efficiency when prices are not fixed: Disentangling quantity and price efficiency

Emmanuel Thanassoulis, Aston Business School, Aston University, Operations and Information Management, B4 7ET, BIRMINGHAM, United Kingdom, e.thanassoulis@aston.ac.uk, *Maria Portela*

We propose an approach to compute and decompose cost efficiency in contexts where both input quantities and their prices can be adjusted to minimise the aggregate cost of the outputs produced. The models developed can accommodate situations where the degree of control over input prices is minimal. We introduce a novel decomposition of the overall measure of cost efficiency into a quantity and a price efficiency component. The efficiency measures are expressed in terms of percentage cost savings that can be attained through changing prices and quantities towards the overall minimum cost target.

3 - Value-based DEA: A piece-wise linear programming approach

Dimitrios-Georgios Sotiros, Department of Informatics, University of Piraeus, 18534, Piraeus, Greece, dsotiros@unipi.gr, *Dimitris Despotis*

Value-based DEA is a general approach to incorporate preferences in DEA efficiency assessments. One among the different methods proposed is to convert the raw input/output data into values (utilities). In this context, we present a piece-wise linear programming approach to DEA efficiency assessments, based on a data transformation-variable alteration technique and assurance-region constraints. Our developments are applicable in both oriented and non-oriented DEA models. We illustrate our approach with a data set drawn from the literature.

4 - An alternative approach to two-stage DEA with a series relationship between the stages

Gregory Koronakos, Informatics, University of Piraeus, KAPETAN ZAXARIAN 39, 18757, KERATSINI, Greece, gkoron@unipi.gr, Dimitris Despotis

The two fundamental approaches to efficiency assessment in two-stage DEA are the multiplicative and the additive. Both approaches assume a series relationship between the two stages and differ in the way they conceptualize the decomposition of the overall efficiency to the efficiencies of the individual stages. We present in this paper an alternative approach to additive efficiency decomposition in two-stage DEA. We test our models with data sets taken from previous studies and we compare the results with those reported in the literature.

■ MB-37

Monday, 10:30-12h00

CC-Act

Bioinformatics II

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: Aleksandra Swiercz, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, ola@man.poznan.pl

Chair: Pawel Wojciechowski, Poznan University of Technology, 60-965, Poznan, Poland, pwojciechowski@cs.put.poznan.pl

1 - Highly efficient parallel algorithm for de novo assembly

Aleksandra Swiercz, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, ola@man.poznan.pl, Piotr Gawron, Jacek Blazewicz, Marta Kasprzak

De novo assembly is the process of reconstructing an unknown DNA sequence from shorter fragments. Short fragments of an organism are read by sequencers, which can produce huge amount of fragments in short time. There is a need for the time-efficient algorithm which could assemble these fragments together. The proposed hybrid parallel method allows using two-level hierarchy: computations in threads (one node with many cores) and computations on different nodes in a cluster. Tests carried out on data of *Prochlorococcus marinus* showed high accuracy of the results and short time of computations.

2 - The fast method for contig extraction from the overlap graph

Piotr Gawron, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2,, 60-965, Poznan, piotr.gawron@cs.put.poznan.pl

In this study a method for fast searching of the overlap graph was proposed. In presented approach the heuristic algorithm looks for the longest path in a graph. This path corresponds to the longest contig in the overlap graph representation of a DNA assembly problem. It bases on an exact algorithm for minimum path coverage in acyclic graph. Because of the fact that overlap graph generally is not acyclic transformation of a graph to the acyclic form has been also proposed. The transformation uses specific properties of the overlap graph.

3 - A greedy randomized adaptive search procedure with Path Relinking for the Shortest Superstring Problem

Theodoros Gevezes, Mathematical, Physical and Computational Sciences, Aristotle University of Thessaloniki, 51124, Thessaloniki, Greece, theogev@gen.auth.gr

The Shortest Superstring Problem (SSP) is an NP-hard Combinatorial Optimization Problem (COP) which has attracted the interest due to its applications in DNA sequencing. GRASP is a heuristic that produces good quality solutions for a variety of COP. Path Relinking (PR) integrates intensification and diversification strategies in search for optimum solutions. An implementation of GRASP with PR for solving the SSP is developed for the first time. Computation results indicate that the new method finds the optimum solution in many cases and if not, its solutions are very close to the optimum ones.

4 - A lattice model approach to the molecular distance geometry problem

Cristina Requejo, Mathematics & CIDMA, University of Aveiro, 3810-193, Aveiro, Portugal, crequejo@ua.pt, Agostinho Agra, Rosa Maria Figueiredo, Carlile Lavor, António Pereira, Nelson Maculan

The Distance Geometry Problem (DGP) consists in finding an embedding in R^n of a given weighted undirected graph such that edge weights are equal to the corresponding Euclidean distances in the embedding. In order to consider distances that might be affected by experimental errors, presented in real applications, we propose a lattice model approach applied to DGP's related to determination of molecular conformations.

■ MB-38

Monday, 10:30-12h00

HH-Colombus

Duality in Multi-objective Optimization

Stream: Multiobjective Optimization

Invited session

Chair: Andreas Löhne, Institut für Mathematik, MLU Halle-Wittenberg, Theodor-Lieser-Straße 5, 06099, Halle (Saale), Germany, andreas.loehne@mathematik.uni-halle.de

1 - Alternative generalized Wolfe type and Mond-Weir type vector duality

Emilia-Loredana Pop, Faculty of Mathematics and Computer Science, Babeş-Bolyai University, 1 M. Kogalniceanu, 400084, Cluj-Napoca, Romania, pop_emilia_loredana@yahoo.com, Sorin-Mihai Grad

To a general vector optimization problem we attach two new vector duals by means of perturbation theory. These vector duals are constructed with the help of the recent Wolfe and Mond-Weir scalar duals for general optimization problems, proposed by R.I. Bot and S.M. Grad, by exploiting an idea due to W. Breckner and I. Kolumbán. Then we attach vector dual problems of Wolfe type and Mond-Weir type by using different vector perturbation functions to both constrained and unconstrained vector optimization problems, seen as special cases of the general vector optimization problem.

2 - Lagrange necessary conditions for Pareto minimizers in Asplund spaces and applications

Christiane Tammer, Mathematics and Computer Science, Martin-Luther-University Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06120, Halle, Germany, christiane.tammer@mathematik.uni-halle.de, Truong Q. Bao

In this talk, new necessary conditions for Pareto minimal points of sets and Pareto minimizers for constrained multiobjective optimization problems are established. Our approach is based on a version of the separation theorem for nonconvex sets and the subdifferentials of vector-valued and set-valued mappings. Furthermore, applications in mathematical finance and approximation theory are discussed.

3 - Applications of duality in multiobjective optimization

Andreas Löhne, Institut für Mathematik, MLU
Halle-Wittenberg, Theodor-Lieser-Straße 5, 06099, Halle
(Saale), Germany, andreas.loehne@mathematik.uni-halle.de

Two applications of duality in multi-objective optimization are discussed. First, duality is essential to develop dual algorithms to solve linear and convex problems. In particular, we focus on the potential of dual algorithms to solve certain classes of multi-objective combinatorial problems efficiently. The second part deals with applications in Mathematical Finance. Multi-objective optimization and duality play a role in market models with transaction costs.

■ MB-39

Monday, 10:30-12h00

HH-Cousteau

MADM Applications II

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration,
Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District,
11111, Taipei, Taiwan, ctlin@mail.mcu.edu.tw

Chair: *Chie-bein Chen*, International Business, National Dong
Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien,
Taiwan, cbchen@mail.ndhu.edu.tw

1 - Evaluating Information Quality and Validity of Value Line Stock Ratings

Shin-Yun Wang, Department of Finance, National Dong Hwa
University, Taiwan, gracew@mail.ndhu.edu.tw, *Po-Lung Yu*

Investment in stock market involves many decision rules and variables; hence investors are increasingly relying on ratings provided by rating agencies to guide their stock selections. However, do these stocks ratings have information value? Are rating agencies' ratings valid? We research these questions by analyzing the performance of rating agencies. We provide empirical evidence on the performance of rating services by analyzing the performance of Value Line. We introduce the concepts of domination cones, domination structures and non-dominated solutions.

2 - Selecting the Optimal Foreign Dramas for Commercial TV Stations in Taiwan Using Delphi and AHP

Pi-Fang Hsu, Department of Communications Management,
Shih Hsin University, No.1, Lane 17, Mu-Cha Road, Sec.1,
11604, Taipei, Taiwan, celina9@ms26.hinet.net, *Shu-Yu Lin*

This study develops a model for selecting foreign dramas based on Commercial TV station manager's perceptions. First, the proposed model adopts the Modified Delphi Method to find out the suitable evaluative criteria of foreign dramas. Next, the model apply the Analytic Hierarchy Process (AHP) to determine the relative weights of criteria, then ranks the alternatives and selects the optimal foreign dramas. The results indicated that concerns think highly of criteria in order are drama content perspective, cast perspective, advertising budget perspective, foreign data of origin perspective.

3 - Developing a Selection Model for Newspaper Integrated Marketing Communication Service

Ya-Han Lin, Department of Communications Management,
Shih Hsin University, No.1, Lane 17, Mu-Cha Road, Sec.1,
11604, Taipei, Taiwan, beth6677@gmail.com, *Pi-Fang Hsu*

This research develops a model for selecting newspaper integrated marketing communication (IMC) service. The proposed model comprises two parts, with the first part using the modified Delphi method to identify suitable evaluative criteria of IMC service, while the second part applies Analytic Hierarchy Process (AHP) to calculate and rank the optimal IMC service. Additionally, the model is then tested by a newspaper IMC service selection case for advertisers. The proposed model helps advertisers to effectively select newspaper IMC service, making it highly applicable for academia and commerce.

4 - Measuring the International Backpackers Travelling Risk

Pin-Ju Juan, Department of International Tourism
Management,, Tamkang University, No.180, Linwei Rd.,
Jiaoxi Township,, 26247, Yilan County, Taiwan,
pj@mail.tku.edu.tw, *Shin-Yi Lin*

This study intends to explore a decision model for international backpackers by developing a travelling risk selection. The factors and criteria for the evaluation decision model are derived from exhaustive literature review and experts interviews. By using the experts' interviews, content analysis and modified Delphi method, the study aims to obtain factors and criteria for travelling risk. Finally, a recommended solutions are presented and analyzed based on the strategic plan and can provide valuable insights for tourism administrators and academics in international tourism market.

■ MB-40

Monday, 10:30-12h00

HH-Livingstone

MADM Applications VI

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration,
Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District,
11111, Taipei, Taiwan, ctlin@mail.mcu.edu.tw

Chair: *Chie-bein Chen*, International Business, National Dong
Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien,
Taiwan, cbchen@mail.ndhu.edu.tw

1 - A qualitative model for collective intelligence analysis

Jiang-Liang Hou, Dept of Ind. Eng. & Eng. Mgt., National
Tsing Hua Univ., No. 101, Section 2, Kuang-Fu Road, 300,
Hsinchu, Taiwan, adamhou02@gmail.com, *Hung Lung Lin*,
Shih-Ting Yang, *Yu-Min Chiang*

Based on the concept of CI, a three-stage tendency determination model of community opinions is proposed to develop a platform for gathering public opinions, determining tendency of the community opinions and supporting decision makers with decision conclusions. The three stages include "analysis of opinions contents", "representation of formatted opinion contents", and "analysis of opinions tendency and representation of conclusions". The proposed model is to extract text-based opinions of individuals into a generally accepted decision-making reference for the decision maker.

2 - Taiwan Health Communication Research: Application and Impact of New Media

Rose Hung, Department of Communications Management,
Shih Hsin University, Taiwan, rose@jetgo.com.tw, *Pi-Fang Hsu*

With the rise of social networks and mobile media, health communication models also come with each passing day, compared to traditional media, new media more effectively to achieve the dissemination of health knowledge and help people or patients to implement lifestyle adjustment? This study analysis of the Taiwan government and private health communication activities in recent years, through the combination of interviews and questionnaires, the results are analyzed to find out the health communication effect and construct a health dissemination pattern.

3 - Hybrid MCDM Approach for Company Growth Strategy Selection in Marketing

Tuncay Gürbüz, Industrial Engineering, Galatasaray
University, Ciragan cad. No.36, Ortakoy, 34357, Istanbul,
Turkey, tuncaygurbuz09@gmail.com, *Y. Esra Albayrak*

In today's competitive markets, one can easily see that the importance is not producing goods and services but being able to sell what one produces. Nowadays, the concept of marketing is customer-oriented and aims to meet the needs and expectations of customers to increase

their satisfaction. While creating a marketing strategy, an enterprise must consider many factors and decide to perform either target determination or company growth strategies. In this study, company growth strategies are analyzed with a hybrid MCDM method consisting of Analytic Network Process and Choquet Integral.

■ MB-41

Monday, 10:30-12h00

HH-Heyerdahl

AHP/ANP 1

Stream: Analytic Hierarchy Process, Analytic Network Process

Invited session

Chair: *Josef Jablonsky*, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

1 - Determinants of customers satisfaction in the Nigerian aviation industry using AHP model

Adebola Adekoya, Business Administration, University of Lagos, Room 111, Dept. of Bus. Admin., Faculty of Bus. Admin., University of Lagos, Akoka, Yaba., 234, Akoka, Yaba, Lagos, Nigeria, agadekoya@unilag.edu.ng, B.e.a. Oghojafor, Emmanuel O. Oyatoye

The airline industry in Africa's most populous nation has witnessed explosive growth in recent years with older domestic airlines being in competition with new entrants. The expansion has given Nigerians a wider choice of airlines. This research is designed to apply the Analytic Hierarchy Process to find out the determinants of customers satisfaction in the Nigerian aviation industry. This is an exploratory study with focus on primary data which will be collected using convenience sampling and snowballing techniques. A quantitative approach is used to analyze data provided.

2 - Performance evaluation of inmetro: a contribution of multicriteria decision aid

Lorena Berzins, ibmec, Rua Ipanema, 99/902, 22631390, Rio de Janeiro, RJ, Brazil, lberzinsmestrado@gmail.com, *Luis Rangel*

A performance appraisal program, when well structured, is a useful tool to measure organization performance. The performance of an employee is measured under multicriteria, and this work uses AHP, a Multicriteria Decision Aiding tool, to structure PA. The study was tested in a governmental organization in Brazil, INMETRO. The method is flexible because it can be adjusted to the needs of each department. But at the same time has the same structure and criteria to the whole organization, so it is possible to evaluate the performance of the company and compare results between each department.

3 - Combine ANP and Fuzzy integral approaches for supplier evaluation and selection

James Liou, Industrial Engineering and Management, National Taipei University of Technology, No. 1 Chung-Hsiao E. Rd. Sec. 3, 106, Taipei, Taiwan, jamesjliou@gmail.com, *Yen-Ching Chuang*, *Gwo-Hshiung Tzeng*

In this study, we propose a novel fuzzy integral-based model, which addresses the dependent relationships between the various criteria and the non-additive weighted gap analysis. The relations-structure among the criteria and the weights of the criteria are built with the aid of the Decision Making Trial and Evaluation Laboratory and Analytical Network Process (DANP) method. The fuzzy integral is then used to aggregate the gaps and weights. The proposed model remedies prior shortcomings and should be more reasonable. The method is demonstrated using data from a Taiwanese company.

4 - Comparison of methods for deriving priorities in the analytic hierarchy process

Josef Jablonsky, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

A crucial problem in the analytic hierarchy/network process is how to derive priorities from pairwise comparison matrices. The most popular methods for deriving priorities are eigenvector, proposed originally by T. Saaty, logarithmic least square and least square method. The paper deals with other alternative approaches using methodology of goal programming — one is based on minimization of sum of absolute or relative deviations and another on minimization of maximum deviation. Results are compared on a set of randomly generated matrices of different sizes and different levels of consistency.

■ MB-42

Monday, 10:30-12h00

BW-Amber

EURO Doctoral Dissertation Award (EDDA 2012)

Stream: EURO Doctoral Dissertation Award (EDDA 2012)

Invited session

Chair: *Jacques Teghem*, Mathro, Faculté Polytechnique/UMonss, 9, rue de Houdain, Rue de Houdain 9, 7000, Mons, Belgium, jacques.teghem@umons.ac.be

Chair: *Silvano Martello*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, silvano.martello@unibo.it

Chair: *Hartmut Stadtler*, Institute for Logistics and Transport, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, h.stadtler@t-online.de

Chair: *Hartmut Stadtler*, Uni Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, hartmut.stadtler@uni-hamburg.de

Chair: *Ahti Salo*, Systems Analysis Laboratory, Aalto University School of Science and Technology, P.O. Box 11100, Otakaari 1 M, 00076, Aalto, Finland, ahti.salo@aalto.fi

Chair: *Stéphane Dauzere-peres*, Manufacturing Sciences and Logistics, Ecole des Mines de Saint-Etienne, 880 avenue de Minet, 13541, GARDANNE, France, dauzere-peres@emse.fr

■ MB-43

Monday, 10:30-12h00

BW-Granite

Stochastic Programming - Stability, Estimation

Stream: Stochastic Programming

Invited session

Chair: *Petr Lachout*, Dept. Probability and Statistics, Charles University in Praha, Sokolovská 83, 186 75, Praha, Czech Republic, lachout@karlin.mff.cuni.cz

1 - Empirical Estimates via Heavy Tails

Vlasta Kaňková, Econometrics, Institute of Information Theory and Automation of ASCR, Pod Vodárenskou věží 4, Praha 8, CZ 18208, Prague, Czech Republic, Czech Republic, kankova@utia.cas.cz

Optimization problems depending on a probability measure correspond to many economic and financial applications. Since this measure is often unknown, a solution has to be usually determined on the data basis, underlying distribution function is replaced by empirical one. Many efforts has been paid to the investigation of the corresponding empirical estimates of an optimal value and an optimal solution. It was mostly done for the underlying distribution with thin tails. The aim of the contribution is to focus on the case of heavy tails, including shape parameter in (1,2).

2 - Stochastic program with additional information

Petr Lachout, Dept. Probability and Statistics, Charles University in Praha, Sokolovská 83, 186 75, Praha, Czech Republic, lachout@karlin.mff.cuni.cz

Treating a stochastic program we usually possess an additional information about the subject and background which should be incorporated in the program. Typically, there are historical observations of the system, recently observed data, expert suggestions and forecasts, knowledge about smoothness of the program, etc. We intend to describe structure of such programs together with a stability discussion.

3 - Universal Confidence Sets - Estimation and Relaxation

Silvia Vogel, Mathematics and Natural Sciences, Ilmenau University of Technology, Postfach 100565, 98684, Ilmenau, Thuringia, Germany, Silvia.Vogel@tu-ilmenau.de

The derivation of universal confidence regions for constraint sets, optimal values and solutions sets of decision problems usually assumes concentration-of-measure properties for the objective and/or constraint functions and some knowledge about the true problem, such as values of a growth function. If these values are not available, one can estimate them relying on the concentration-of-measure inequalities for the true functions. We show how such estimates can be derived and incorporated. Furthermore, we investigate confidence sets which are obtained via relaxation of certain inequalities.

4 - Stability and convexity of chance-constrained problems with structural dependence

Michal Houda, Econometrics, Institute of Information Theory and Automation of the ASCR, Pod Vodárenskou věží 4, Praha 8, CZ 18208, Prague, Czech Republic, houda@ef.jcu.cz

In chance-constrained problems, the convexity of the constraint set is important. It is known that a suitable combination of a concavity property of the probability distribution and concavity of constraint mappings are sufficient conditions to the convexity of the constraint set. We assume furthermore a structural dependence assumption: constraint rows not required to be independent. The resulting constraint set is non-convex but can be approximated by a convex one. We show that, applying stability results on optimal values and optimal solutions, these remain stable under common assumptions.

■ MB-44

Monday, 10:30-12h00

BW-Marble

Inventory, Pricing, and Customer Behavior

Stream: Revenue Management

Invited session

Chair: *Qing Li*, Dept. of ISOM, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, imqli@ust.hk

1 - Group buying mechanisms

Rachel Zhang, IELM, Hong Kong UST, Clear Water Bay, 00000, Kowloon, Hong Kong, rzhang@ust.hk

When a seller offers quantity discounts, interested buyers may either self-organize or rely on a third party to aggregate their purchasing quantities to obtain lower prices. This paper concerns group buying among heterogeneous buyers given a seller's quantity discount schedule under both the uniform price and non-uniform price group buying mechanisms. We show that the latter have a direct impact on the buyers' payments, purchase quantities, and the seller's revenue. We also compare buyers' purchasing quantities and surplus under different group buying mechanisms and when buyers buy alone.

2 - Optimal pricing policy for recyclable short life-cycle products

Hsiao-Fan Wang, IEEM, Natl Tsing Hua University, 101 Sec.2, Kuang-Fu Rd., 30043, Hsinchu, Taiwan, hsiaofanwang@gmail.com

Because of the environmental degradation, producing green products is necessary. Since green products are market driven, proposing a method for pricing on a short-life, green product in market so that an enterprise or a retailer can make profit from producing and selling the green products is our primal intention. Under a given market scale and recycling principle, the optimal pricing policy based on Game Theory was proposed by a developed DP model for two kinds of products which have different degrees of greenness from different manufacturers sold by one retailer.

3 - Managing perishable goods under different customer preferences

Qing Li, Dept. of ISOM, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, imqli@ust.hk, *Xiaoli Wu*

The shelf lives of perishable goods are influenced by decisions made along the supply chains and on shelves. How should firms coordinate the shelf life decisions and inventory decisions? We show that the answer depends critically on customers' sensitivity to freshness. We consider two classes of customers and measure sensitivity to freshness by the percentage of customers who purchase only new items, and whether the customers who accept both new and aged items retrieve items FIFO or LIFO.

■ MB-45

Monday, 10:30-12h00

BW-Water

Applications of Pricing and Revenue Management

Stream: Revenue Management

Invited session

Chair: *Luce Brotcorne*, INRIA, Parc Scientifique de la Haute Borne, 40 avenue Halley, Bat a Park Plaza, 59650, Villeneuve d'Ascq, France, luce.brotcorne@inria.fr

1 - Revenue management in sequential distribution: An application to the Hindi Movie Industry

Megha Sharma, Operations Management, Indian Institute of Management Calcutta, A-306, Academic Block, IIM Calcutta, Joka, DH Road, Kolkata, 700104, Kolkata, West Bengal, India, megha@iimcal.ac.in, *Sumanta Basu*

With about 125 movie releases in a year, Hindi movie industry is one of the largest producers of movies in the world. Over the years the life cycle of movies has shortened significantly and a movie is typically premiered on TV within 4 months of its release. While a movie's earnings from TV premier are significant and decrease sharply with time, an early release cannibalizes revenue from other channels. This work attempts to determine the optimal timing of TV premier using statistical methods and mathematical modeling in light of video piracy, and movie reviews through social media.

2 - Dynamic pricing with predefined tariff constraints

Kris Meyers, Vlerick Leuven Gent Management School and Ghent University, Reep 1, 9000, Gent, Belgium, kris.meyers@vlerick.com, *Mario Vanhoucke*, *Behzad Samii*

We develop a discrete dynamic pricing model for electricity (but also for applications like mobile communication, car rental) to maximize profit under fluctuating demand, in a discrete finite time horizon. The seller has an agreement with the buyers to sell at preset tariffs. He can charge the highest tariffs for a limited amount of periods. Cost is a piecewise linear function of the quantity sold. We propose an IP formulation, test the model with numerical experiments and develop algorithms for several extensions like multiple customer segments, cost for changing tariffs, stochastic demand.

3 - An efficient heuristic approach for a dynamic pricing problem in telecommunications

Jean-robin Medori, OrangeLabs, France,
jeanrobin.medori@orange.com, Mustapha Bouhtou, Michel Minoux

We consider a new pricing problem where a carrier wants to set dynamic prices to maximize daily revenue from a voice service. A Mixed Integer Quadratic Program (MIQP) is proposed to model this problem. Because of network load constraints, finding an optimal solution is challenging. To bypass this computational limitation we propose a heuristic which solves easier MIQP sub-problems. The heuristic guarantees a feasible solution whenever the original pricing problem is feasible. Experimentations show that it consistently produces solutions close to exact optimum within reduced computation times.

4 - A Bilevel Approach for a Long Haul Freight Transportation Pricing Problem

Luce Brotcorne, INRIA, Parc Scientifique de la Haute Borne, 40 avenue Halley, Bat a Park Plaza, 59650, Villeneuve d'Ascq, France, luce.brotcorne@inria.fr, Diaby Moustapha, El-ghazali Talbi

In this talk we consider a pricing problem involving two long-haul full load freight carriers (A,B) operating similar markets. We assume that carrier B cannot serve all the demand addressed to him with its own transportation fleet. He thus needs to use outsourcing: carrier A or its competitors. Carrier A, which unused capacity, has thus to define prices to carrier B transportation requests to maximize revenue and balance the load. This sequential and non-cooperative decision-making process is represented as a bi-objective bilevel program. Numerical results are given.

Monday, 12:30-14:00

■ MC-01

Monday, 12:30-14:00

RB-Alfa

Keynote Lecture: Professor Ceyda Oguz

Stream: Keynote, Tutorial and Plenary Lectures

Keynote session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Computational Biology and Operations Research

Ceyda Oguz, Department of Industrial Engineering, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, coguz@ku.edu.tr

Advancing the scientific understanding of organisms through computation has an ever-increasing importance that necessitates more research into fundamental problems of molecular biology. Research direction for these problems involves better analytical tools and more efficient algorithms due to massive volume of data. Hence computational biology can benefit from operations research area for developing mathematical models and devising efficient algorithms. In the literature, while integer programming and network models are usually employed at the modeling stage, dynamic programming, branch-and-bound algorithm, heuristics and metaheuristics are the prevalent computational methods employed for the problems. In this talk, I will give an overview of application of operations research methods to several computational problems that are faced in molecular biology.

■ MC-02

Monday, 12:30-14:00

RB-Beta

Scheduling Approaches for Complex Manufacturing Systems

Stream: Scheduling

Invited session

Chair: *Lars Moench*, FernUniversität in Hagen, 58097, Hagen, Germany, lars.moench@FernUni-Hagen.de

1 - A GRASP Approach for the Job Shop Scheduling Problem with Total Weighted Tardiness Objective

Jens Kuhpfahl, School of Economics and Business, Chair of Production and Logistics, MLU Halle-Wittenberg, Germany, jens.kuhpfahl@wivi.uni-halle.de, *Christian Bierwirth*

Supply chain cooperation of companies requires a complex coordination of distributed but interdependent production processes. A consequence of this development is that production scheduling is often more concerned with keeping due dates than realizing short flow times of the jobs. In our talk we consider the job shop scheduling problem with minimizing the total weighted tardiness. We present a greedy randomized adaptive search procedure that includes a powerful construction heuristic, an effective selection of neighbourhoods within the improvement phase and a navigation concept for the search.

2 - Heuristics for Integrated Process Planning and Scheduling

Oleh Sobeyko, University of Hagen, 58097, Hagen, Germany, Oleh.Sobeyko@FernUni-Hagen.de, *Lars Moench*

We consider an integrated process planning and scheduling problem for a flexible job shop. The performance measure is the total weighted tardiness. A mixed integer programming formulation is presented. Because the problem is NP hard, we propose an iterative procedure. A variable neighborhood search scheme is used to select appropriate process models, i.e., bill of materials and routes. A shifting bottleneck heuristic is used to schedule the jobs given a process model. We present the results of computational experiments.

3 - Scheduling Flowline Manufacturing Cells with Inter-cellular Moves: The Cell Scheduling Problem

Janis Sebastian Neufeld, Industrial Management, TU Dresden, TU Dresden, Fakultät Wirtschaftswissenschaften, 101062, Dresden, Germany, Janis_Sebastian.Neufeld@tu-dresden.de, *Udo Buscher*

The scheduling of multiple manufacturing cells with intercellular moves has not received much attention so far. Analogously to group scheduling, for the so called cell scheduling problem a sequence of jobs within each cell as well as a sequence of part families are determined. We point out some major differences between the cell and group scheduling problem. Furthermore, specific problem structures are identified and two simulated annealing algorithms are presented to solve the permutation as well as non-permutation cell scheduling problem more effectively than existing heuristic approaches.

4 - A New Hybrid Algorithm for Solving the Resource-Constrained-Project-Scheduling-Problem (RCPSp)

Luis Moreno, Sistemas, Universidad Nacional de Colombia, Cra. 80 65-223, Bloque M8A of. 207, Medellin, Antioquia, Colombia, lfmoreno@unal.edu.co, *Javier Diaz*, *Gloria Peña*

The RCPSp is an NP-hard problem, for which numerous heuristic methods have been proposed for a solution. Our research presents an algorithm that is a combination of a known exact branch and bound algorithm, with a new heuristic manner of "uniformly" visiting, a pre-defined number of times, all of the areas for the feasible space of solutions, and skipping branches in the solution tree, while making additional search efforts in promising areas. The algorithm is evaluated based on 480 different instances of 30 activities from the PSPLIB library which is available online.

■ MC-03

Monday, 12:30-14:00

RB-L1

Business Excellence in Logistics: Advanced Vehicle and Inventory Routing

Stream: Business Excellence in Logistics
Invited session

Chair: *Martin Josef Geiger*, Logistics Management Department, Helmut-Schmidt-University, Holstenhofweg 85, 22041, Hamburg, Germany, m.j.geiger@hsu-hh.de

1 - Cyclic Delivery Schedules for Inventory Routing Problem

Gultekin Kuyzu, Industrial Engineering, TOBB University of Economics and Technology, Sogutozu Caddesi No:43, Sogutozu, 06560, Ankara, Turkey, gkuyzu@etu.edu.tr, *Ali Ekici*, *Okan Ozener*

We consider an inventory routing problem where a common vendor is responsible for replenishing the inventories of several customers over a perpetual time horizon. The objective of the vendor is to minimize the total cost of transportation of a single product from a single depot to a set of customers with deterministic and stationary consumption rate over a planning horizon while avoiding stock-outs at the customer locations. We focus on constructing a repeatable (cyclic) delivery schedule for the product delivery.

2 - Multi-Objective Inventory Routing: Recent Advances

Martin Josef Geiger, Logistics Management Department, Helmut-Schmidt-University, Holstenhofweg 85, 22041, Hamburg, Germany, m.j.geiger@hsu-hh.de, *Thibaut Barthelemy*, *Marc Sevaux*

We consider a multi-objective generalization of the inventory routing problem, in which inventory levels and routing costs are not combined into an overall evaluation function but treated separately. The problem is solved by local search, and numerical results are computed and reported. Particular emphasis has been laid on the representation of solutions from a practical point of view. In detail, individual frequency values are derived for each customer, implementing a recurring delivery policy. Our findings show that there is great potential for tradeoffs between the two objectives.

3 - A Multi-Stage Optimisation Approach for Delivery Planning and Scheduling

Vitaly Bolshakov, Department of Modelling and Simulation, Riga Technical University, Kalku Street 1, LV-1658, Riga, Latvia, Latvia, Vitalijs.Bolsakovs@rtu.lv, *Galina Merkurjeva*, *Michael Affenzeller*, *Erik Pitzer*

Product delivery planning has a high priority in the modern transportation logistics. In distribution centres, this task is related to tactical planning of different types of product deliveries, taking into account predetermined time constraints, transportation costs and variable demand. Real-life applications also require solution of multiple tasks. A multi-stage optimisation approach for delivery planning and scheduling is proposed. Optimisation solutions for separate stages are built within HeuristicLab environment and adjusted for a specific business case.

4 - Selective and Periodic Inventory Routing Problem

Özge Tüncel, Industrial Engineering, Koc University, Koc University Rumelifeneri Yolu, Saryer, 34450, İstanbul, Turkey, otuncel@ku.edu.tr, *Sibel Salman*, *Onur Kaya*, *Deniz Aksen*

A biodiesel production facility collecting waste vegetable oil from source nodes uses the collected waste as raw material for biodiesel production. The manager needs to decide which of the source points to include in the collection program, which of them to visit on each day, which periodic routing schedule to repeat over an infinite horizon and how many vehicles to operate such that the total cost is minimized while the production requirements and operational constraints are met. A heuristic model is constructed in order to find near optimal solutions for small and large sets of instances.

■ MC-04

Monday, 12:30-14:00

RB-L2

Optimal Control I

Stream: Optimal Control
Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: *Ekaterina Kostina*, Department of Mathematics and Computer Science, University of Marburg, Hans-Meerwein-Str., 35032, Marburg, kostina@mathematik.uni-marburg.de

1 - Direct Optimal Control Methods for a Centralized Approach to Separation Management

Ekaterina Kostina, Department of Mathematics and Computer Science, University of Marburg, Hans-Meerwein-Str., 35032, Marburg, kostina@mathematik.uni-marburg.de

A key element of future Air Traffic Management concepts are automation tools helping to separate aircrafts in a tactical environment. This work investigates optimal control approach to separation. Our optimization framework has full information of the traffic situation in an airspace volume and hence generates conflict-free trajectories for all aircrafts within a regarded airspace. Real-time simulations showed that compared to human solutions the method could yield a significant decrease of delay, flight track excess, as well as fuel savings. Joint work with M. Poppe and L. Walter.

2 - Optimal control models of renewable energy production under fluctuating supply

Gernot Tragler, OR and Control Systems, Vienna University of Technology, Argentinierstr. 8/105-4, A-1040, Vienna, Austria, tragler@eos.tuwien.ac.at, *Elke Moser*, *Dieter Grass*, *Alexia Prskawetz*

We consider optimal control models with infinite horizon, in which fossil and renewable energy cover production-related energy demand. The main focus lies on the investigation how prices and policy interventions (e.g. taxes, subsidies, quotas) can affect the attractiveness of

renewable energy and whether a switch towards a more sustainable energy supply can be stimulated. The assumption of fluctuating supply of renewable energy sources implies non-autonomy, which requires sophisticated numerical solution methods. Parameter values are supported by data and sensitivity analyses are carried out.

3 - Proposing and simulating a new suboptimal hybrid embedding-PMP technique for tumor anti-angiogenesis optimal control

Alireza Fakharzadeh, Mathematics Dept., Shiraz University of Technology, 71555-313, Shiraz, Iran, Islamic Republic Of, a_fakharzadeh@sutech.ac.ir, *Zahra Khoshgam*

Several mathematical models exist on describing tumor angiogenesis process. A famous one the models is proposed by Hahnfeldt et al. which Ledzewics gained a complete solution for that optimal control model based on the Pontryagin Maximum Principle (PMP). This protocol is not applicable. We introduce a new suboptimal protocol (hybrid embedding-PMP technique). The simulation results and comparison between the analytical solution and the hybrid embedding-PMP protocol, for the same initial condition, indicate that our suggested protocol is easier, practical and acceptable.

■ MC-05

Monday, 12:30-14:00

RB-L3

Liner shipping optimization

Stream: Maritime Transportation

Invited session

Chair: *Fernando Alvarez*, Goteborggata 9, 0566, Oslo, Norway, jfa2@cornell.edu

1 - A Multi-period Planning Model for Liner Shipping's Bunker Management

Xiaoyu Wang, School of Civil and Environmental Engineering, Nanyang Technological University, School of CEE, NTU, 50 Nanyang Avenue, Singapore, 639798, Singapore, Outside US, Singapore, wang0519@e.ntu.edu.sg, *Chee Chong Teo*

This paper considers bunker risk management for container lines. A nonlinear finite horizon optimization program is developed to simultaneously optimize liner network planning and bunker hedging. The model captures the uncertainty of bunker price and the associated tolerance for bunker risk exposure. As a rolling-horizon model, it allows the updating of the market information and forecast, such as bunker prices, over the planning horizon. The insights gained from our analysis would be useful for the container shipping industry in improving their bunker risk management.

2 - The Vessel Schedule Recovery Problem - disruption management in liner shipping

Berit Dangaard Brouer, DTU Management Engineering, Technical University of Denmark - DTU, Bygning 426, 2800, Kongens Lyngby, Denmark, blof@man.dtu.dk, *Christian Edinger Munk Plum*, *Bo Vaaben*, *David Pisinger*, *Jakob Dirksen*

Maritime transportation is the backbone of world trade and is accountable for around 3% of the world's CO2 emissions. We present the Vessel Schedule Recovery Problem (VSRP) to evaluate a given disruption scenario and to select a recovery action balancing the trade off between increased bunker consumption and the impact on the remaining network and the customer service level. The model is applied to 4 real cases from Maersk Line. Solutions are comparable or superior to those chosen by operations managers. Cost savings of up to 58% may be achieved.

3 - Decision Support to Overcome Traffic Congestion in Constrained Transport Corridors

Stefan Voss, Wirtschaftsinformatik/Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, stefan.voss@uni-hamburg.de, *Silvia Schwarze*, *Xiaoning Shi*

To cope with increasing traffic, network resource extension may be traded against congestion based costs. We focus on game theoretic methods applied on scenarios for constrained transport corridors, like canals in maritime shipping or similar bottlenecks in other traffic systems. Real-world traffic corridors are analyzed to obtain information on restrictions at bottlenecks and corresponding behavior of their users. In particular, the change of delay and costs when switching from decentralized to centralized models is of interest as well as an analysis of the interaction between both positions.

4 - Competition and efficiency in the container liner shipping industry

Christa Sys, Transport and Regional Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, christa.sys@ua.ac.be

The present paper examines a model-based measure of competition. This measure of competition based on Boone's theoretical work quantifies the impact of marginal costs on performance. Boone shows that when profit differences are increasingly determined by marginal cost differences, this indicates increased competition. The evolution of competition will be calculated using a pooled data set of 20 liner operators. After correcting for industry-specific effects (i.e. number of services, average ship size), the findings suggest that over the 2000-2008 period the competition has intensified.

■ MC-06

Monday, 12:30-14:00

RB-Gamma

Production, planning and facility location

Stream: Metaheuristics

Invited session

Chair: *Maria Eugénia Captivo*, Departamento de Estatística e Investigação Operacional, Universidade de Lisboa, Faculdade de Ciências and Centro de Investigação Operacional, Campo Grande, Bloco C6, Piso 4, 1749-016, Lisboa, Portugal, mecaptivo@fc.ul.pt

1 - A Dynamic Scheduling Approach for Solving the Single Machine Total Weighted Tardiness Problem

Sener Akpinar, Industrial Engineering, Dokuz Eylül University, 35160, Izmir, Buca, Turkey, sener.akpinar@deu.edu.tr, *Alper Hamzadayi*, *Simge Yelkenci Kose*, *Hanifi Okan Isguder*, *Atabak Elmi*

In this paper we aim at solving the single machine total weighted tardiness problem (SMTWT) by combining simulation via genetic algorithm (GA). In the classical SMTWT all jobs are available at time zero to be processed on the machine. In this study jobs enter the system according to an arrival process and processed on a single machine with regard to a priority and a due date assigned to each job. The problem consists of a set of independent jobs with distinct processing times, weights and due dates to be scheduled on a single machine. The solution approach is based on GA and simulation.

2 - A competitive genetic algorithm for single row facility layout

Ravi Kothari, Production & Quantitative Methods, Indian Institute of Management Ahmedabad, c/o SAO Office, Dorm-21, Room-16, Vastrapur, IIM Ahmedabad, 380015, Ahmedabad, Gujarat, India, ravikothari@iimahd.ernet.in, *Diptesh Ghosh*

The single row facility layout problem (SRFLP) is the NP-hard problem of arranging facilities on a line, so as to minimize the weighted sum of the distances between all pairs of facilities. We present a genetic algorithm to solve large SRFLP instances. Our computational experiments show that an appropriate selection of genetic operators can yield high quality solutions in spite of starting with an initial population that is largely randomly generated. Our algorithm improves on the previously best known solutions for 24 of 43 benchmark instances and is competitive for the remaining ones.

3 - A genetic approach for planning elective surgeries in a Portuguese hospital

Maria Eugénia Captivo, Departamento de Estatística e Investigação Operacional, Universidade de Lisboa, Faculdade de Ciências and Centro de Investigação Operacional, Campo Grande, Bloco C6, Piso 4, 1749-016, Lisboa, Portugal, mecaptivo@fc.ul.pt, *Inês Marques, Margarida Pato*

Reduced budgets in the healthcare sector pressure health institutions to an efficient use of resources. The operating theatre represents a great proportion of the hospital budget. Furthermore, it is a central service with connections and implications in the service of many other hospital units. A more efficient use of the operating room becomes of great relevance within the hospital administration. This talk presents a genetic approach developed to address the elective surgery planning problem arising in a hospital in Lisbon. Some results obtained with the hospital's data are presented.

4 - A Hybrid Metaheuristic-Dynamic Programming Algorithm for Integrated Optimization of Manual Order Picking and Sorting Warehouse Operations

Athanassios Nikolakopoulos, Chemical Engineering, National Technical University of Athens, Heron Polytechniou, 9, 15780, Athens, Greece, nikolako@mail.ntua.gr, *Ioannis Ganas, Ioannis Konstantaras, Konstantina Skouri*

This work introduces an ILP formulation of the problem of throughput time minimization of order picking and sorting warehouse operations. It includes due times, sorting times and TSP sub-problems with bin packing constraints. An Evolutionary Threshold Accepting algorithm and a Dynamic Programming part are combined into a hybrid solution method. Results are produced for artificial and real life instances and compared to the results of the algorithmic simulation of conventional practices. Computational experience shows a 10% reduction of average total makespan in affordable computational times.

■ MC-07

Monday, 12:30-14:00

RB-Eta

Applications of Vehicle Routing

Stream: Vehicle Routing and Logistics Optimization
Invited session

Chair: *Johan Oppen*, Molde University College, P O Box 2110, 6402, Molde, Norway, johan.oppen@hiMolde.no

1 - A Real-World VRP with Uncertain Delivery Quantities

Birk Baumbach, Operations Research, Fraunhofer IVI, Zeunerstrasse 38, 01069, Dresden, Germany, birk.baumbach@ivi.fraunhofer.de, *Axel Simroth*

An LPG logistics service provider with a fleet of 200 tank trucks supplies some 150,000 customers. Daily up to 2,000 shipments at a total distance of 40,000 km are handled. The main challenge of this real-world VRP is the dynamics due to uncertainty in delivery quantities. We present a practical solution approach that is twofold: (1) Additional information relevant to planning is provided by the use of telematics. (2) Uncertainty is considered by specialised algorithms that enable a permanent dynamic route planning in real-time. As a result the distance travelled could be decreased by 9.8%.

2 - A two phase multi-objective algorithm for the bi-objective VRP

Jorge Oyola, Molde University College, 6411, Molde, Norway, jorge.oyola@himolde.no, *Arne Løkketangen*

This work deals with a bi-objective vehicle routing problem. This includes the balance of the tour lengths as an objective, in addition to the usual minimization of the total tour length. A two phase algorithm is proposed to approximate the set of solutions to the problem. In phase I a tabu search heuristic is used to find the solutions that optimize each of the objectives independently. In the second phase, more solutions are found either through an iterative process that combines path-relinking and local search or a GRASP ruin-and-recreate algorithm. Computational results will be presented

3 - Milk Collection in Western Norway Using Trucks and Trailers

Arild Hoff, Molde University College, P.O.Box 2110, 6402, Molde, Norway, arild.hoff@himolde.no

Milk collection is a problem which is well known in rural areas all around the world. This talk considers a real world problem for a Norwegian dairy company collecting raw milk from farmers. Most farms are inaccessible for a large truck carrying a trailer. Thus the routes are organized as a main tour between larger parking spots where the trailer is left behind, and the truck drives subtours from this spots to visit the actual farms. The talk will present heuristics for constructing such tours and computational results comparing our result with the current plan of the company.

4 - Intermodal flexible liner shipping

Johan Oppen, Molde University College, P O Box 2110, 6402, Molde, Norway, johan.oppen@hiMolde.no

We present a maritime transportation problem dealing with the transport of frozen

fish from Russia and Norway to terminals in Norway, the Netherlands and the UK. The problem can be viewed as a flexible liner shipping problem, as both the first and the last port, as well as some terminals along the route, are fixed, while other terminals may also be served by truck via another terminal to save time, or to relieve vessel capacity restrictions. We present a mathematical model and show that small problem instances can be solved to optimality using standard software.

■ MC-08

Monday, 12:30-14:00

RB-Epsilon

Network Optimization 3

Stream: Network Optimization
Invited session

Chair: *M. Emre Keskin*, Industrial Engineering, Bogazici University, Bogazici Universitesi Endustri Muhendisligi, Hisarustu / Besiktas, 34470, Istanbul, Turkey, m.emre.keskin@gmail.com

1 - DiffServ Aware Routing Optimization in Telecommunication Networks

Amaro de Sousa, Universidade de Aveiro, Instituto de Telecomunicações, Campus Universitário de Santiago, VAT Nr. PT502854200, 3810-193, AVEIRO, Portugal, asou@ua.pt, *Carlos Lopes, Dorabella Santos, Filipe Alvelos*

Differentiated Services (DiffServ) aim to provide different QoS levels to different service classes. We propose the implementation of bandwidth based DiffServ where traffic flows of higher QoS classes are routed by less loaded network links. We define the routing problem as an Integer Programming Model, which let us obtain lower bounds, and propose heuristics to compute feasible solutions. We present computational results showing that the heuristics compute good routing solutions and that proper routing optimization can efficiently achieve service differentiation.

2 - Optical Fiber Network Design with Real Life Constraints and Cost Function

Stanislas Francfort, CORE/M2V, Orange Labs, 38-40 rue du general leclerc, issy les moulineaux, France, stanislas.francfort@orange.com, *Frederic Moulis, Cédric Hervet, Matthieu Chardy*

The deployment of Fiber To The Home (FTTH) is crucial to telecommunication operators for both economical and quality of service reasons. This presentation deals with a Passive Optical Network (PON) design problem focusing on real-life optical cabling constraints. A large set of expenses, such as labor expenses, is also considered into the cost function we wish to minimize. This optimization problem is formulated as an integer linear program (ILP) and several solving approaches are designed. Tests performed on real instances assess the efficiency of the proposed solution algorithms.

3 - The Package Server Location Problem

Arnaud Malapert, Laboratoire I3S - UMR7271 - UNS CNRS, 2000, route des Lucioles - Les Algorithmes - bât. Euclide B, BP 121, 06903, Sophia Antipolis, France, arnaud.malapert@unice.fr, *Mohamed Rezgui*, *Jean-Charles Régin*, *Jean Parpaillon*, *Yvan Manon*

We introduce the package server location problem. A number of package servers are to be located at nodes of a network. Demand for these package servers is located at each node. The objective is to minimize the number of package servers while maximizing the efficiency and the reliability of the broadcast of packages to clients. These objectives are clearly contradictory: the broadcast becomes more efficient as the number of servers increases. The problem is formulated and analyzed as a multi-objective optimization problem. Results for exact approaches using MILP are reported.

4 - An integrated approach to lifetime maximization in wireless sensor networks

M. Emre Keskin, Industrial Engineering, Bogazici University, Bogazici Universitesi Endustri Muhendisligi, Hisarustu / Besiktas, 34470, Istanbul, Turkey, m.emre.keskin@gmail.com, *I. Kuban Altinel*, *Necati Aras*, *Cem Ersoy*

Mathematical programming provide a very utilizable tool for optimizing some Wireless Sensor Network (WSN) performance metrics by concentrating on some of the decision instruments such as, sensor placement, sensor scheduling, data and mobile sink routing. In this work, we introduce two new mathematical programming models, which integrate all the decision instruments. We quantify the effect of our integrated approach by comparing results of our models with the results of some mathematical models from the literature.

MC-09

Monday, 12:30-14:00

RB-Zeta

Cutting and Packing 3

Stream: Cutting and Packing
Invited session

Chair: *Ramon Alvarez-Valdes*, Statistics and Operations Research, University of Valencia, Faculty of Mathematics, Doctor Moliner 50, 46100, Burjassot, Spain, ramon.alvarez@uv.es

1 - An analysis of the problem instances and the data sets used for computational experiments in the Identical Item Packing Problem

Elsa Silva, INESC TEC, Porto, Portugal, emsilva@inescporto.pt, *José Fernando Oliveira*, *Gerhard Wäscher*

The two-dimensional rectangular Identical Item Packing Problem (IIPP) consists in placing the maximum number of identical rectangular items onto a single rectangular pallet. This problem has been widely studied in the last forty five years, and different problem instances and data sets had been used for the computational experiments of the different approaches proposed to solve the problem. In this work, these problem instances and data sets are analyzed and the hardest and unsolved problem instances pointed out, highlighting the direction for future research in the IIPP.

2 - Optimizing Shelf Space in Retail Stores

Teresa Bianchi-Aguiar, INESC TEC, Faculty of Engineering, University of Porto, Portugal, mtbaguiar@fe.up.pt, *Maria Antónia Carravilla*, *José Fernando Oliveira*

In retail stores, the number of available products is constantly increasing, leading to a continuous need for space management. To do so, retailers rely on planograms, designs of fixtures (e.g. shelves) showing the desired products allocation. Driven by the case of a Portuguese supermarket chain, we will present a hierarchical approach to planogram generation, a Placement C&P Problem known in literature as Shelf Space Allocation Problem. The proposed approach splits the problem into two main levels: allocation of space to each product and placement of product items into each allocated space.

3 - A local optimization switch algorithm for packing non-identical circles

Georgiy Yaskov, Department of Mathematical Modeling and Optimal Design, Institute for Mechanical Engineering Problems, National Academy of Sciences of Ukraine, 2/10 Pozharsky St., 61046, Kharkov, Ukraine, yaskov@ukr.net, *Yuri Stoyan*

We consider a problem of packing non-identical circles into a rectangle of minimal length. The problem is reduced to a problem of packing circles of variable radii. A mathematical model of the problem is constructed and its characteristics are studied. Based on the characteristics we offer a solution strategy of the problem including a number of subproblems. For searching for local minima and solving the subproblems a gradient method of the second order is used. A novel way of switching from a local minimum to another one is applied. We compare 146 numerical benchmark examples.

4 - Determining the best shipper sizes for sending products to customers

Ramon Alvarez-Valdes, Statistics and Operations Research, University of Valencia, Faculty of Mathematics, Doctor Moliner 50, 46100, Burjassot, Spain, ramon.alvarez@uv.es, *Maria Teresa Alonso Martínez*, *Francisco Parreno*, *Jose Tamarit*

A distribution company in Spain has to send products, packed into shipper boxes, from the store to the retail shops. The problem is to decide the sizes of the shipper boxes to keep at the store so as to minimize the cost of packing all the forecasted demands along the planning horizon. In this work we describe several integer linear programming formulations for the problem and a metaheuristic algorithm based on reducing and increasing the sizes of shipper boxes. A computational study conducted on real instances provided by the company is presented and discussed.

MC-10

Monday, 12:30-14:00

RB-Theta

Non-deterministic models

Stream: Production and the Link with Supply Chains
Invited session

Chair: *Farouk Yalaoui*, Institut Charles Delaunay, ICD LOSI, University of Technology of Troyes, 12, Rue Marie Curie BP 2060, 10000, Troyes, France, farouk.yalaoui@utt.fr
Chair: *De Souza Mauricio*, Departamento de Engenharia de Produção, Universidade Federal de Minas Gerais, Av. Presidente Antônio Carlos, 6627, Belo Horizonte, Brazil, mauricio.souza@pq.cnpq.br

Chair: *Y. Ilker Topcu*, Industrial Engineering, Istanbul Technical University, Istanbul Teknik Universitesi, Isletme Fakultesi, Macka, 34357, Istanbul, Turkey, ilker.topcu@itu.edu.tr

1 - Manufacturing flexibility in an oligopoly competition with demand uncertainty

Liu Yang, Business School, University of International Business and Economics, Business School, University of International Business and Economics, No. 10, Hui Xin Dong Jie, Chao Yang District, Beijing, 100029 China, 86-010, Beijing, China, amyangliu@gmail.com, *Chi To Ng*

This paper investigates manufacturing flexibility in an oligopoly competition with demand uncertainty. We consider a general oligopoly model consisting of n firms who adopt either flexible capacity strategy or in-flexible capacity strategy to compete in a same market. We characterize the equilibrium of the competition. We find that the equilibrium is classified into four situations, when FCS is dominant; IFCS is dominant; two strategies coexist; and none is profitable, respectively. We also conduct sensitive analyses of the key influential factors and provide some managerial insight.

2 - Designing a robust supply chain for competition against existing competitors in retailer level

Ghasem Rajabloo, Industrial Engineering, Urmia University of Technology, Band Ave, Urmia, Iran, Urmia, West Azarbayjan, Iran, Islamic Republic Of, gh.rajabloo@ine.uut.ac.ir, *Shabnam Rezapoor*, *Maghsud Solimanpur*

We present a model for robust design of the network of an entrant supply chain in markets with price dependent demands and a pre-existing competing chain. The model assumes dynamic competition between new and existing supply chains, probabilistic customers' behavior and probability of disruption in facilities and transportation links. We consider extra capacity, strategic stock and substitutable facility strategies to mitigate the effects of possible disruptions and the impact of facility location decisions. We illustrate and discuss the obtained results through several numerical examples.

3 - A decision analysis on cooperative advertising

Sebnem Burnaz, Management Engineering, Istanbul Technical University, ITU Isletme Fakultesi, Macka, 34357, Istanbul, Turkey, burnaz@itu.edu.tr, *Esin Ekmekci*, *Y. Ilker Topcu*

Today competition takes place among supply chains. Therefore, it is critical for the companies to sustain collaborative relationships with their stakeholders. At this point, cooperative practices gain more importance to build competitive advantage. Manufacturers use cooperative (co-op) advertising to strengthen the image of their brands and to motivate consumers in their buying decisions. This study aims to analyze the changes in the portions of manufacturer and distributor in sharing co-op advertising in sectors represented by different levels of substitution rate and competition intensity.

3 - Development of an optimisation framework for scheduling of street works

Rahman Pilvar, Institute for Transport Studies, University of Leeds, LS2 9JT, LEEDS, WEST YORKSHIRE, United Kingdom, r.pilvar03@leeds.ac.uk

Urban transportation networks are subject to various capacity-degrading events due to road maintenance and utility works activities. All so often a conflict of interest prevails among the stakeholders regarding the underlying street works details such as the timing, suitable level of capacity occupation, etc. The present article provides a Network Design Problem framework for optimum scheduling of street works in a transportation network. A multi-objective bi-level programming formulation is presented to minimise the total costs associated with delays to road users and utility companies while ensuring that the accessibility level of the network would be minimally affected.

4 - Optimal Bus Route Frequency Allocation in a Large-Scale Urban System

Hani Mahmassani, Transportation Center, Northwestern University, 600 Foster St, 60208, Evanston, Illinois, United States, masmah@northwestern.edu, *Ismail Omer Verbas*

This study develops new formulations for the bus frequency allocation problem. Existing bus frequency allocation in the literature maximizes ridership and waiting time savings subject to budget, fleet, policy headway and maximum load constraints by solving for route frequencies. The formulations consider routes with multiple service patterns, and include cost minimization with minimum ridership constraint, bus size selection as an additional decision variable, and maximum load as a penalty function. The approach is demonstrated in an actual large-scale system.

■ MC-11

Monday, 12:30-14:00

RB-Iota

Transport Planning

Stream: Transportation and Logistics

Invited session

Chair: *Hani Mahmassani*, Transportation Center, Northwestern University, 600 Foster St, 60208, Evanston, Illinois, United States, masmah@northwestern.edu

1 - New Algorithm for the Stochastic Generalized Transportation Problem

Marcin Anholcer, Department of Operations Research, Poznan University of Economics, Al. Niepodleglosci 10, 61-875, Poznan, Poland, m.anholcer@ue.poznan.pl

Generalized Transportation Problem (GTP) is a variant of Transportation Problem where the amounts (or values) of good change during the transportation process. We consider the stochastic version of the problem, where the values of demand of the destination points are random variables. The goal is to minimize the expected value of the total cost. We present new exact method for the GTP.

2 - The Dynamic Driver-Routing Problem

Niels Agatz, Decision and Information Science, RSM University, Burg. Oudlaan 50, 3000DR, Rotterdam, Netherlands, nagatz@rsm.nl, *Jordan Srour*, *Johan Oppen*

The dynamic dial-a-driver service is an innovative concept in the realm of passenger transportation in which the customer requests a driver to transfer him/her from one location to another in the customer's own car. A particularly dynamic application of this service focuses on people who must get themselves and their car home safely after drinking too much. In this study, we consider the problem of assigning drivers to customer requests and company chase cars to driver requests with the objective to minimize the total distance traveled by the chase vehicles.

■ MC-12

Monday, 12:30-14:00

RB-Omicron

Application of fuzzy logic and soft methodologies in decision-making and financial modelling

Stream: Fuzzy Sets and Soft Computing

Invited session

Chair: *Robert Fullér*, IAMSR, Åbo Akademi University, Joukahainengatan 3-5, 20520, Åbo, Finland, rfuller@abo.fi
Chair: *Mikael Collan*, Department of Business Economics and Law, Lappeenranta University of Technology, Raivaajankatu 5 as. 3, 24100, Salo, Finland, mikael.collan@lut.fi

1 - Fuzzy Models and Statistics

Reinhard Viertl, Statistics and Probability Theory, Vienna University of Technology, Wiedner Hauptstr. 8, 1040, Wien, Austria, R.Viertl@tuwien.ac.at

In statistics there appear different kinds of uncertainty. One which is frequently neglected is fuzziness of data. In order to obtain realistic results from statistical inference it is necessary to describe the fuzziness of data quantitatively. This is possible using fuzzy models. Generalized statistical methods are available and related software is under development. Another kind of fuzziness is the uncertainty of a-priori distributions in Bayesian inference. This uncertainty can be described by so-called fuzzy probability distributions. Related generalized procedures will be given.

2 - An Integration of TOPSIS Method and Interval Type II Fuzzy Sets to Evaluate Municipality Investment Alternatives: The Case of Istanbul Municipality

Nazmi Sener, Industrial Engineering, University of Yalova, Muhendislik Fakultesi Sehit Ömer Faydali Cad., Yalova Atatürk Stadyumu karsisi Merkez, 77100, Yalova, Turkey, nazmi.sener@yalova.edu.tr, *Hasan Huseyin Turan*

Due to the limited capital sources, municipalities have to be careful about defining the investment priorities. Thus, in this study the extension of TOPSIS method and interval type II fuzzy sets is suggested to guide municipalities. A survey conducted on strategic planning experts is used as initial information for the proposed model. As a case study suggested method is tested to rank several alternatives in Istanbul. The results reveal insights for feasibility and effectiveness of proposed methodology. Finally, sensitivity analysis is performed to test the stability of the rankings.

3 - Quantifying expected benefits from investment projects with the fuzzy pay-off method

Mikael Collan, Department of Business Economics and Law, Lappeenranta University of Technology, Raivaajankatu 5 as. 3, 24100, Salo, Finland, mikael.collan@lut.fi

The pay-off method is a simple new method for framing the investment profitability analysis problem and for enhancing the support for investment decision making. The method is based on directly deriving a fuzzy number from a set of cash-flow scenarios that is then used as a basis for derivation of descriptive numbers. These descriptive numbers include, e.g., the real option value. The method is a complement to the profitability analysis toolpack of managers and is very robust and can be used for all types of investments, it is "excel compatible" and fully transparent all the way.

4 - Numerical Patent Analysis with a Fuzzy Compound Real Option Model

Xiaolu Wang, Åbo Akademi University, Finland, xiawang@abo.fi

Patent valuation has always been a difficult task due to the great uncertainties involved in patent exploitation process, which provides us with the incentive to use fuzzy estimator for the volatility of the expected future monopoly profits. It is also recognizable that investing in patent application buys the investor an right, but not an obligation, to commercialize the innovation, we therefore present how the proposed fuzzy compound real option model can be used to generate decision-support for deciding whether to go ahead with a patent application or not.

■ MC-13

Monday, 12:30-14:00

RB-Tau

Lot-sizing and Related Topics 3

Stream: Lot-sizing and Related Topics
Invited session

Chair: *Franklina Toledo*, Applied Mathematics and Statistic, ICMC - USP, Av. Trabalhador Saocarlene, 400, CP 668, 13.560-970, Sao Carlos, Sao Paulo, Brazil, fran@icmc.usp.br

1 - An approach of implementing the Kalman filter in the calculation of lot sizes

Katharina Amann, Chair of Production and Logistics, Georg-August-University Goettingen, Platz der Göttingen Sieben 3, 37073, Göttingen, Lower Saxony, Germany, kamann@gwdg.de, *Jutta Geldermann*

Nowadays, Production Planning is an important assignment in industrial companies. In fact, many companies use simple approaches with several restrictions to plan their production. The presentation introduces an advanced approach in Production Planning: It includes the Kalman filter as an estimator of the customers demand in the calculation of lot sizes. A forecasting competition between the Kalman filter and well-know forecasting methods is performed. Based on these results, the possible impact of forecasting methods on lot sizes and stock levels as well as service levels is analyzed.

2 - Hybrid relax-and-fix heuristics for the lot-sizing and scheduling problem in the industry of consumer goods for personal hygiene

Debora Ronconi, Production Engineering, University of Sao Paulo, Av. Prof. Almeida Prado,128, 05508070, Sao Paulo, Sao Paulo, Brazil, dronconi@usp.br, *Márcio Kawamura*

This work addresses the integrated lot sizing and scheduling problem that occurs in a very competitive market in which the good service level show up in the competition for the clients. The operational environment is composed of unrelated parallel machines with sequence-dependent setup times and costs. Backordering is allowed but it is extremely undesirable. We propose several resolution methods based on the relax-and-fix heuristics where hybrid partitioning strategies are analyzed. The computational experiments were conducted on randomly generated instances and real problems.

3 - A hybrid metaheuristic for production planning in the spinning industry

Victor Camargo, Institute of Mathematics and Computer Sciences, University of São Paulo, Av. do Trabalhador são-carlense, 400, 13566-590, São Carlos, SP, Brazil, victor@icmc.usp.br, *Franklina Toledo*, *Bernardo Almada-Lobo*

We investigate a two-stage lot-sizing and scheduling problem arising at a spinning industry. A new hybrid metaheuristic called HOPS (Hamming-Oriented Partition Search) are proposed to solve the problem. It is a branch-and-bound procedure that incorporates a fix-and-optimize improvement method. An innovative partition choice for the fix-and-optimize is developed. The computational tests with instances generated based on real data attest the HOPS to be a good alternative to solve MIPs with recognized partitions such as the lot-sizing and scheduling case.

■ MC-14

Monday, 12:30-14:00

RB-Omega

Resource allocation and scheduling in practice: further complexity

Stream: Scheduling under Resource Constraints
Invited session

Chair: *Sacramento Quintanilla*, Economia Financiera y matematica, University of Valencia, Avda. Naranjos s/n, 46071, Valencia, Spain, Maria.Quintanilla@uv.es

1 - Balancing the use and distribution of warehouse resources: a scheduling pre-processing procedure

M. Angeles Pérez, Mathematics for Economy, University of Valencia, Avda Naranjos s/n, 46021, Valencia, Spain, angeles.perez@uv.es, *Francisco Ballestin*, *M.Pilar Lino*, *Sacramento Quintanilla*, *Vicente Valls*

Scheduling warehouse storage/retrieval orders is a complex process that assigns to each order a location, a forklift and a start time, taking into account pallet specifications, traffic restrictions and forklift capabilities. Locations are previously selected maximizing total free storage space but, their spatial distribution and forklift requirements influence the total time required to complete the orders. We present a multi-objective heuristic algorithm that re-assigns locations balancing spatial distribution and forklift workloads. Computational results are also presented.

2 - Simultaneous allocation of medical resources and scheduling of visits in a Hospital at Home service

Sacramento Quintanilla, Economia Financiera y matematica, University of Valencia, Avda. Naranjos s/n, 46071, Valencia, Spain, Maria.Quintanilla@uv.es, *Francisco Ballestin*, *M.Pilar Lino*, *M. Angeles Pérez*, *Vicente Valls*

In a Hospital at Home Service, patients are at home and have to be visited regularly by a team comprising a doctor and a nurse. The Service has a pool of doctors and nurses with different specializations. The team that visits a patient has to have the expertise required to treat the patient. The Service daily determines the teams and vehicles that will visit patients and also establishes the sequence of visits for each team with the objective of cost minimization. We present a solution procedure for this resource allocation and task scheduling problem and some computational results.

3 - Approximate algorithms for simultaneous project scheduling and resource allocation with controllable processing times

Jose M. Framinan, Industrial Management, School of Engineering, University of Seville, Avda. de los Descubrimientos s/n, Seville, Spain, jose@esi.us.es, Victor Fernandez-Viagas Escudero

This paper presents several heuristics for an integrated Project Scheduling and Staff Assignment (PSSA) problem where tasks have precedence relations and release times. The processing time of each task depends on the amount of resources assigned (over- and under-coverage is allowed). Furthermore, the employee can perform certain task only feasible if he/she possesses the appropriate skill. The objective is to minimize the makespan of the project. A GRASP and an Iterated Greedy algorithm have been designed and successfully tested on a test-bed based on the well-known library SPLIB.

4 - Project Resource Leveling and Robustness Optimization using ANP

Elena Rokou, Industrial Management & OR, Mechanical Engineering, National Technical University of Athens, Heron Polytechniou 9 9, Athens, Greece, Greece, erokou@mail.ntua.gr, Konstantinos Kirytopoulos

The paper presents a DSS for multi-objective project scheduling under precedence and resource constraints. It handles both preemptive and not scheduling, multiple performing modes and partial or full allocation of resources to activities. Project performance criteria are makespan minimization, resource leveling and robustness. Firstly the decision maker sets the weighting factors for each component using ANP and a linear value function is formed. Secondary, backward and forward SGS along with priority rules generate initial feasible schedules that are further exploited by an adaptive GA.

Two mixed-integer non-linear programming (MINLP) models for the optimal short-term hydro-scheduling (STHS) are compared. These two models include the following features: head-dependency, start/stop of units, discontinuous operating regions, and discharge ramping constraints. Furthermore, they consider hydroelectric power generation as a nonlinear function of both the water discharge and the net head. In order to compare assumptions and results of both models, we adjusted the first one in order to apply it in the case of the second, the main cascaded hydro systems in Portugal.

3 - Continuous optimization using a biologically-motivated multilevel system

JongChen Chen, Information Management, National YunLin University of Science and Technology, 123 University Road, Section 3, Douliu, Taiwan, Taiwan, jchen@yuntech.edu.tw

Our group had previously developed a multilevel system operating across a wide spectrum of organizational levels. The interactions among different levels of information processing expand its problem solving capability. To address the continuous optimization problems, we used the system to control the motions of a walking robot. The experimental results showed that the robot was capable of learning in a continued manner in a physical environment. We then made some change in the robot's structure, and the results showed the system possessed continuous optimization capability.

4 - Nonlinear Optimal Control of Spacecraft Attitude Using Internal Momentum Rotors

M. Navabi, Shahid Beheshti University, GC, Iran, Islamic Republic Of, civil.space.edu@gmail.com, Mina Tavanna

In this paper, attitude of a satellite is controlled by internal momentum rotors utilizing a nonlinear optimal control method. This method is based on State Dependent Riccati Equation. It is difficult to solve a nonlinear system optimally with state and control constraints. The capabilities of State Dependent Riccati Equation technique are illustrated in producing control design for spacecraft attitude control with quadratic constraint on quaternion. The simulation results show that the mentioned method have desired accuracy for spacecraft attitude nonlinear control problems.

■ MC-15

Monday, 12:30-14:00

RB-2101

Nonlinear Optimization and Applications 2

Stream: Nonlinear Programming

Invited session

Chair: Edite M.G.P. Fernandes, Algoritmi R&D Centre, University of Minho, School of Engineering, Campus de Gualtar, 4710-057, Braga, Portugal, emgpf@dps.uminho.pt

1 - A multi-layers method to improve optimization algorithms. Application to the design of bioreactors for water treatment.

Benjamin Ivorra, Matematica Aplicada, Universidad Complutense de Madrid, Plaza de ciencias, 3, 28040, Madrid, Spain, Spain, ivorra@mat.ucm.es, Juan M. Bello Rivas, Jérôme Harmand, Angel Manuel Ramos, Alain Rapaport

We envision global optimization as finding a suitable initial guess of a considered optimization algorithm. One can imagine that this possibility improves the existing optimization methods. To do so, we present a methodology that consists in the resolution of a sub-optimization problem by using a multi-layers line search algorithm. We check the efficiency of this approach by considering benchmark and industrial problems. In particular, we focus on the optimization of the shape and hydrodynamic properties of a bioreactor in which a wastewater substrate is degraded by a microbial ecosystem.

2 - Comparing two MINLP models for the Hydro Scheduling Problem: The case of a head-dependent cascaded reservoir system in Portugal

Javier Diaz, Sistemas e Informatica, Universidad Nacional de Colombia, Cra 80 65-223, Facultad de Minas Bloque m8A oficina 212, 1, Medellin, Antioquia, Colombia, javidiaz@unal.edu.co, Luis Moreno

■ MC-16

Monday, 12:30-14:00

RB-2103

Numerical methods of nonsmooth optimization

Stream: Nonsmooth Optimization

Invited session

Chair: Albert Ferrer, Dpt. of Applied Mathematics I, Technological University of Catalonia, Av. Doctor Marañon, 44-50, 08028, Barcelona, Catalunya, Spain, alberto.ferrer@upc.edu

1 - Hyperbolic smoothing function method for minimax problems

Adil Bagirov, School of Science, Information Technology & Engineering, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.bagirov@ballarat.edu.au

In this talk, we discuss an approach for solving finite minimax problems. This approach is based on the use of hyperbolic smoothing functions. In order to apply them we reformulate the objective function in the minimax problem. Based on these results an algorithm for solving the finite minimax problem is proposed. We present results of numerical experiments and compare the proposed algorithm with the algorithm that uses the exponential smoothing function as well as with the algorithm based on nonlinear programming reformulation of the finite minimax problem.

2 - Nonsmooth nonconvex optimization via smooth optimization

Gurkan Ozturk, Industrial Engineering, Anadolu University, AU-MMF-Industrial Engineering, Iki Eylul Campus, 26480, Eskisehir, Turkey, gurkan.o@anadolu.edu.tr, *Adil Bagirov*

In this paper, an algorithm for minimizing locally Lipschitz functions is developed. Descent directions in this algorithm are computed by solving a system of linear inequalities. In order to solve this system we reduce it to the minimization of the convex piecewise linear function over the unit ball. Then the hyperbolic smoothing function is applied to approximate this problem by the sequence of smooth problems.

3 - A Truncated Codifferential Method: Using hypogradients from current and previous iterations

Ali Hakan Tor, Department of Mathematics, Middle East Technical University, Inonu Bulvari, Cankaya, 06531, Ankara, Turkey, htor@metu.edu.tr, *Adil Bagirov*

The proposed method uses the concept of codifferential. To construct the whole set of codifferential is too complicated, so a few elements of this set are used to find the descent directions. Moreover, the method employs not only a few elements from the codifferential at current iteration but also some codifferentials from previous iterations for computation of descent directions. The convergence of the proposed method is proved. By using performance profiles, results of numerical experiments addressing a set of convex and nonconvex test problems are reported by comparing some other methods.

4 - Iterative local search algorithm for solving non-smooth flow shop problems

Albert Ferrer, Dpt. of Applied Mathematics I, Technological University of Catalonia, Av. Doctor Marañon, 44-50, 08028, Barcelona, Catalunya, Spain, alberto.ferrer@upc.edu, *Angel, A. Juan, Helena Ramalhinho Lourenço*

This work discusses the use of an Iterative Local Search (ILS) algorithm for solving flow-shop problems with non-smooth objective functions. The ILS framework has been adapted to perform a parameter-free local-global search process. The parameter-free property distinguishes our approach from other similar approaches, which performance strongly depends upon several parameters. A set of experiments have been carried out. The results obtained so far suggest that our approach can be successfully applied in a variety of non-smooth scheduling problems.

■ MC-17

Monday, 12:30-14:00

RB-2105

Reverse Logistics Network Design

Stream: Applications of Location Analysis
Invited session

Chair: *Sibel A. Alumur*, Industrial Engineering Department, TOBB University of Economics and Technology, Sogutozu cad. No:43, Sogutozu, 06560, Ankara, Turkey, salumur@etu.edu.tr

1 - Sustainable Reverse Logistics Network Design for Multi-modal Transport of Household Plastic Waste

Jacqueline Bloemhof, Operations Research and Logistics, Wageningen University, Hollandseweg 1, 6700 EW, Wageningen, Netherlands, jacqueline.bloemhof@wur.nl, *Xiaoyun Bing, Jack van der Vorst*

Household plastic waste can be collected, separated and treated to be used as recycled plastics again. This is both an economically and environmentally attractive option, although transportation of the plastic waste also causes extra environmental and economic costs. This paper studies the reverse logistics network of plastics in the Netherlands and adopts multi-modality transportation to deal with future increase of plastic waste. We use an MILP model-based scenario study taking into account transportation, processing and emission costs to develop a sustainable logistics network design.

2 - Integrating forward and reverse flows: a generic model for remanufacturing activity

Neslihan Demirel, Industrial Engineering, Gazi University, Turkey, neslihanozgun@gazi.edu.tr, *Hadi Gökçen*

The importance of the recovery of used products has been widely recognized in the literature and practice. This is mainly due to the environmental deterioration and the limited capacities of disposal areas. To plan a closed loop supply chain strategically and to coordinate production, remanufacturing, disposal and outsourcing operations efficiently, we proposed a multi-level, multi-product, multi-period mixed integer linear programming (MILP) model. We illustrated the model on a numerical example and carried out sensitivity analyses.

3 - Multi-Period Reverse Logistics Network Design

Sibel A. Alumur, Industrial Engineering Department, TOBB University of Economics and Technology, Sogutozu cad. No:43, Sogutozu, 06560, Ankara, Turkey, salumur@etu.edu.tr, *Stefan Nickel, Francisco Saldanha-da-Gama, Vedat Verter*

In this paper, we propose a profit maximization modeling framework for reverse logistics network design problems. We present a mixed-integer linear programming formulation that is flexible to incorporate most of the reverse network structures plausible in practice. The proposed general framework is justified by a case study in the context of reverse logistics network design for washing machines and tumble dryers in Germany. We conduct extensive parametric and scenario analysis to illustrate the potential benefits of using a dynamic model, and also to derive a number of managerial insights.

■ MC-18

Monday, 12:30-14:00

RB-2107

Financial Modelling

Stream: Financial Modelling & Risk Management (contributed)

Contributed session

Chair: *Tatjana Slijepcevic-Manger*, Faculty of Civil Engineering, University of Zagreb, Fra Andrije Kacica-Miosica 26, 10000, Zagreb, Croatia, tmanger@grad.hr

1 - Moment-matching method with monomial approach

Alessandro Staino, Business Science Department, University of Calabria, Via Pietro Bucci Cubo 3c, 87036, Arcavacata di Rende (CS), Italy, alessandro.staino@unical.it, *Andrea Consiglio*

Moment-Matching methods are often used to find an approximated solution to stochastic programming problems where the uncertainty is modeled through continuous distributions. In this paper we present a moment-matching method coming from the monomial method which is a technique to solve systems of algebraic equations iteratively. Specifically, we show how to generate distributions of financial returns so that some statistics are matched. A very valuable feature of our method is its capability of generating arbitrage-free financial markets.

2 - Stratified Sampling Implementations in Financial Simulation

Ismail Basoglu, Industrial Engineering, Science Institute, Industrial Eng. Dept. Engineering Faculty, Bogazici University South Campus Bebek, 34342, Istanbul, Turkey, ismail.basoglu@boun.edu.tr, *Wolfgang Hörmann*

Monte Carlo methods are applicable to most of the rare event financial problems. Yet, the yielding variance is large for this type of stochastic events. One can use stratified sampling, which is based on the decomposition of the sampling domain and conditional sampling within each stratum and simulation results are combined throughout the strata. Our research is mainly focused on optimal construction of strata structures and implementing stratified sampling in an automatic and efficient manner for different type of financial problems.

3 - Modeling Hedge Fund Performance Using Neural Network Models

Joseph Paradi, Chemical Engineering and Applied Chemistry, University of Toronto, 200 College Street, M5S3E5, Toronto, Ontario, Canada, paradi@mie.utoronto.ca, *Marinos Tryphonas*

New neural network model evaluates monthly mutual fund using backwards elimination regression for explanatory variable selection. The case study on 293 N/A hedge funds between 1998 and 2010. 25 risk factors including equity, fixed income, foreign exchange, and commodity factors were employed as explanatory variables. Two main conclusions: 1) the new neural network model delivered better out-of-sample performance compared to linear regression models; 2) risk factor selection based on backwards elimination regression consistently improved the model performance across the whole time period.

4 - Ruin probability functions with N intersections

Tatjana Slijepcevic-Manger, Faculty of Civil Engineering, University of Zagreb, Fra Andrije Kacica-Miosica 26, 10000, Zagreb, Croatia, tmanger@grad.hr

In this paper we show that for any positive integer N we can construct two spectrally negative Levy processes such that their ruin probability functions have at least N positive intersections. This means that in some cases the optimal ruin strategy can be very unstable.

■ MC-19

Monday, 12:30-14:00

RB-2111

Quantitative approaches to bank performance and asset evaluation

Stream: Operational Research and Quantitative Models in Banking
Invited session

Chair: *Enrique Ballester*, Escuela Politecnica Superior de Alcoy, Technical University of Valencia, 03801, Alcoy (Alicante), Spain, eballe@esp.upv.es

Chair: *Mila Bravo*, ALCOY SCHOOL, TECHNICAL UNIVERSITY OF VALENCIA, 03801, ALCOY, Spain, mibrasel@epsa.upv.es

1 - Ranking funds offered by the Spanish CaixaBank: A compromise approach to performance

Enrique Ballester, Escuela Politecnica Superior de Alcoy, Technical University of Valencia, 03801, Alcoy (Alicante), Spain, eballe@esp.upv.es

The CaixaBank offers funds to customers. To evaluate their performance a linear-quadratic compromise programming model is developed. This measure can be extended to many investment criteria while the traditional ratio-based and leverage-based measures are essentially limited to profitability and risk. It also avoids negativity in the ratio values. Sophisticated compromise programming proves superior to the simple use of ratios. Customers' profiles of The CaixaBank are defined by weighting systems. Each one leads to coherent results which are compared to the results from domination analysis.

2 - Evaluating artistic assets: A multicriteria method

Paloma Pareja, Independent consultant, Spain, arenillas.pal@gmail.com, *Sonia Zendejaban*

To assess painting assets of bank collections in terms of quality, a multicriteria model is developed relying on domination analysis and moderate pessimism decisions under uncertainty. As preferences for the artistic criteria change from a decision maker to another, they are considered unknown. The criteria are features such as theme originality, drawing and color. As a result, the assets are ranked by quality indexes, which is a previous step to determine quality to price ratios. Data from collections as well as the computational process and results are tabulated and analysed.

3 - Multicriteria ranking of Spanish banks from the 2011 European Banking Authority wide stress test

Mila Bravo, ALCOY SCHOOL, TECHNICAL UNIVERSITY OF VALENCIA, 03801, ALCOY, Spain, mibrasel@epsa.upv.es, *Antonio Benito*

This paper aims at ranking 25 Spanish banks from external information published by the Bank of Spain, which provides financial criteria from the European Banking Authority (EBA)-wide stress test in 2011. As a previous step, each bank is characterized from the criteria as non-dominated or dominated by convex combinations of the other banks. Weighted goal programming (which requires assuming preferences for the criteria) and the moderate pessimism decision making model under uncertainty (which does not require assumptions on preferences) are used to rank the non-dominated banks.

■ MC-20

Monday, 12:30-14:00

RB-2113

Risk Analysis and Credit Scoring

Stream: Data Mining in the Financial Sector
Invited session

Chair: *Cristian Bravo*, Department of Industrial Engineering, University of Chile, Republica 701, Santiago, 8370439, Santiago, Chile, cribravo@ing.uchile.cl

1 - Improving Credit Scoring by Differentiating Defaulter Behavior

Cristian Bravo, Department of Industrial Engineering, University of Chile, Republica 701, Santiago, 8370439, Santiago, Chile, cribravo@ing.uchile.cl, *Lyn Thomas*, *Richard Weber*

In this work, we formalize the common notion that there are two types of defaulter, those who do not pay because of cash flow problems, and those that do not pay because of lack of willingness to pay. We propose to differentiate them using a game theory model to describe their behavior, and from this model construct a set of constraints for a semi-supervised constrained clustering algorithm that creates a new target variable. We benchmark several multiclass supervised models to test the approach, finding significant improvement in classification accuracy, and strong insights about defaulters.

2 - Intensity models and transition probabilities for credit card loan delinquencies

Jonathan Crook, University of Edinburgh Business School, University of Edinburgh, Credit Research Centre, 50 George Square, EH8 9AL, Edinburgh, Lothian, United Kingdom, jonathan.crook@ed.ac.uk

We estimate the probability of delinquency and default for a sample of credit card loans using intensity models, via semi-parametric multiplicative hazard models with time-varying covariates. These models allow for insights into the factors that affect movements towards (and recovery from) delinquency, and into default (or not). Results indicate that different types of debtors behave differently while in different states. The probabilities estimated for each type of transition are then used to make out-of-sample predictions over a specified period of time.

3 - Comparative Analysis of Dynamic Models Specification for Behavioral Scoring in a Microfinance Portfolio

Jose Pizarro, Department of Industrial Engineering, University of Chile, Santiago, Chile, jopizarr@gmail.com, *Cristian Bravo*

Traditional approach in the analysis and estimation of the probability of default is based on static frameworks. It has been shown that these models can be improved using panel data, in which the model is built considering the observed dynamic of the included variables. We study if the traditional dynamic logistic model can be improved if we modify the specification using a neural network model, and test if the dynamic aspect of the model improves classification capacity. We conclude analyzing if these changes improve the prediction capability of the model.

4 - Dynamic affordability assessment

Katarzyna Bijak, School of Management, University of Southampton, Highfield, SO17 1BJ, Southampton, United Kingdom, k.bijak@soton.ac.uk, *Lyn Thomas*

In the credit decision making process, both applicant's creditworthiness and affordability should be assessed. Affordability is often checked on the basis of declared current income, assumed standard expenditure and existing debts. In contrary, a dynamic affordability assessment is proposed by us. The affordability at a given moment in time is defined as a total amount of money which the applicant can use to service their debts. It depends on the applicant's income and expenditure which both vary in time. The suggested model can contribute to responsible lending.

■ MC-21

Monday, 12:30-14:00

RB-2115

Financial Mathematics and OR 3

Stream: Financial Mathematics and OR
Invited session

Chair: *Tansel Avkar*, Department of Mathematics, Middle East Technical University, 06531, Ankara, Turkey, tanselavkar@gmail.com

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - A Rank-based Approach to Cross-Sectional Analysis

Ludovic Cales, HEC - Department of Finance, University of Lausanne, Dorigny, 1015, Lausanne, Switzerland, ludovic.cales@unil.ch, *Monica Billio*, *Dominique Guegan*

This paper studies the cross-sectional effects present in the market using a new graph theoretic framework. We model the evolution of a dynamic portfolio, i.e., a portfolio whose weights change over time, as a function of cross-sectional factors where the predictive ability of each factor is described by a variable. This modeling permits us to measure the marginal and joint effects of different cross-section factors on a given dynamic portfolio. Associated to a regime switching model, we are able to identify phases during which the cross-sectional effects are present in the market.

2 - Bayesian approach for stochastic models with conditional heteroscedasticity in the analysis of the return volatility of an agricultural commodity

Sandra Cristina Oliveira, Business Administration, UNESP - Univ. Estadual Paulista, Av. Domingos da Costa Lopes, 780, 17602-496, Tupã, São Paulo, Brazil, sandra@tupa.unesp.br

The volatility of returns generated by commodities has implications in formulation of policies for the country's economic performance. Given the relevance of ARCH family models in the solution of economical and financial problems, this work compares the Bayesian estimates for the parameters of AR-ARCH processes with normal and Student's t distributions for returns of coffee beans prices. An informative prior distribution was adopted and posterior summaries were obtained by Monte Carlo Markov Chain simulation. Results showed that AR-ARCH process with t distribution adjusted better to the data

3 - Solving Large Two-Stage Stochastic Optimization Problems with Portfolio Safeguard

Stan Uryasev, Director of Risk Management and Financial Engineering Lab, University of Florida, FL 32611-6595, Gainesville, 303 Weil Hall, Florida, United States, Uryasev@ufl.edu

Although the solving two-stage stochastic optimization problems is well developed, there are few practical examples of applications. Mostly, example calculations were done by researchers in stochastic optimization area to exemplify new efficient mathematical programming approaches. Few engineers have such extensive expertise. These complications lead to the development of special meta-commands in Portfolio Safeguard (PSG) software for efficient coding. To be less conservative than maximum loss, but more conservative than average, you can use the CVaR operator.

4 - Corporate Control with Cross-Ownership

Marc Levy, CEB, ULB, 50, av. F.D. Roosevelt, 1050, Brussels, Belgium, marc.levy@ulb.ac.be, *Ariane Szafarz*

In cross-ownership structures, existing methods are unable to evaluate control stakes. This is because cross-ownership induces circularity, and makes it impossible to identify winning coalitions among shareholders. To fill this gap, this paper proposes a novel theoretical approach. This approach generalizes the Banzhaf index from game theory and combines it with Markov voting chains. From a governance standpoint, we show that cross-ownership may favor shareholder expropriation. To illustrate this point, we revisit the case of the German Allianz Group. This paper also puts forward an algorithm.

■ MC-23

Monday, 12:30-14:00

RB-Delta

Generalized Convexity and Optimization

Stream: Generalized Differentiation and Optimization
Invited session

Chair: *Alexander Kruger*, School of Science, Information Technology & Engineering, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - On the pseudoconvexity of a wide class of generalized fractional functions

Laura Carosi, Statistics and Applied Mathematics, University of Pisa, Via Ridolfi, 10, 56124, Pisa, Italy, lcaros@ec.unipi.it, *Laura Martein*, *Alberto Cambini*

Even though pseudoconvexity plays an important role in optimization, very few classes of pseudoconvex functions are known. We consider a wide class of generalized fractional functions: the sum between a linear one and a ratio which has an affine function as numerator and the p -th power of a positive affine one as denominator; p can be any positive number different from 1. Provided nonnegativity conditions and these functions to be not pseudoconvex, we study pseudoconvexity on the nonnegative orthant. We derive necessary and sufficient conditions expressed in terms of the initial data.

2 - Continuous-time nonlinear programming under generalized type I invexity

Andreea Madalina Stancu, Institute of Mathematical Statistics and Applied Mathematics, The Romanian Academy, Calea 13 Septembrie, nr 13, RO-050711, Bucharest, Romania, andreea_madalina_s@yahoo.com, *Ioan Stancu-Minasian*

We consider a continuous-time programming problem (P) with nonlinear operator equality and inequality constraints. This problem belongs to the area of generalized convex optimization. In fact, we establish sufficiency optimality criteria under generalized type I invexity conditions.

3 - Weak pseudo-invexity, generalized Fritz-John optimality and duality in nonlinear programming

Hachem Slimani, Laboratory of Modeling and Optimization of Systems LAMOS, Computer Science Department, University of Bejaia, 06000, Bejaia, Algeria, haslimani@gmail.com, *Mohammed Said Radjef*

We use a generalized Fritz-John condition and weak invexity to derive optimality conditions and duality results for a constrained nonlinear programming. A new concept of Fritz-John type stationary point is defined and a characterization of solutions is established. Moreover, we prove several duality results for a Mond-Weir type dual. It is shown, that the introduced generalized Fritz-John condition combining with the invexity with respect to different functions are especially easy in application and useful in the sense of sufficient optimality conditions and of characterization of solutions.

■ MC-24

Monday, 12:30-14:00

CC-A11

OR in Human Resources

Stream: OR in Human Resources

Invited session

Chair: *Irina Kazina*, Telematika and Logistika, TTI, Lomonosova str.1, Riga, Latvia, irinakazina@yahoo.com

Chair: *Majda Bastic*, Faculty of Economics and Business, University of Maribor, Razlagova 14, 2000, Maribor, Slovenia, majda.bastic@uni-mb.si

1 - The influence of individual factors and work environment on creativity

Majda Bastic, Faculty of Economics and Business, University of Maribor, Razlagova 14, 2000, Maribor, Slovenia, majda.bastic@uni-mb.si, *Gabrijela Leskovar-Špacapan*

The main aim of the present study was to answer the question which factors significantly contribute to individual commitment to creativity. Questionnaire was administered to MBA and part-time students with working experience in Slovenian organizations. Methods used included instrument development, an exploratory analysis, a confirmatory factor analysis, and a test of a structural model. The results show that individual characteristics and leadership have a positive affect on creativity. The relationship between knowledge management and creativity was not found as significant.

2 - Functionality of self-assessment in 360 degree feedback method

Gözde Kubat, Kazan Vocational School, Başkent University, Ankara, Turkey, gozer@baskent.edu.tr, *Şükran Öktem*, *Hakan Turgut*, *İsmail Tokmak*

The importance of human factors is increasing in quality improvement. Companies are directed to Total Quality Management to establish a standard structure. In this research, human resources researched in various aspects. A questionnaire has been applied in various sectors in Ankara-Turkey as a dimension of individual performance measurement as the size of the self assessment. Information from multi-sector employees has been obtained with the Snowball Method. Self-assessment of the data obtained as a result of the analysis is aimed to reveal the size of the 360 (DFM) functionality.

3 - Research of control systems within the limits of the educational program

Irina Kazina, Telematika and Logistika, TTI, Lomonosova str.1, Riga, Latvia, irinakazina@yahoo.com, *Rostislav Kopytov*

The purpose of the present work consists in showing as it is possible to conduct research of a control system on the basis of studying of its characteristics. In process of studying extend representation about a control system. That representation is formed at the expense of system acceptance as single whole, and being in somebody a system environment. The offered technique is spent on comparison of degree of the competence of discipline to program requirements by the account of 72 characteristics. The received results testify to high degree of coincidence.

4 - Is there a place for OR in the HR Metrics World?

Gregory Lee, Wits Business School, University of the Witwatersrand, #2 St David's Place, Parktown, 2000, Johannesburg, Gauteng, South Africa, gregory.lee@wits.ac.za

HR metrics has taken the human resources world by storm, with an explosion of business analytics, data, and financial analysis. The HR metrics field has largely been shaped through industrial psychology. Does modern operational research have new insights to offer HR metrics over and above the current standards? I argue that OR does have much to offer, including the shaping of metrics systems through problem-based methods, the incorporation of data mining and simulation techniques, optimisation possibilities, and others. Implications for human resource thinking and implementation are suggested.

■ MC-26

Monday, 12:30-14:00

CC-A24

OR in Agriculture I

Stream: OR in Agriculture, Forestry and Fisheries

Invited session

Chair: *Sara Veronica Rodriguez-Sanchez*, Graduate Program in Systems Engineering, Universidad Autonoma de Nuevo Leon, 66450, San Nicolas de los Garza, Nuevo Leon, Mexico, srodriguez090444@gmail.com

1 - Surveillance systems in livestock production chains:

An approach for quantitative economic optimization

Xuezheng Guo, Business Economics Group, Wageningen University, Hollandseweg 1, WAGENINGEN, 6700EW, wageningen, Netherlands, xuezheng.guo@wur.nl, *G.D.H. (Frits) Claassen*, *Alfons Oude Lansink*, *Helmut Saatkamp*

A novel conceptual approach is presented aimed at economic optimization of portfolios of surveillance systems for livestock hazards, operated by e.g. a Food Safety Authority (FSA). Subjective appraisal of surveillance criteria by a multitude of stakeholders is major factor in estimating the portfolio surveillance performance, eventually determining surveillance resource allocations. This approach comprises (1) linear optimization, (2) stakeholder elicitation and (3) subjective weighing of surveillance performance. The approach is illustrated with results regarding application by the Dutch FSA.

2 - A mixed integer linear programming model for production planning of supply chains in the Spanish pig industry

Lluís Pla, Mathematics, University of Lleida, Jaume II, 73, 25001, Lleida, Spain, lpla@matematica.udl.es, *Esteve Nadal*

This study introduces a preliminary formulation of a mixed integer linear programming model to optimize the production planning of a pig supply chain in Spain. This model takes into consideration the costs associated to each type of farm (breeding-growing-finishing). As result occupancy of facilities is maximised and corresponding flow of animals from farm to farm derived. All-in all-out management is considered in fattening (finishing) farms while continuous management is considered for the rest. Furthermore, constraints represent a typical Spanish supply chain delivering pigs to an abattoir.

3 - How to improve profitability of the beef herd ? - the application of the multi-level hierarchic Markov method.

Anna Stygar, Department of Cattle Breeding, University of Agriculture in Krakow, al. Mickiewicza 24/28, 30-059, Cracow, Poland, astygar@ar.krakow.pl, *Anders Ringgaard Kristensen*, *Joanna M. Makulska*

In this paper the authors present the optimization and simulation model of beef heifer management that could be used to support the economically optimal decisions made by beef producers. The model was formulated as 3-level hierarchic Markov process. The optimized decisions concerned: feeding level in suckling and weaning period, weaning and breeding strategy. Optimal rearing strategy was found by maximizing total discounted net revenues from the predicted lifetime productivity measured by the cumulative standard weight of weaned calves.

4 - Production planning in a Beef meat packing plant

Sara Veronica Rodriguez-Sanchez, Graduate Program in Systems Engineering, Universidad Autonoma de Nuevo Leon, 66450, San Nicolas de los Garza, Nuevo Leon, Mexico, srodriguez090444@gmail.com, *Alysson M. Costa*, *Roger Z. Rios-Mercado*

The production planning of a beef meat packing plant involves the task of determining the number of cattle to use and how to cut them up in order to meet a given demand. There are several cutting patterns. Each pattern yields a specific set of products. The major challenge faced by the top management is to balance the benefits of selling products from one part of the carcass when there is less demand for products from

other parts. We develop a mixed integer linear programming model for this problem and illustrate how the use of this model has a positive impact in the company revenue.

■ MC-27

Monday, 12:30-14:00

CC-A25

Decision Analysis and Group Decision Making

Stream: Decision Processes

Invited session

Chair: *Jeffrey Keisler*, Management Science & Information Systems, University of Massachusetts Boston, 100 Morrissey Blvd, M/5-249, 02125, Boston, MA, United States, jeff.keisler@umb.edu

1 - Decision analysis with function-valued variables

Jeffrey Keisler, Management Science & Information Systems, University of Massachusetts Boston, 100 Morrissey Blvd, M/5-249, 02125, Boston, MA, United States, jeff.keisler@umb.edu

DA models typically include uncertain real and discrete state variables. In principle, state variables could themselves be functions. This is useful for incorporating frameworks from various fields of knowledge. While theoretically allowed, this extension presents practical challenges throughout the DA process. Model structure determines required assessments and calculations. The latter may involve simplifying assumptions, e.g., restricting to the space of quadratic functions. To implement this idea, we must balance precision of results against ease and speed of assessment and computation.

2 - On the notion of dictatorship in group utility functions

Luis C. Dias, Faculdade de Economia / INESC Coimbra, INESC Coimbra, Rua Antero de Quental, 199, 3000-033, Coimbra, Portugal, lmcdias@fe.uc.pt, *Paula Sarabando*

Keeney proposed a cardinal utility axiomatization for the problem of aggregating utility functions of members of a group. One of the assumptions in this axiomatization was nondictatorship. We propose stronger formulations for this condition introducing the concept of strategic dictator and presenting the corresponding characterization of compliant group cardinal utility functions. We also characterize an extension to extend this notion of dictator to groups of individuals. An example using robustness analysis will illustrate the application of these nondictatorship principles.

3 - Individual heuristics and group decision effectiveness

Matthias Seifert, Operations & Technology, IE Business School, Maria de Molina 12, 5th Floor, 28006, Madrid, Spain, matthias.seifert@ie.edu, *Manel Baucells*

We use reduced ordered binary decision diagrams (ROBDDs) to study the link between individual heuristic processes and group decision effectiveness. Exploiting the concept of cumulative dominance in multi-attribute choice contexts, we start out by analyzing the probability that individuals identify dominant alternatives if they make errors during the evaluation of the choice set. We then demonstrate how such individual inefficiencies influence the effectiveness of group decisions relying on majority voting.

■ MC-28

Monday, 12:30-14:00

CC-A27

Nonsmooth Optimization I

Stream: Structured Optimization and Applications

Invited session

Chair: *Dominik Dorsch*, Dept. Mathematics, RWTH Aachen

University, Templergraben 55, 52056, Aachen, NRW, Germany, dorsch@mathc.rwth-aachen.de

1 - Lower Level Chance Constraints in Robust Portfolio Optimization

Marcel Sinske, Institute of Operations Research, Karlsruhe Institute of Technology, Kaiserstraße 12, 76131, Karlsruhe, Germany, sinske@kit.edu

We combine the well-known mean-variance approach by H.M. Markowitz and the robust counterpart for a convex optimization problem, introduced by A. Ben-Tal and A. Nemirovski, to achieve a robust portfolio optimization problem. Further we consider for the uncertain parameters a minimum volume ellipsoid as the uncertainty set. Such problems can be formulated as bilevel problems with a chance constraint in the lower level problem. We show some properties of this type of problem and develop an approach to solve it.

2 - Generalized derivatives of the projection onto the cone of positive semidefinite matrices

Anna-Laura Wickström, Universität Zürich, Switzerland, anna-laura.wickstroem@business.uzh.ch

We are interested in sensitivity and stability analysis of solution sets of optimization problems under set or cone constraints. A main motivation behind our work is the analysis of semidefinite programs (SDPs). We wish to explore the sensitivity analysis of SDPs with help of generalized derivatives.

3 - Nonsmooth versions of Sard's theorem

Tomas Bajbar, Institute of Operations Research, Karlsruhe Institute of Technology, Kaiserstraße 12, 76131, Karlsruhe, Germany, tomas.bajbar@kit.edu, *Vladimir Shikhman*

We present a comparison between some versions of Sard's Theorem which have been proven recently for special function classes with different definitions of critical points. Considering the class C_k , the class of min-type or min-max functions, the motivation for the definition of critical point is the topological structure of the inverse image. We compare topological critical points and critical points defined via metric regularity in the class of min-type and min-max functions. We illustrate the whole problematic by some examples.

4 - Express Line Queues and Space-Time Geometry

Eitan Bachmat, Computer Science, Ben-Gurion U., 1 Ben Gurion Ave, 84105, Beer Sheva, Israel, ebachmat@cs.bgu.ac.il

We consider queues in which jobs are sent to servers according to size cutoffs, as with express lines in supermarkets. We show that the optimal choice of cutoffs is governed by an equation which is similar to the geodesic equation in space-time geometry. We consider the queueing theoretic consequences of this relation and exhibit a queueing theoretic analogue of curvature.

■ MC-29

Monday, 12:30-14:00

CC-A29

Algorithms and Methods for MINLP problems

Stream: Mixed-Integer Non-Linear Programming

Invited session

Chair: *Sonia Cafieri*, Lab. MAIAA, Dept. de Mathématiques et Informatique, Ecole Nationale d'Aviation Civile, 7 Ave. Edouard Belin, 31055, Toulouse, France, sonia.cafieri@enac.fr

Chair: *Claudia D'Ambrosio*, LIX, CNRS - Ecole Polytechnique, route de Saclay, 91128, Palaiseau, France, dambrosio@lix.polytechnique.fr

1 - Mixed-integer programming under the presence of uncertainty: On the solution of multi-parametric MILP problems

Martina Wittmann-Hohlbein, Imperial College London, United Kingdom, m.wittmann-hohlbein09@imperial.ac.uk, *Efstathios Pistikopoulos*

We consider multi-parametric MILP problems with uncertainty simultaneously present in the coefficients of the objective function and the constraints. We present two-stage methods for the approximate solution such that the computational burden to derive explicit solutions is reduced. The first approach combines robust optimization and multi-parametric programming. In the second approach we exploit the special structure of the problems and employ suitable relaxations of bilinear terms. In particular, we embed novel MILP-relaxations of bilinear terms in the proposed procedure.

2 - GloMIQO: Global Mixed-Integer Quadratic Optimizer

Christodoulos Floudas, Chemical Engineering, Princeton University, 08544, Princeton, NJ, United States, floudas@princeton.edu, *Ruth Misener*

The Global Mixed-Integer Quadratic Optimizer, GloMIQO, is a numerical solver addressing mixed-integer quadratically-constrained quadratic programs (MIQCQP) to epsilon-global optimality. Algorithmic components are presented for: reformulating user input, detecting special structure, generating tight convex relaxations, dynamically generating cuts, partitioning the search space, bounding the variables, and finding feasible solutions. We extensively test GloMIQO using a suite of 399 problems from process networks applications, computational geometry problems, and standard performance libraries.

3 - A new Branch and Bound algorithm for MIQPs

Amélie Lambert, CEDRIC, CNAM, 292 rue saint martin, 75141, paris, France, amelie.lambert@cnam.fr, *Alain Billionnet*, *Sourour Elloumi*

Let (MQP) be a MIQP that consists in minimizing a quadratic function subject to linear constraints. Our approach to solve (MQP) is first to consider (MQP'), an equivalent MIQP that has a convex objective function, additional variables and constraints, and additional quadratic constraints. Then, we propose a new Branch and Bound based on the relaxation of the quadratic constraints to solve (MQP'). We perform experiments on pure and mixed-integer instances of medium size, and show that their solution times are improved by our Branch and Bound in comparison with two existing approaches.

4 - Optimistically Approximating Non-linear Optimization Problems through MILP

Claudia D'Ambrosio, LIX, CNRS - Ecole Polytechnique, route de Saclay, 91128, Palaiseau, France, dambrosio@lix.polytechnique.fr, *Andrea Lodi*, *Silvano Martello*, *Riccardo Rovatti*

We present a new piecewise linear approximation of nonlinear functions. It can be seen as a variant of classical triangulations with more degrees of freedom to define any point as a convex combination of the samples. For example, in the case of functions of 2 variables, each point is approximated as convex combination of 4 samples instead of 3 like in the traditional triangulation approach. When embedded in MILP models it results in a smaller number of binary variables. We show theoretical properties of the approximating functions and provide computational evidence of the impact of the method.

■ MC-30

Monday, 12:30-14:00

CC-A31

Emerging Applications in Production Management

Stream: Emerging Applications in Finance and Logistics

Invited session

Chair: *Jakob Krarup*, Dept. of Computer Science, University of Copenhagen, Ydervang 4, DK-3460, Birkerød, Denmark, krarup@diku.dk

1 - Assigning experts to tasks in a project

Stanislaw Walukiewicz, Systems Research Institute, Polish Academy of Sciences, ul. Newelska 6, 01-447, Warsaw, Poland, Stanislaw.Walukiewicz@ibspan.waw.pl, *Jakob Krarup*

The problem of assigning experts to tasks in a project can be modeled with the so-called Virtual Production Line (VPL) proposed by Walukiewicz in 2006. VPL appears to be a natural extension of the Classical Production Line (CPL) dating back to the car manufacturer Ford in 1913. Our approach is based on the concepts of social capital and proximity where social capital is defined as formal or informal relations between at least two experts. The proximity refers to specific interrelations linking experts on VPL. Comparisons of the assignments of experts to VPL and workers to CPL are considered.

2 - An inventory model with time dependent demand rate, trade credits and partial backlogging

Vikram jeet Singh, MATHEMATICS, Lovely Professional University, Jalandhar-Delhi G.T Road(NH-1), 144402, Phagwara, Punjab, India, vikram31782@gmail.com

In this paper we developed an inventory model for deteriorating items with time dependence of demand. Many inventory models in past were developed under the assumption that the holding cost is constant for the entire inventory cycle. But this is particularly false in the storage of deteriorating and perishable items such as food products. The holding cost is assumed to be varying over time in only few inventory models. Partially backlogged shortages are permitted and backlogging rate is waiting time for the next replenishment.

3 - Whole Life Costing (WLC) model in asset management

Wenjuan Zhang, Warwick Business School, Warwick University, ORMS Group, CV4 7AL, Coventry, United Kingdom, wenjuan.zhang@wbs.ac.uk

A Whole Life Cost (WLC) approach has been developed for determining capital expenditure requirements for asset management. This approach has addressed the problem caused by uncertainty associated with the maintenance cost and their timing by modelling asset degradation (timing to performance loss and boundary condition intervention states) capital and maintenance costs, risks and their probabilities, using Bayesian statistics, for each Maintainable Item (MI).

■ MC-31

Monday, 12:30-14:00

CC-A33

Mathematical methods for decision support in energy and industrial sectors

Stream: Iterative Methods for Economic Models

Invited session

Chair: *Elisabetta Allevi*, Quantitative Methods, University of Brescia, Contrada Santa Chiara, 50, 25122, Brescia, Italy, allevi@eco.unibs.it

Chair: *Adriana Gnudi*, Mathematics, Statistics, Computer science and Applications, University of Bergamo, Via dei Caniana, 2, 24127, Bergamo, Italy, adriana.gnudi@unibg.it

Chair: *Igor Konnov*, University of Kazan, Kazan, Russian Federation, Igor.Konnov@ksu.ru

1 - The steel industry: a mathematical model under environmental regulations

Rossana Riccardi, Quantitative Methods, University of Brescia, Contrada Santa Chiara, 50, 25122, Brescia, Italy, riccardi@eco.unibs.it, *Elisabetta Allevi*, *Adriana Gnudi*, *Francesca Bonenti*, *Claudia Avanzi*

In this work, a spatial equilibrium problem is formulated for analyzing how the price of electricity can influence investment decisions in the steel sector under EU ETS. In this light, two main processes for steel making have to be considered: integrated mills (BOF) and Electric

Arc Furnace (EAF) in minimills. Integrated mills produce high levels of direct emissions while emissions in EAF are indirect emissions in the form of electricity. A technological representation of the market will be introduced and the possibility of electricity auto-production in integrated mills will be analyzed.

2 - Evaluating the Impacts of the EU-ETS on Prices, Investments and Profits of the Italian Electricity Market

Giorgia Oggioni, Department of Quantitative Methods, University of Brescia, Italy, Contrada Santa Chiara, 50, 25122, Brescia, Italy, Italy, oggioni@eco.unibs.it, *Francesca Bonenti, Elisabetta Allevi, Giacomo Marangoni*

This paper investigates the economic impacts of the European Emission Trading Scheme (EU-ETS) on the Italian electricity market by a power generation expansion model where generators behave either as Cournot or perfectly competitive players. The developed models are used to measure the effects of the EU-ETS on electricity prices and demand, investments and generators' profits taking also into account the implications of the third phase. The solution of the overall system is found by exploiting the mixed complementarity theoretical framework and the implementation is conducted in GAMS.

3 - Electricity markets under linear price/demand and quadratic costs: Equilibrium à la Cournot and Supply Function Equilibrium

Francesca Bonenti, Quantitative Methods, University of Brescia, Contrada Santa Chiara 50, 25122, Brescia, Italy, Italy, francesca.bonenti@eco.unibs.it, *Magali E. Zuanon*

The Supply Function Equilibrium approach in an electric market takes place whenever firms compete in offering a schedule of quantities and prices. On the other hand, in the Cournot equilibrium model each firm chooses the optimal output by maximizing its own profit. Bonenti and Zuanon presented the explicit expressions characterizing analytically the Cournot equilibrium and the Supply Function equilibrium values for the produced quantities, the market-clearing price and the profits in a particular version of the models under linear price/demand and quadratic costs.

4 - Splitting Methods for Dynamic Auction Problems With Set Valued Mappings

Adriana Gnudi, Mathematics, Statistics, Computer science and Applications, University of Bergamo, Via dei Caniana, 2, 24127, Bergamo, Italy, adriana.gnudi@unibg.it, *Elisabetta Allevi, Igor Konnov*

We present a spatial price equilibrium model for the dynamic case with set valued cost functions. The model describes the behavior of a system of auction markets joined by transmission lines subject to joint balance and capacity flows constraints for a certain time period. We treat this model as an extended primal-dual system of variational inequalities. Some splitting type methods are proposed to find its solution with inexact and exact optimization algorithms.

■ MC-32

Monday, 12:30-14:00
CC-A34

Understanding the Practice of Soft OR Interventions II

Stream: Soft OR and Problem Structuring Methods
Invited session

Chair: *Ashley Carreras*, Leicester Business School, De Montfort University, Marketing, The Gateway, LE19BH, Leicester, United Kingdom, acarreras@dmu.ac.uk

1 - A Code of Best Practice for Soft Operational Analysis

Diederik J.D. Wijnmalen, Dept. for Behavioural and Societal Sciences, TNO Organisation for Applied Scientific Research, P.O. Box 96864, 2509 JG, The Hague, Netherlands, diederik.wijnmalen@tno.nl

The purpose of the 'NATO Guide for Judgement-based OA in Defence Decision Making' is to create an understanding of what judgement-based OA is; to clarify what this type of analysis can do to help address problematic situations; and, to provide guidance on how a judgement-based OA study should be carried out to maximise the validity, credibility and acceptance of such a study and its outcomes. In three volumes the Guide addresses analysts, clients and executives. The presentation will focus on its Code of Best Practice volume which is considered to be relevant to a general analyst audience.

2 - Planning Soft Workshops: getting the right people in the room

Sue Merchant, Blue Link Consulting, 4, Shepherds Way, WD3 7NJ, Rickmansworth, Hertfordshire, United Kingdom, suemerchant@hotmail.com

Soft OR has many techniques available now, along with much practical advice, for the successful running of a range of different types of workshop or decision conference. A critical aspect of planning a workshop involves making sure that the right people attend the workshop in the first place. This presentation looks at the questions which organisers need to ask themselves regarding participants when arranging a workshop, notes some of the advice available in the literature, and reports on good practice recently distilled from a group of practitioners.

3 - Enhancing the Dimensions of Procedural Justice in Focus Group Workshops using Facilitated Group Decision Software

Parmjit Kaur, De Montfort University, LE19BH, Leicester, United Kingdom, pkcor@dmu.ac.uk, *Ashley Carreras*

This paper examines the way in which causal mapping aided by group decision software adheres to the tenets of procedural justice. The workshops utilise a dual facilitation process that allows a more authentic participant voice to be heard. We seek to explain why this process of investigation surfaces more authentic qualitative data by aligning the process of investigation with the principles of procedural justice as found in organisational justice literature.

4 - Mapping Collective Intentions

Ashley Carreras, Leicester Business School, De Montfort University, Marketing, The Gateway, LE19BH, Leicester, United Kingdom, acarreras@dmu.ac.uk

An integral part of Strategy Workshops utilising causal mapping is the movement towards a collected set of actions that participants in that workshop commit themselves to. This paper outlines one approach to understanding this degree of collectiveness by utilising the concept of intentionality, proposed by Searle and refined by Velleman, to match content of one person's agreement to action with another's. After outlining this approach to collective intentions the paper looks at examples of such agreements in the maps of workshops facilitated by the author.

■ MC-33

Monday, 12:30-14:00
CC-A37

Humanitarian Logistics and Disaster Management

Stream: OR for Development and Developing Countries

Invited session

Chair: *Begoña Vitoriano*, Estadística e Investigación Operativa I, Fac. Matemáticas, Universidad Complutense de Madrid, Plaza de Ciencias, 3, Ciudad Universitaria, 28040, Madrid, Spain, bvitoriano@mat.ucm.es

1 - Structured classification of disasters and emergencies

J. Tinguaro Rodriguez, Department of Statistics and Operational Research, Complutense University of Madrid, Plaza de Ciencias, 3, 28040, Madrid, Spain, jtrodrig@mat.ucm.es, *Javier Montero, Begoña Vitoriano*

A fully precise numerical evaluation of disasters' effects is unrealistic in the time-pressured, highly uncertain decision context taking place just after a disaster strike. Instead of a numerical evaluation, here it is considered that it is rather more plausible and realistic to classify the severity of the consequences of a disaster in terms of the relevant scenarios for NGO's decision makers. However, some features of that context entail the necessity of considering and assuming a structure over the set of classes, somehow modelling those features inside of the classification model.

2 - Uncertainty and Robustness in Humanitarian Supply Chains for Disaster Relief

Alistair Clark, Dept of Engineering Design and Mathematics, University of the West of England, Frenchay Campus, Coldharbour Lane, BS16 1QY, Bristol, United Kingdom, Alistair.Clark@uwe.ac.uk

A bidirectional supply chain network model to get humanitarian aid quickly to needy recipients in a natural disaster is formulated mathematically, and then discussed in the context of uncertainty about transportation resources, aid availability, and the suddenness and degree of "demand", poor information feedback and multiple decision-makers in different aid agencies. How can robust and stable plans be maintained and disruption limited when new events or information necessitate the revision and updating of existing plans and decisions?

3 - Decision Aid Models on Preparedness Operations on Disaster Management

Begoña Vitoriano, Estadística e Investigación Operativa I, Fac. Matemáticas, Universidad Complutense de Madrid, Plaza de Ciencias, 3, Ciudad Universitaria, 28040, Madrid, Spain, bvitoriano@mat.ucm.es, *M. Teresa Ortuño*, *Federico Liberatore*, *Celeste Pizarro Romero*, *Clara Simon de Blas*

Natural disasters can strike a population suddenly and unexpectedly or being slower and repeated. Especially in this second case that forecasting is possible, it becomes crucial for an effective response having prepared population, emergency protocols, resources location, and planning operations. Decision aid models into this context should consider not only the immediate response but also the subsequent treatment of victims. A multicriteria model for shelters location taking into account the evacuation operations and the later distribution of humanitarian aid will be presented.

4 - Model to validate the quality of data sources in a ubiquitous crowd-sourcing context

Jose Robledo, Sistemas de Información, Universidad de Guadalajara, PERIFERICO NORTE 799 MOD L 305, LOS BELENES, 45100, ZAPOPAN, JALISCO, Mexico, jrobledo@dip.udg.mx, *Laura Plazola Zamora*

Gathering data by a crowd-sourcing method through the use of ubiquitous computing is a relatively new approach for acquiring and processing data related to real issues such as vehicle traffic, epidemic spread and in general incidence of alerts. A concern that arises when data is acquired by this manner in order to be used to feed a decision support system is to ensure that data collected complies with certain quality criteria. This work proposes the use of a model to validate the quality of data sources through mechanisms of redundancy, trust and reputation in order to meet the set requirements.

1 - Enumerations of voting systems: Fibonacci sequences and the gold number

Josep Freixas, Applied Mathematics 3, Technical University of Catalonia, Av. Bases de Manresa, 61-73, E-08242 MANRESA, Spain, 08242, Manresa, Spain, josep.freixas@upc.edu, *Sascha Kurz*

Voting systems are structures which are numerable as a function of the number of voters. The Fibonacci sequences appear regularly for games with some few types of equivalent players and many of them just differ asymptotically by a multiplicative factor, which is the gold number or its square. The paper summarizes enumerations of voting structures which follow some patterns. Additionally, we also point out some problems, related to values of cooperative games, where the number of possible rankings for the Shapley value in different games is the k -dimensional Catalan numbers.

2 - Finding extremal voting systems via integer linear programming

Sascha Kurz, Mathematics, Physics and Computer Science, University of Bayreuth, Universitätsstraße 30, 95440, Bayreuth, Bavaria, Germany, sascha.kurz@uni-bayreuth.de

Different types of yes/no voting systems are frequently studied. Using integer linear programming we determine extremal voting systems. As examples we consider voting systems whose Shapley-Shubik vector has minimal distance to a given power distribution; whose Public Good Index maximally violate local monotonicity; or which are farthest away from weighted voting games with respect to a recently introduced hierarchy of simple games. We present the general underlying ideas and computational results for instances where exhaustive enumeration of all voting systems is infeasible.

3 - Success and decisiveness on symmetric games

Montserrat Pons, Applied Mathematics 3, Technical University of Catalonia, Av. Bases de Manresa 61-73, 08242, Manresa, Spain, montserrat.pons@upc.edu, *Josep Freixas*

The notion of success has usually been considered just a secondary aspect of decisiveness, due partially to the fact that success and decisiveness show a linear relationship when all vote configurations are equally probable.

In our work we analyze the relationship between success and decisiveness for anonymous and independent probability distributions on symmetric games.

4 - A model for players' tendencies when playing a cooperative game

M. Albina Puente, Applied Mathematics III, Technical University of Catalonia, Av. Bases de Manresa-61-73, Manresa, Spain, M.Albina.Puente@upc.edu, *Francesc Carreras*

We present the theory for multibinary probabilistic values on cooperative games. As they are defined by tendency profiles, new tools are provided to encompass situations due to the influence of players' personality when playing a given game. When the profile is positive, the multilinear extension is a potential function and gives a computational tool. We also adapt to these values some properties, concerning null and nonnull players, balanced contributions, dominance and monotonicity, and regularity arises as a convenient condition. The subject falls within the topic of restricted cooperation.

■ MC-34

Monday, 12:30-14:00

CC-A39

Topics in Cooperative Game Theory

Stream: Cooperative Game Theory

Invited session

Chair: *Manuel A. Pulido Cayuela*, Statistics and Operations Research, University of Murcia, Campus de Espinardo. Facultad de Matemáticas, 30100, Murcia, Murcia, Spain, mpulido@um.es
Chair: *Josep Freixas*, Applied Mathematics 3, Technical University of Catalonia, Av. Bases de Manresa, 61-73, E-08242 MANRESA, Spain, 08242, Manresa, Spain, josep.freixas@upc.edu

■ MC-35

Monday, 12:30-14:00

CC-A41

Engineering Optimization

Stream: Engineering Optimization

Invited session

Chair: *Wolfgang Achtziger*, Department of Mathematics, University of Erlangen-Nuremberg, Chair of Applied Mathematics 2, Cauerstrasse 11, 91058, Erlangen, Germany, achtziger@am.uni-erlangen.de
Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Development of a multi-layer ANFIS model for the prediction of tertiary scale formation in the steel industry

Jonathan Kennedy, Specific, Swansea University, Baglan Bay Innovation & Knowledge Centre, Baglan Energy Park, Central Avenue, SA12 7AX, Baglan, Port Talbot, Wales, United Kingdom, jon.ian.kennedy@googlemail.com

Scale is an oxide that forms on steel during the hot mill process that has a detrimental effect on the surface quality of surface critical products. Scale formation is dependent on numerous factors such as thermo-mechanical processing routes, chemical composition, thickness and rolls used. This paper describes the early development of a 3 layer Adaptive Neuro Fuzzy Inference System (ANFIS) model, which predicts the formation of scale on strip steel from various input criteria. The ANFIS model deployed in this work is purely spreadsheet based with Excels Solver used for optimising the weights.

2 - Design of a RFID Based Real Time Warehouse Management System for Steel Industry

Ozgur Eski, Industrial Engineering Dept., Celal Bayar University, 53.Sok. No:6 Daire:20, Baki Aktuglu Apt. Bornova, 35040, IZMIR, Turkey, ozgur.eski@cbu.edu.tr, *Ceyhun Araz*, *Levent Bayoglu*, *Filiz Turan*

In steel industry, the efficient storage of steel coils is important. In traditional systems, coils are randomly placed on the floor and the performance of the storage operations depends on operator's experience. This results in inefficient use of warehouse and mistakes. In this study we proposed an RFID based real-time warehouse management system (RWMS). RWMS helps the warehouse managers to achieve better inventory control and to improve the efficiency of operations. We also developed a heuristic for efficient placement of steel coils. A case study is conducted in Norm Fasteners Co, Turkey.

3 - Damage characteristic of hybrid composite plaques in 2m/s speed impact

Levent Bozkurt, Ilgin Vocational School of Higher Education, 42600, Ilgin/ Konya, Turkey, bozlev@hotmail.com

Hybrid composite can be defined as having more than one staple within same composite. However, in stratified composite materials, generally low velocity impacts are considered as impacts which are lower than 100 m/s. In this study, characteristics of hybrid composite stratifies which are exposed to low velocity impact are studied. Low velocity impact experiments are done in testing device which is developed for weight fall. After experiments which are done under different border conditions, dynamical answer of the material, rising damages and elastic specifications are searched.

4 - Conjoint analysis for Concept Design of Commercial Diesel Engine

Jeasu Jeon, Information&Industrial Engineering, Yonsei University, 134 Shinchon-dong, Seoul, Korea, Republic Of, jeasu.jeon@doosan.com, *So Young Sohn*

Commercial diesel engine is a main component for various application domains such as excavator, commercial vehicle, generator, etc. The regulation concerning green management along with various customers' needs has to be reflected on the design of diesel engine. However, diesel engine manufacturers rarely produced customer oriented products. In this paper, we apply adaptive conjoint analysis to identify the most sensitive design attribute for commercial diesel engine design and forecast the ideal product for China market which has the highest share in the world.

1 - Measuring the efficiency of a pharmacy chain by means of Advanced DEA

Ludmila Neumann, Institute of Management Control and Business Accounting, TU Braunschweig, Pockelsstraße 14, 38106, Braunschweig, Lower Saxony, Germany, l.neumann@tu-bs.de, *Heinz Ahn*

The Advanced DEA is a methodological enhancement of the traditional DEA that allows the inclusion of a hierarchical goal structure into the analysis. This approach does not only consider inputs and outputs, but also their impact on the relevant objectives. The present study provides an application of Advanced DEA to measure the efficiency of a European pharmacy chain with 49 DMUs. The results show to be particularly appropriate for identifying partial inefficiencies that are not recognized by traditional DEA models.

2 - Benchmarking on Spanish University libraries

Clara Simon de Blas, Statistics & Operations Research, Rey Juan Carlos University, Departamental II, Desp. 042, C/Tulipan s/n, 28933, Mostoles, Madrid, Spain, clara.simon@urjc.es, *Jose Simon Martin*, *Alicia Arias*

In 47 Spanish university libraries, efficiency is computed in the use of human resources in the execution of internal library processes. DEA and outlier detection methods are combined to assess management on benchmarking efficiency. DMUs that are primarily identified as efficient are submitted to a complementary analysis to detect the number of times they perform as peer. If the number of reference units is low, then other evidences for establishing the superiority of its performance is realized through the analysis of results excluding an output, as the roll of the output in the variables set.

3 - Service Benchmarking in the Portuguese Hospitals: An Application of Data Envelopment Analysis

Ricardo A. S. Castro, Faculdade de Engenharia, Universidade do Porto, Portugal, ricardo.alves.castro@fe.up.pt, *Maria Portela*, *Ana Camanho*

In this study we present an evaluation model of hospital services in Portugal, using an efficiency of care perspective. Multiple inputs and outputs were chosen based on their impact on the total costs incurred by all clinical services. A DEA model was applied to a specific service and constraints on the weights were imposed to avoid efficient units with an injudicious choice of them. Results show the factors where the biggest possible savings can be made. A comparison between best-practice services and inefficient services is also presented, revealing the reasons for a superior performance.

4 - Using DEA to evaluate Brazilian Institutions of Higher Education

Armando Zeferino Milioni, Departamento de Organizacao, Instituto Tecnologico de Aeronautica, CTA ITA IEMB, 12228-900, Sao Jose dos Campos, Sao Paulo, Brazil, milioni@ita.br, *Diego Geraldo*, *Joyce Teixeira*, *Luciene Alves*

Every year Brazilian institutions of higher education are evaluated and the final result of the evaluation is a number called GIC - general index of courses. The GIC is calculated from the weighted sum of the results of the evaluation of undergraduate and postgraduate (masters and doctorate) courses of each institution. The weighting factors, which take into account the number of enrolled students, are often an object of long discussions. We show that, indeed, the ranking of institutions according to GIC can vary widely according to the weighting factors. We use DEA to discuss this issue.

■ MC-36

Monday, 12:30-14:00

CC-A43

DEA and Performance Measurement: Applications 1

Stream: DEA and Performance Measurement
Invited session

Chair: *Armando Zeferino Milioni*, Departamento de Organizacao, Instituto Tecnologico de Aeronautica, CTA ITA IEMB, 12228-900, Sao Jose dos Campos, Sao Paulo, Brazil, milioni@ita.br

■ MC-37

Monday, 12:30-14:00

CC-Act

Bioinformatics III

Stream: Computational Biology, Bioinformatics and Medicine
Invited session

Chair: *Marta Szachniuk*, Institute of Bioorganic Chemistry, PAS, Noskowskiego 12/14, 61-704, Poznan, Poland, Marta.Szachniuk@cs.put.poznan.pl

Chair: *Jacek Blazewicz*, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

1 - An optimization framework for intensity modulated proton therapy treatment planning

Gino Lim, Industrial Engineering, University of Houston, E206, Engr. Bldg 2, 77204, Houston, TX, United States, ginolim@uh.edu, *Wenhua Cao*, *Xiaodong Zhang*

Intensity modulated proton therapy (IMPT) has rapidly emerged as an advanced type of radiation therapy for cancer patients because it can achieve precise dose to the tumor volume while greatly sparing the normal tissues. However, use of mathematical programming techniques has not been widely addressed for optimizing treatment parameters. Therefore, we introduce an optimization framework to optimize beam angles, spot positions and corresponding spot intensities simultaneously. Benefits of proposed methods are demonstrated by several case studies on clinical prostate cancer patients.

2 - On the selection of images and determining the age of acquisition of words for a recognition test using exploratory data analysis

Gastão Gomes, Métodos Estatísticos, Universidade Federal do Rio de Janeiro, Rua Dois de Dezembro, 15/804, Flamengo, Rio de Janeiro, 22220-040, Rio de Janeiro, Rio de Janeiro, Brazil, gastao@im.ufrj.br, *Sergio Camiz*, *Christina Gomes*, *Fernanda Senna*

We are concerned about the evaluation of images to be used in a test with aphasic patients. Correspondence Analysis (CA) was applied to evaluate 38 subjects, in order to understand to what extent they identify the image. As a result 161 words were selected. These new selected words were now submitted to two sets of judges with differently suggested scales of age of acquisition: a free-scale one and another with the suggested slots of ages. The effect of the scale was studied by PCA, Multiple CA and Multiple Factor. The results indicate a good agreement between the two scales.

3 - Benchmarking and proposed improvements of the database of Clusters of Orthologous Genes (COG)

Farzana Rahman, Computational Biology Group, University of Glamorgan, United Kingdom, frahman1@glam.ac.uk, *Mehedi Hassan*, *Tatiana Tatarinova*, *Alexander Bolshoy*

We developed a non-parametric Bayesian method for validation of consistency of COG database. We were motivated by the observation that for at least 35% clusters from COG database, the distribution of gene length cannot be approximated using hierarchical Poisson-Gamma distribution, but as a mixture of distributions. In the framework of Non-parametric Bayesian approach, model parameter distributions consist of multiple discrete 'support' points, up to one per subject in the population. Each support point is a set of point estimates of each model parameter value, plus probability of that set.

■ MC-38

Monday, 12:30-14:00

HH-Colombus

Multicriteria Decision Support Systems in Industry

Stream: Multiobjective Optimization

Invited session

Chair: *Karl-Heinz Kuefer*, Optimization, Fraunhofer ITWM, Fraunhofer-Platz 1, D-67663, Kaiserslautern, Germany, karl-heinz.kuefer@itwm.fraunhofer.de

Chair: *Kai Plociennik*, Optimization, Fraunhofer ITWM, Germany, kai.plociennik@itwm.fhg.de

1 - Efficient Approximation of Convex and Non-Convex Pareto-Frontiers with Application to Chemical Process-Optimization

Uwe Nowak, Optimization, Fraunhofer ITWM, Fraunhofer-Platz 1, 67663, Kaiserslautern, Germany, uwe.nowak@itwm.fraunhofer.de, *Michael Bortz*, *Karl-Heinz Küfer*

In many practical simulation-based optimization problems, an efficient approximation of the (possibly non-convex) Pareto frontier is highly desirable. We consider this problem for very involved simulations of chemical processes. We present different Pareto set approximation schemes: The weighted sum sandwiching algorithm for convex is very fast. In contrast, the slower Pascoletti-Serafini hyperboxing algorithm is applicable to non-convex Pareto sets. Furthermore, we present a combination of both algorithms, suited for practical problems with only small non-convex parts of the Pareto frontier.

2 - A multicriteria optimization approach for radiofrequency ablation (RFA) planning

Katrin Teichert, Optimization, Fraunhofer ITWM, Fraunhofer-Platz 1, 67663, Kaiserslautern, Germany, katrin.teichert@itwm.fraunhofer.de, *Philipp Süß*, *Karl-Heinz Kuefer*

In RFA treatment planning, high-frequency current is applied to locally heat up and destroy cancerous tissue. A placement of the needle-shaped applicator is considered good if it leads to complete tumor destruction and also avoids specific treatment risks. In the modeling of this multicriteria optimization problem a main difficulty lies in the disconnectedness of the feasible set, as the applicator must not intersect with bones or organs. We investigate how the Pareto set is affected and, based on our findings, propose a method to interactively navigate on the set of non-dominated solutions.

3 - Multicriterial decision support for photovoltaic power plant design

Kai Plociennik, Optimization, Fraunhofer ITWM, Germany, kai.plociennik@itwm.fhg.de, *Hendrik Ewe*, *Ingmar Schüle*, *Karl-Heinz Kuefer*

Finding a good photovoltaic power plant design is a complex task with many decisions to be made. The right electrical component types and amounts (PV modules, inverters, cables) and the best component layout and electrical design have to be found. Since a multitude of (partially conflicting) objective functions like "minimize construction costs" or "maximize energy yield" is present, the problem is strongly multicriterial. We present software which proposes a set of reasonable plant designs, from which the engineer chooses the best in a multicriterial decision support system.

4 - Multicriteria Rolling Wave Planning and Scheduling

Bastian Bludau, Optimization, Fraunhofer ITWM, Germany, bludau@itwm.fraunhofer.de, *Sebastian Velten*, *Karl-Heinz Kuefer*

In real-life industrial applications of production planning and scheduling, new tasks and unforeseen events force a once computed schedule to be adjusted over and over again. A common way to deal with such dynamic problems in practice is rolling wave scheduling. We present a periodic rescheduling model that uses flexible bounding constraints to simultaneously control multiple objective criteria such as resource utilization, adherence to delivery dates, and schedule stability. Particular emphasis is given on the adjustment of the bounding constraints.

■ MC-39

Monday, 12:30-14:00

HH-Cousteau

MADM Applications III

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration, Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District, 11111, Taipei, Taiwan, ctklin@mail.mcu.edu.tw

Chair: *Chie-bein Chen*, International Business, National Dong Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien, Taiwan, cbchen@mail.ndhu.edu.tw

1 - Identifying Reasons of Customer Waiting

Chih-Chin Liang, Department of Business Administration, National Formosa University, Taipei, Taiwan, lgcowow@gmail.com

Customers may become angry and leave after waiting an intolerably long time, leading to marketing opportunities being lost. Once a service sector understands the factors driving customers to join a line, that company might adopt marketing strategies targeting waiting customers. To identify factors, this study uses principal component analysis to identify the importance of each factor. Finally, the weight of each component is also found and assigned to help understand the importance of each component in decisions about joining a queue.

2 - Identifying Hierarchical and Simultaneous Multi-player Game-solution for (Non-) cooperative Advertising in Manufacturers and Retailers Using MOPSO-CD or NSGA II

Chie-bein Chen, International Business, National Dong Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien, Taiwan, cbchen@mail.ndhu.edu.tw, *Jung-Ho Lu, Yuanchau Liour*

This research is to solve the vertical (non-)cooperative advertising problem under different market response functions using MOPSO-CD or NSGA II integrated the Stackelberg game or Nash game to identify their equilibriums (or solution) by considering the policies in long-term branding investments by manufacturers and in short-term promotion efforts by retailers. Finally, this research will implement some cases and their numerical results will demonstrate the feasibility and their different numerical results of the vertical cooperative advertising in supply chain.

3 - Application of Fuzzy Subsethood Measure as the Filter for Outliers in Likert's Questionnaire Analysis

Cheng-Chuang Hon, Department of Industrial Engineering and Management, Minghsin University of Science and Technology, 1 Hsin-Hsing Road, Hsin-Fong, Hsinchu, Taiwan., 304, Hsinchu, Taiwan, cchon@must.edu.tw, *Ling-Lang Tang*

In order to avoid deviations caused by autocratic and subjective attitudes in decision making process, bringing decision makers together to obtain group consensus is one of the best choices for achieving accurate performance. For collection of individual judgment was used Likert Scale questionnaire. We propose Fuzzy Subsethood Measure as the "Outlier Elimination" method for fuzzy data analysis expressed in types of triangular fuzzy number, which can adjust the calculated results escaping from the bias. Also an empirical example, data collection through Likert's questionnaire is provided.

4 - An Evaluation Model of Implementing RFID for 3PL's Service Agility and Value

Ling-Lang Tang, School of Management, Yuan Ze University, 135 Yuan-tung road., 320, Chung-Li, Taoyuan, Taiwan, balltang@saturn.yzu.edu.tw, *Cheng-Chuang Hon, Ming-Tsang Lu*

This paper builds up an evaluation model for company using RFID system and finds how RFID affects organization's agility and service value. We use system dynamics to evaluate and explain the complicated nonlinear and dynamic business process. Through this model, we found that corporation's agility, advance visibility of RFID and IT assistants could bring higher business benefits and reduce customers waiting time. It proves that adopting RFID system has ability to boost agility capability. The 3PL implementing RFID makes process more efficient and save more cost than before.

Chair: *Chie-bein Chen*, International Business, National Dong Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien, Taiwan, cbchen@mail.ndhu.edu.tw

1 - Efficiency and Productivity of Human Resources in Science and Technology in Innovation and Efficiency Driven Nations

Ying-Chyi Chou, Department of Business Administration, Tunghai University, 181 Taichung-kang Rd., Sec. 3, Taichung, Taiwan, R.O.C., 407, Taichung., Taiwan, rosechyi@yahoo.com.tw, *Hsin-Yi Yen*

Data Envelopment Analysis (DEA) was applied to assess the relative efficiency of HRST and determine productivity variation of each nation using the Malmquist model. The empirical results demonstrate that the efficiency of HRST differs among nations, depending on the level of economic development. From Malmquist model estimates, productivity indices were calculated and decomposed into two categories: technological change and efficiency change of productivity variation. A benchmark for nations aiming to improve their HRST efficiency and productivity has been established.

2 - An Assessment of Taiwan's Solar Water Heater Subsidy Policy Using Logistic Diffusion Curves

Pao-Long Chang, Department of Business Administration, Feng Chia University, 100, Wenhwa Road, Seatwen, Taichung, Taiwan, R.O.C, 407, Taichung, Taiwan, paolong_chang@yahoo.com.tw, *Chiung-Wen Hsu*

As many countries are implementing policies to achieve carbon reduction, assessing the effectiveness of measures is important. Using installation area data from the non-subsidized period (1992—1999) and subsidized period (2000—2010), logistic curves are used to model the adoption of solar water heating and assess the effectiveness of Taiwan's solar water heater subsidy policy. The result showed that the government's average annual investment of NT \$1,052 for solar water heaters led to a 1-ton carbon emission reduction in 10 years. Thus, only 57% of the goal by 2020 can be achieved.

3 - Investigation of feature dimension reduction based GLCM/SVM for color filter defect classification

Yu-Min Chiang, Industrial Management, I-Shou University, No.1, Sec. 1, Syuecheng Rd., Dashu District., 84001, Kaohsiung City, Taiwan, Taiwan, ymchiang@isu.edu.tw, *Yao-Chang Lin, Jiang-Liang Hou, Shih-Ting Yang*

This paper presents an efficient color filter (CF) defect recognition system, based on gray-level co-occurrence matrix (GLCM) and support vector machines (SVM). GLCM is used to extract textural information first. The extracted features are further selected by F-score, information gain and individual feature accuracy selection methods. The idea is to reduce dimensionality of CF defect space. The selected features are used as features for the SVM classification process. Experimental results indicate the proposed method achieves outstanding performance for CF defect classification.

4 - Environmental Fuzzy Multi-Attribute Decision-Making in Integrated Wastewater Management

Hojjat Mianabadi, Faculty of Civil Engineering and Geosciences, TU Delft, Room 4.92.2, Building 23, Stevinweg 1, 2628 CN, Delft, Netherlands, hmianabadi@gmail.com, *Mehrdad Mirabi, Erik Mostert, Mohammad Bagher Sharifi*

One of the important challenges of modern human life is increasing production of urban wastewater in metropolises. Hence, selection the best method to collect and reuse of wastewater is important. There are different methods to run sewage systems; the best method of which should be selected considering structural conditions, economic, social, and political criteria. Wastewater management of the Niasar city, Iran, is investigated as a real case study using two risk based MADM methods. The results show that MADM methods are necessary to reach sustainable development in waste water management.

MC-40

Monday, 12:30-14:00

HH-Livingstone

MADM Applications VII

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration, Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District., 11111, Taipei, Taiwan, cotlin@mail.mcu.edu.tw

■ MC-41

Monday, 12:30-14:00

HH-Heyerdahl

AHP/ANP 2

Stream: Analytic Hierarchy Process, Analytic Network Process

Invited session

Chair: *Tihomir Hunjak*, The Faculty of Organization and Informatics, Croatia, thunjak@foi.hr

1 - Combination of DEMATEL and ANP for the cargo shipping company selection problem

Nilsen Kundakci, Business Administration, Pamukkale University, Pamukkale University, Faculty of Economics and Administrative Sciences, Department of Business Administration, 20070, Denizli, Turkey, nkarakasoglu@pau.edu.tr, *Esra Aytaç*, *Ayşegül Tuş Işık*

Cargo shipping is a vital part of logistic functions but selecting the right cargo shipping company is a difficult task for companies. This selection can be handled with the help of multiple criteria decision making (MCDM) methods. This paper attempts to solve the cargo shipping company selection problem by adopting MCDM model that combines Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytical Network Process (ANP). DEMATEL is employed to compute the effects between selection criteria and ANP is used to determine the best cargo shipping company considering all alternatives.

2 - Utilization of Multi-Criteria Decision Making Methods at the Phase of Compare and Contrasting of the Course of Actions within the Military Decision Making Process.

Erman Atak, war academy, Turkey, ermanatak@yahoo.com

It is concluded that using Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP), one of the methods of Multi-Criteria Decision Making, will provide an important benefit at the phase of compare and contrasting the course of actions, evaluated as the poor point of AKVES. The criteria which have to be used for AHP and ANP, being applied in a military operation, have been established. In the light of established criteria, how a model of ANP can be set up, has been showed.

3 - Analysis of course selection using ahp and discrete choice analysis

Anamarija Jazbec, Mathematic and Technical Basics, Faculty of Forestry, University of Zagreb, Sveti�imunska c.25, 10000, Zagreb, Croatia, jazbec@sumfak.hr

The main objective of this paper is to determine the importance of the criteria in the selection of courses at the graduate level at Faculty using the AHP method and discrete choice analysis, compare the obtained results. Students (n = 22) were asked about the criteria for choosing courses: 1) usefulness, 2) interesting program, 3) easiness, 4) recommendation of senior colleagues. AHP and discrete choice analysis produced very similar results: usefulness of knowledge looking for job and recommendations of senior colleagues has proved to be equally important criteria for selection of courses.

4 - An AHP/DEA hybrid model for the evaluation of Croatian research institutes performances

Tihomir Hunjak, The Faculty of Organization and Informatics, Croatia, thunjak@foi.hr

The purpose of the analysis was to compare the research institutes from two aspects; accountability toward their mission and their autonomy. For research outputs assessment, an indicator was developed using the appropriate AHP model and in consultations with an expert for bibliometrics. As a measure of autonomy, the ratio between own income and the amount of funding gained from the state budget was used. As a part of the research, cross efficiency analysis was conducted and the sensitivity analysis was performed by weight restrictions.

■ MC-42

Monday, 12:30-14:00

BW-Amber

EEPA 2012 - 1

Stream: EURO Excellence in Practice Award 2012
Invited session

Chair: *Michel Bierlaire*, ENAC INTER TRANSP-OR, École Polytechnique Fédérale de Lausanne (EPFL), GC B3 454, Station 18, CH-1015, Lausanne, Switzerland, michel.bierlaire@epfl.ch

1 - Clearance Pricing Optimization at Zara

Felipe Caro, UCLA Anderson School of Management, 110 Westwood Plaza, Suite B420, 90095, Los Angeles, CA, United States, fcaro@anderson.ucla.edu, *Jérémie Gallien*

Until 2007, Zara used a manual process for determining price markdowns. This is a challenging problem due to the variety of unsold articles with few price data points. In collaboration with Zara's pricing team, we developed an alternative process relying on a formal forecasting model feeding a price optimization model. As part of a controlled field experiment conducted in Belgium and Ireland during the 2008 Fall-Winter season, this new process increased clearance revenues by approximately 6%. Zara is currently using this process worldwide for its markdown decisions during clearance sales.

2 - Scheduling the German Basketball League

Stephan Westphal, Institute for Numerical and Applied Mathematics, University of Goettingen, Lotzestr. 16-18, 37083, Göttingen, Germany, s.westphal@math.uni-goettingen.de

Each season, the German First Division Basketball League (Beko BBL) is faced with the problem of scheduling the games among their teams. In addition to the typical constraints that arise in creating a schedule, the league is faced with several special constraints. As the classical schedules and models applied so far have caused numerous problems, resulting in postponed games, lost ticket sales and unbalanced standings, we developed a new approach taking all these requirements into account. This approach was first used by the BBL to generate the schedule for the season 2011/2012.

3 - Optimization of advertisement revenue for the French TV group TF1

Thierry Benoist, e-lab, Bouygues SA, 32 avenue Hoche, 75008, PARIS, France, tbenoist@bouygues.com, *Frédéric Gardi*, *Antoine Jeanjean*

Bouygues' operations research team (the e-lab) has been working with the leading French TV channel TF1, for the past 15 years. This talk presents our achievements in working with this advertising broadcaster and identifies the practical keys to success in this partnership. The selected projects, which cover the Internet and television businesses, gave TF1 a competitive advantage by allowing it to provide quicker and better answers to advertisers' requests and to better use its limited and perishable airtime inventory. TF1 estimates the resulting revenue increase at 20 million euros per year.

■ MC-43

Monday, 12:30-14:00

BW-Granite

Stochastic Programming: Applications to the energy sector

Stream: Stochastic Programming
Invited session

Chair: *Marida Bertocchi*, Department of Mathematics, Statistics, Computer Science and Applications, University of Bergamo, Via dei Caniana 2, 24127, Bergamo, BG, Italy, marida.bertocchi@unibg.it

Chair: *Maria Teresa Vespucci*, Department of Information Technology and Mathematical Methods, University of Bergamo, via Marconi, 5a, 24044, Dalmine (BG), Italy, mtvespucci@tin.it

1 - Operating fully renewable power systems: biomass and wind case

Ruth Dominguez, Electrical Engineering, Universidad de Castilla - La Mancha, Avda. Carlos III, s/n, 45071, Toledo, Spain, Spain, ruth.dominguez@uclm.es, Miguel Carrión, Antonio J. Conejo

Renewable energy sources play an increasingly significant role in current power systems. Despite of the numerous advantages of renewable sources, most of them are non-dispatchable and cannot be continuously controlled by the system operator. This complicates the operation of power systems with large renewable integration. We propose an operational tool to be used in power systems including wind farms and biomass units. Opposite to wind units, biomass plants are dispatchable and can be used to counteract the wind power uncertainty. An example is presented to illustrate the proposed model.

2 - A multi-stage stochastic programming model for investments in natural gas infrastructure

Asgeir Tomasgard, Applied economics and operations research, Sintef Technology and society, Trondheim, Norway, asgeir.tomasgard@sintef.no

We present a multistage stochastic model that evaluates investments in natural gas infrastructure, taking into account existing and planned design. The uncertainty facing the decision makers include both upstream and downstream uncertainty, such as; reservoir volumes, the composition of the gas in new reservoirs, market demand and price levels. The model integrates analysis of long-term and short-term uncertainty.

3 - A multistage stochastic model for the electric power generation capacity expansion problem under different risk measures.

Maria Teresa Vespucci, Department of Information Technology and Mathematical Methods, University of Bergamo, via Marconi, 5a, 24044, Dalmine (BG), Italy, mtvespucci@tin.it, Marida Bertocchi, Laureano Fernando Escudero, Stefano Zigrino

We consider the electric power generation capacity expansion problem, over a long horizon of a price-taker power producer, who has to choose among thermal power plants and power plants using renewable energy sources (RES), while considering regulatory constraints on CO₂ emissions, incentives to generation from RES and risk. The maximization of the expected profit will be subject, alternatively, to CVaR, to first-order stochastic dominance constraints (SDC), and to second-order SDC. Results of a computational comparison between the above risk measures will be reported.

■ MC-44

Monday, 12:30-14:00

BW-Marble

Incorporating uncertainty in Energy Management Optimization Problems: A long and winding road

Stream: Stochastic Programming
Invited session

Chair: Sandrine Charousset-brignol, OSIRIS, EDF, 1 Avenue du Général de Gaulle, 92141, CLAMART Cedex, France, sandrine.charousset@edf.fr

Chair: Wim van Ackooij, OSIRIS, EDF R&D, 1 Avenue du Général de Gaulle, 92141, Clamart, France, wim.van-ackooij@edf.fr

1 - Incorporating uncertainty in large scale Energy Management Optimization Problems in practice.

Sandrine Charousset-brignol, OSIRIS, EDF, 1 Avenue du Général de Gaulle, 92141, CLAMART Cedex, France, sandrine.charousset@edf.fr

Uncertainty plays a key role in Energy management optimization problems. The difficulty of incorporating it in decision making tools resides in the intractability of fully general stochastic optimization problems. Even stochastic dynamic programming struggles for realistically sized models. For this reason many heuristics are used in practice. In this talk, we will discuss some of these and emphasize the importance of properly integrating uncertainty.

2 - Towards a Multi-stage Robust Formulation for the Nuclear Reactor Outage Scheduling Problem

Nicolas Dupin, univ Bordeaux1 - EDF R&D, 33405, Talence, France, Nicolas.Dupin@math.u-bordeaux1.fr, Marc Porcheron, Pascale Bendotti

Each month EDF staff computes nuclear reactor outage dates and refueling quantities over a multi-year forecast. The schedule has to comply with various constraints. Problem data is subject to uncertainty in generation capacity as well as outage duration, and monthly updates lead to uncontrolled changes in the forecast not compatible with stability requirements. A multi-stage robust formulation with "adaptive" recourse on dates is proposed for a simplified problem involving uncertainty on outage duration.

3 - Modeling the residential electrical load curve: a stochastic algorithm for realistically starting the domestic appliances

Arnaud Grandjean, Enerbat, EDF R&D, Site des Renardières, Avenue des Renardières, Bâtiment W 49-51, 77818, Moret sur Loing, France, arnaud-2.grandjean@edf.fr

The electrical load curve is an essential tool in the electricity supply field. The power demand curve of the domestic sector is particularly interesting because a series of technical and behavioural breaks are going to impact on it in a near future. In order to enhance the knowledge of the residential load curve, we built a bottom-up, technically explicit reconstitution model. One of its key points is the way electrical end-uses are launched within the day. We propose a new stochastic algorithm that realistically starts the domestic appliances without "simply" reproducing metered data.

■ MC-45

Monday, 12:30-14:00

BW-Water

Management accounting and management control 1

Stream: Simulation in Management Accounting and Management Control
Invited session

Chair: Stephan Leitner, Dept. for Controlling and Strategic Management, Alpen-Adria-Universität Klagenfurt, Universitätsstrasse 65-67, 9020, Klagenfurt, Austria, stephan.leitner@uni-klu.ac.at

1 - Agent-based simulation analysis of performance measurement systems considering uncertainties of a learning model

Yusuke Goto, Dept. of Software & Information Science, Iwate Prefectural University, 152-52, Sugo, 020-0193, Takizawa, Iwate, Japan, y-goto@iwate-pu.ac.jp, Shingo Takahashi

The agents' learning model is considered highly contingent on organizational culture, various environmental factors, individual characteristics, etc. It is difficult to specify the agents' learning model by an empirical investigation into the real organization to be modeled, while the agents' learning model is an essential module of the agent-based model to analyze the effectiveness of performance measurement systems (PMSs) under a given situation. We conduct scenario analysis of PMSs considering uncertainties of agents' learning model. Several learning models are to be analyzed.

2 - A computational tool for performing production and warehouse budgets in an environment with uncertainty and seasonality

Jairo Coronado-Hernandez, Ingeniería Industrial, Universidad Tecnológica de Bolívar, 130001, Cartagena de Indias, Bolívar, Colombia, jcoronado@unitecnologica.edu.co, *José P. García-Sabater*

Our problem is framed in a multi-product, -period and a limited production and storage capacity. We intend that the generated budget is robust to fluctuations and seasonality of demand subject to the limitations of system and requirements. We propose a method of 3 stages: i. the demand is time-disaggregated; ii. objective stock levels are calculated with a fuzzy linear programming model with the aim of providing a long-term vision to the third stage models; iii. developing the budget structured in a set of scenarios as a consequence of a simulation/optimization in rolling horizon.

3 - Simulation comparison of relative and absolute operators for the inference of criteria weights from discordance related information

Andrej Bregar, Informatika, Vetrinjska ulica 2, 2000, Maribor, Slovenia, andrej.bregar@informatika.si

Several methods/operators exhibiting various levels of relativity are introduced for the automatic derivation of criteria weights according to selective effects of veto. They are applicable to outranking and MAUT based methods, whereby in the case of MAUT a special criterion type is proposed to allow for veto modeling in the form of global discordance functions. Absolute and relative measurements are studied with a simulation based experiment, which considers sensitivity to inputs, rank reversals, richness of information and ability to discriminate conflicting alternatives.

4 - Financial structure optimization by using an adapted goal programming method

Tunjo Perić, Bakeries Sunce, Komedini 1, 10090, Zagreb, Croatia, tunjo.peric1@zg.t-com.hr, *Zoran Babic*

This paper proposes an adapted goal programming method for solving multicriteria fractional linear programming models. The proposed methodology is tested on the example of company's financial structure optimization. The obtained results indicate the possibility of efficient application of the proposed methodology for company's financial structure optimization as well as for solving other multicriteria fractional programming problems.

Monday, 14:30-16:00

■ MD-01

Monday, 14:30-16:00

RB-Alfa

Tutorial Lecture: Professor Kenneth Sörensen

Stream: Keynote, Tutorial and Plenary Lectures
Tutorial session

Chair: *Marc Sevaux*, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - Metaheuristics - the metaphor exposed

Kenneth Sörensen, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerpen, Belgium, kenneth.sorensen@ua.ac.be

In recent years, the field of combinatorial optimization has witnessed a true tsunami of "new" metaheuristic methods, most of them based on a metaphor of some natural process. The behavior of virtually any species of insects, the flow of water, musicians playing together, it seems that no ideas are too far-fetched to serve as inspiration to launch yet another metaheuristic. In this tutorial, we will critically investigate whether the resulting methods are truly original, or just a repackaging of old ideas. In general, the usefulness of metaphor-based methods will be put to the test.

On the other side of the spectrum, researchers in metaheuristics are picking up ideas traditionally found in exact methods only, such as an intelligent decomposition of the problem and the use of exact methods to solve subproblems. In some problem domains such as vehicle routing or scheduling, a consensus is starting to condense on which ideas and which methods work and which do not. This is the result of many years of development of ever more powerful metaheuristics, combined with a careful study of the combinatorial properties of the problem. Additionally, deconstructing of a method, combined with statistical testing of the components and parameters of a metaheuristic can reveal those components and parameter settings that truly contribute to the performance.

The main aim of this talk is to provide some guidelines on how to develop an efficient and effective metaheuristic. We will show that the way forward is through the rigorous use of scientific methods, rather than through the indiscriminate introduction of yet another metaphor.

■ MD-02

Monday, 14:30-16:00

RB-Beta

Scheduling models in Logistics

Stream: Scheduling

Invited session

Chair: *Dirk Briskorn*, University of Siegen, Germany, dirk.briskorn@uni-siegen.de

1 - Determining crane areas for balancing workload among interfering and non-interfering cranes

Nils Boysen, Lehrstuhl für ABWL/ Operations Management, Friedrich-Schiller-Universität Jena, Carl-Zeiß-Str. 3, 07743, Jena, Germany, nils.boysen@uni-jena.de, *Malte Flidner*, *Simon Emde*

This paper treats the problem of subdividing an area for storing containers, such that the workload is evenly shared among the cranes operating the resulting subareas. We consider two crane sets: while non-crossing constraints between cranes of the same set need to be observed, cranes of different sets do not interfere. This problem is, for instance, relevant for scheduling the (un-)loading of vessels by parallel quay cranes operating on opposing berths. We formalize the resulting optimization problem, prove computational complexity, and present exact and heuristic solution procedures.

2 - Packing chained items into bins with applications to container handling and project scheduling

Malte Fliedner, TU Darmstadt, Hochschulstrasse 1, 64289, Darmstadt, Hessen, Germany, fliedner@bwl.tu-darmstadt.de, *Dirk Briskorn*

In this work we study a variant of the well-known bin packing problem where items are subject to chaining constraints. The problem is encountered in rail container terminals, but can also be seen as a basic scheduling problem under partially renewable resources. We provide complexity results for its decision version and develop exact solution approaches with (pseudo-)polynomial runtime for specific subproblems. We further investigate two optimization versions of the problem and provide efficient approximation algorithms.

3 - A dynamic programming approach to the aircraft landing problem with aircraft classes

Alexander Lieder, Chair of production management, University of Mannheim, Schloss, Schneckenhof Ost, 68131, Mannheim, Germany, lieder@uni-mannheim.de, *Raik Stolletz*, *Dirk Briskorn*

The static aircraft landing problem is to find a minimum-cost schedule of aircraft landings while assuring that the necessary separation time between two landings is kept. By assuming a limited number of aircraft classes with common separation times and cost functions, the problem can be solved to optimality in polynomial time. We present a dynamic programming approach which is able to solve medium-sized problem instances (30-50 aircraft), that take hours to be solved by a MIP solver could be solved within seconds. To cope with larger instances, a CPS-heuristic has been implemented.

4 - Scheduling of the batch annealing process in a fastener company

Ceyhun Araz, Industrial Engineering Dept., Celal Bayar University, Turkey, ceyhun.araz@cbu.edu.tr, *Ozgur Eski*, *Levent Bayoglu*, *Filiz Turan*

This study deals with the scheduling problem for the batch annealing process in the heat treatment of steel coils. It is a parallel-machine multi-product scheduling problem with constraints on products including material type and size. The multiple objectives in scheduling the batch annealing process are to minimize total tardiness of steel coils and to maximize coil stacks throughput. The scheduling algorithm developed was applied to the batch annealing shop in Norm Fasteners Co., Turkey. The industrial application shows the effectiveness of the developed scheduling algorithm.

■ MD-03

Monday, 14:30-16:00

RB-L1

Logistics, Transportation, Traffic - 1

Stream: Logistics, Transportation, Traffic
Contributed session

Chair: *Thierry Benoist*, e-lab, Bouygues SA, 32 avenue Hoche, 75008, PARIS, France, thenoist@bouygues.com

1 - Two-stage vehicle routing problem with dynamic selection of entrepots

Juraj Pekár, Department of Operations Research and Econometrics, University of Economics, Dolnozemska 1, 85235, Bratislava, Slovakia, pekar@euba.sk, *Ivan Brezina*, *Zuzana Čičková*

The paper presents two-stage vehicle routing problem with dynamic selection of entrepots. The goal is to carry the goods from a central store to the entrepots with the use of different types of vehicles as from entrepots to final customers. The problem could not be decomposed into two separate one-stage problems, since the selection of entrepots is realized dynamically from the selected set of nodes. The object is to construct a mathematical model, so that the total costs of delivery of goods were as low as possible.

2 - The Line Traveling Salesman with partial ordering

Thierry Benoist, e-lab, Bouygues SA, 32 avenue Hoche, 75008, PARIS, France, thenoist@bouygues.com, *Antoine Jeanjean*, *Vincent Jost*

The Line Traveling Salesman with Partial Order is a variant of the Traveling Salesman Problem, where the cities to be visited lie on a line, the distance between two cities is the absolute difference between their abscissae and a partial ordering is given on the set of cities. We prove that this problem, encountered on linear construction schemes, is NP-complete. Using key dominance properties and lower bounds, we design a call-based dynamic program able to solve instances with up to 450 cities.

3 - Degrees of freedom in calculating inventory-carrying costs: a simulation study

Christoph Siepermann, Faculty of Mathematics and Economics, Ulm University, Helmholtzstr. 22, 89081, Ulm, Germany, christoph.siepermann@uni-ulm.de

The determination of inventory-carrying costs causes serious problems which result amongst others from different ways of calculating the average capital tied up in storage. The paper tries to estimate, by means of a simulation study, the extent of differences between the various ways of determining the average value of inventory as they can occur in practice. It will be shown that, under certain circumstances, the different formulas for calculating the average value of inventory can lead to quite different results and therefore to degrees of freedom in determining inventory-carrying costs.

4 - The Target Visitation Problem

Achim Hildenbrandt, Computer Science, Ruprecht-Karls-University Heidelberg, Im Neuenheimer Feld 368, Room 104, 69120, Heidelberg, Baden-Württemberg, Germany, achim.hildenbrandt@informatik.uni-heidelberg.de, *Gerhard Reinelt*

The target visitation problem (TVP) is concerned with finding a route to visit a set of targets starting from and returning to some base. In addition to the distance travelled a tour is evaluated also by taking into account preferences which address the sequence in which the targets are visited. The problem is thus a combination of two well known optimization problems: the travelling salesman and the linear ordering problem. In our talk we point out some properties of the complex but nevertheless interesting polyhedral structure and show approaches to solve the TVP to optimality.

■ MD-04

Monday, 14:30-16:00

RB-L2

Optimal Control II

Stream: Optimal Control
Invited session

Chair: *Gernot Tragler*, OR and Control Systems, Vienna University of Technology, Argentinierstr. 8/105-4, A-1040, Vienna, Austria, tragler@eos.tuwien.ac.at

1 - Normality of the maximum principle for the Bolza problem under state and end point constraints

Daniela Tonon, Institut de mathématiques de Jussieu, Université Pierre et Marie Curie Paris 6, 4 Place Jussieu, 75252, Paris, France, tonondaniela83@gmail.com, *Helene Frankowska*

It is well known that every strong local minimizer of the Bolza problem under state constraints satisfies a constrained maximum principle. Its normality is very useful for investigating the Lipschitz continuity of local minimizers, for regularity of the adjoint state and optimal controls and for derivation of higher order optimality conditions. We present sufficient conditions for normality of optimal trajectories in the presence of general state and end point constraints. This is accomplished thanks to a new inward pointing condition applicable to unbounded control systems.

2 - Network based computing environment for solving optimal control problems

Radoslaw Pytlak, Mechatronics, Institute of Automatic Control and Robotics, Warsaw University of Technology, 02-525, Warsaw, Poland, r.pytlak@mchtr.pw.edu.pl, Tomasz Tarnawski, Mariusz Kaleta, Tomasz Sliwinski

The aim of the presentation is to show the current state of work on computing environment IDOS (Interactive Dynamic Optimization Server) which enables solving optimal control problems by using Internet services. The computing environment is equipped with dynamic optimization modeling language — DOML which is an extension of Modica language. The presentation will focus on optimization solvers for optimal control problems with integer valued controls; elements of DOML language; mechanism of adding new solvers to the environment. Also the use of the environment IDOS will be discussed.

3 - Dynamic Programming Approach to Optimal Control Problems with Pure State Constraints

Daniel Hoehener, Institut de Mathématiques de Jussieu, Université Pierre et Marie Curie, 4 place Jussieu, 75005, Paris, France, hoehener@math.jussieu.fr, Giancarlo Facchi

We consider an optimal control problem with pure state constraints. It is well-known that the dynamic programming principle allows to prove that the value function is a generalized solution of the HJB equation. By using viability techniques, we show that the value function is actually the unique solution of the HJB equation, even if the dynamics are discontinuous in the time variable. The main novelty of the proof is an approximation result of feasible trajectories by trajectories lying in the interior of the constraints. Such approximations have also other applications in control theory.

4 - Determining the optimal strategies for stochastic control problem with finite time horizon

Dmitrii Lozovanu, Institute of Mathematics and Computer Science, Academy of Sciences of Moldova, Academiei 5, IMI, MD-2020, Chisinau, Moldova, Moldova, Republic Of, lozovanu@math.md

The stochastic version of classical discrete optimal control problem with finite set of states and finite time horizon is formulated and studied. In the considered problem we assume that the dynamic system may admit states in which the vector of control parameters is changed randomly and we are seeking for a strategy that minimize the expected total cost during a given number of state transitions. We show that the optimal solution of the stochastic problem can be found using the backward dynamic programming method.

2 - Heuristics for Stochastic and Dynamic Maritime Pickup and Delivery Problems

Lars Magnus Hvattum, Dept of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz veg 3, Sentralbygg 1, N-7491, Trondheim, Norway, lars.m.hvattum@iot.ntnu.no, Gregorio Tirado, Kjetil Fagerholt, Jean-François Cordeau

Recent years have shown that static and deterministic vehicle routing problems can be solved to near optimality with acceptable computational times using metaheuristics. However, many real world applications are dynamic and include stochastic aspects, such as unknown future customer requests. Explicitly taking into account available stochastic information may yield benefits in these cases. Here, three different heuristics are considered and evaluated in terms of their ability to minimize transportation costs in a dynamic and stochastic maritime planning problem.

3 - Modeling ballast water in container stowage planning

Dario Pacino, IT-University of Copenhagen, Rued Langaard Vej 7, 2300, Copenhagen, Denmark, dpacino@itu.dk, Alberto Delgado, Rune Jensen

Automated stowage planning has come to the attention of the industry. Published work in this area assumes constant displacement of the vessels, which simplifies the linearization of the hydrostatic calculation. In those models ballast tanks are not taken into account. Since ballast water can contribute up to 25% of the total displacement, ignoring it could become a great source of error. We present a model for stowage planning with ballast tanks and show how to handle the non-linearities that variable displacement forces on the model. Preliminary results show the feasibility of this approach.

4 - Fleet deployment with speed optimization

Henrik Andersson, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Gløshaugen, Alfred Getz vei 3, NO-7491, Trondheim, Norway, Henrik.Andersson@iot.ntnu.no, Kjetil Fagerholt, Kirsti Hobbesland

We will present a rolling horizon heuristic for a fleet deployment problem with speed optimization. The heuristic is tested on real world instances from one of the largest car transporters of the world and shows good results.

■ MD-05

Monday, 14:30-16:00

RB-L3

Maritime Transportation 2

Stream: Maritime Transportation

Invited session

Chair: Henrik Andersson, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Gløshaugen, Alfred Getz vei 3, NO-7491, Trondheim, Norway, Henrik.Andersson@iot.ntnu.no

1 - Maritime transport as an important link in the global supply chain

Algirdas Šakalys, Competence Centre of Intermodal Transport and Logistics, Vilnius Gediminas Technical University, Plytins st. 27, LT-10105, Vilnius, Lithuania, algirdas.sakalys@vgtu.lt

The East West Transport Corridor, connecting northern Europe with Russia and Far East is an excellent platform to develop an innovative pilot testing ground where modern technology and information systems contribute to increased efficiency, traffic safety and security as well as reduced environment impact in the corridor. The corridor stands out as green transport corridor which will reflect an integrated transport concept where Short Sea Shipping, rail, inland water ways and road complement each other to enable the choice of environmentally friendly transport.

■ MD-06

Monday, 14:30-16:00

RB-Gamma

Vehicle routing problems

Stream: Metaheuristics

Invited session

Chair: Cédric Verbeeck, Industrial management, Ghent University, Technologiepark 903, B-9052, Zwijnaarde, Belgium, cedricverbeeck@gmail.com

1 - A local search heuristic algorithm for the CVRP with open routes

R. Aykut Arapoglu, Industrial Engineering Department, Eskisehir Osmangazi University, Meselik Campus, 26480, Eskisehir, Turkey, arapoglu@ogu.edu.tr, Abdurrahman Yildiz

We present a variant of the classical capacitated VRP that allows closed routes ending at the depot as well as open routes that end at customer demand node(s). The problem arises when the company's current fleet of vehicles cannot meet the total demand. Closed routes are operated by the vehicles of existing fleet whereas open routes are run by extra vehicles. The objective is to find a route for each vehicle used, minimizing the total distance traveled. A local search improvement algorithm is implemented. The performance of the algorithm is tested on data sets adapted from the literature.

2 - Comparing metaheuristics for the Time-Dependent Orienteering Problem

Cédric Verbeeck, Industrial management, Ghent University, Technologiepark 903, B-9052, Zwijnaarde, Belgium, cedricverbeeck@gmail.com, *Pieter Vansteenwegen*

This research focuses on developing and comparing efficient solution methods to solve time-dependent orienteering problems (TD-OP) in real time. A time dependent local search move and local evaluation metric have been successfully implemented together with three basic metaheuristic frameworks. Test instances were developed in a way to simulate real life congestions patterns. Comparing the results proves that obtaining solutions in real-time is feasible. Currently, instances are being developed so that the optimal solution is known, providing more insight in the obtained results.

3 - A Tabu Search Method for a Cement Delivery Problem

Marc Uldry, Département d'Informatique, Université de Fribourg, Boulevard de Pérolles 90, 1700, Fribourg, Switzerland, marc.uldry@unifr.ch, *Alain Hertz*, *Marino Widmer*

We consider a cement delivery problem with a heterogeneous fleet of vehicles and several depots. The orders are often larger than the vehicle capacity; consequently, most customers are visited several times. This is a split delivery vehicle routing problem with additional constraints. A Tabu Search resolution method is first described. Experiments on real life instances are then performed. Comparisons between these results, those obtained using a MILP formulation and those given by the cement supplier company are also presented. Tabu Search produces better results in a few minutes.

4 - A multi-objective inventory routing problem for sustainable waste management under uncertainty

Pamela Nolz, Department of Information Systems and Operations, Vienna University of Economics and Business, Nordbergstrasse 15, 1090, Vienna, Austria, pamela.nolz@wu.ac.at, *Nabil Absi*, *Dominique Feillet*

We formulate a stochastic inventory routing problem for infectious medical waste collection minimizing two criteria: (i) distribution costs comprising routing costs and fixed costs incurred each time a tour is planned, (ii) expected inventory costs reflecting social objectives, specifically the satisfaction of pharmacists and patients, as well as the minimization of public health risks. We develop a hybrid multi-objective solution approach integrating an adaptive large neighborhood search into an evolutionary algorithm. Computational experiments are performed for real-world problem instances.

■ MD-08

Monday, 14:30-16:00

RB-Epsilon

Network Optimization 4

Stream: Network Optimization

Invited session

Chair: *Axel Werner*, Optimization, Zuse Institut Berlin (ZIB), Takustr 7, D-14195, Berlin-Dahlem, Germany, werner@zib.de

1 - Bundling Telecommunication Services with Network Costs

Juan Perez, Industrial Engineering, Universidad de Los Andes de Chile, Av. San Carlos de Apoquindo 2200, Comuna las Condes, Santiago, Región Metropolitana, Chile, jperez@uandes.cl, *Alejandro Jofre*

We propose a non-linear model for bundling telecommunication services explicitly considering the costs and capacities of the network. We consider bundles composed of: mobile telephone and internet. The decision variables are the fixed prices for bundles and the quantities of each service. We analyze the following aspects: users that have already have a bundle with a company, the effect of considering a cost for users when they buy a new bundle, the optimum time between offers, and that targeting segments of users not only depends on it reservation prices but also on the cost function.

2 - The effects of inaccurate information on the queue joining policy

David Raz, Management of Technology, Holon Institute of Technology, Holon, Israel, davidra@hit.ac.il

The efficiency aspects of the queue joining policy were thoroughly studied, starting probably with Winston (1977). It is widely accepted that the Shortest Queue (SQ) policy is optimal, with some counterexamples noted by Whitt in 1986. However, the body of research assumes information is fully available and accurate, which is not always the case. In this work we study the effects of inaccurate or missing information on the efficiency and fairness of the queue joining policy. The results show that SQ may not always be the optimal policy to use, if the information is incomplete.

3 - Free Riding Solution for Hybrid P2P Networks

Amad Mourad, LAMOS, Bejaia University, Bejaia, Algeria, amad.mourad@gmail.com, *Djamil Aïssani*, *Moumen Hamouma*

Free riding is an important problem in P2P networks in which nodes take without giving, they benefit from shared resources without sharing their own. The objective of our study is to ensure the collective participation of P2P members, by encouraging them to be more active. For this, we introduce a new solution against free riders; it is based on friend's lists in each peer, adding only peers that share interesting contents. A queuing mechanism with priority is also used at each super peer. This priority is calculated based on the number of peer's friends and their free times.

4 - Optimizing energy consumption of telecommunication networks

Axel Werner, Optimization, Zuse Institut Berlin (ZIB), Takustr 7, D-14195, Berlin-Dahlem, Germany, werner@zib.de

Already today, a considerable part of energy worldwide is spent on the operation of telecommunication networks. With steadily growing internet traffic this share will further increase, unless energy consumption of future networks is optimized and adapted to switched traffic instead of provided capacity. We present mixed integer programming models for the optimization of multi-layer telecommunication networks using load-adaptive equipment and dynamic energy management. We discuss preliminary results of computations, based on sndlib instances, as well as networks by Deutsche Telekom.

■ MD-09

Monday, 14:30-16:00

RB-Zeta

Cutting and Packing 4

Stream: Cutting and Packing

Invited session

Chair: *Ozgur Kulak*, Çorlu Engineering Faculty, Namık Kemal University, N.K.Ü. Çorlu Mühendislik Fakültesi, Silahtar Mahallesi, Sinan Dede Mevkii Çerkezköy Yolu 3. km, Çorlu, 59860, Tekirdağ, Turkey, okulak@nku.edu.tr

1 - Linearization of Non-oriented Polygonal Placement Optimization Problem

Marina Novozhilova, Department of Economic Cybernetics and Information Technologies, Kharkov National University of Construction and Architecture, 61046, Kharkov, Ukraine, m.novozhilova04@gmail.com, *Igor Chub*

The non-oriented convex polygon placement optimization problem is considered in the linearized statement. The additional properties of the problem linearized feasible region are studied. The method of searching a problem local minimum based on the active set idea is proposed. The scheme for determining the descent direction along the frontier of the connected component of the linearized feasible region has been developed. A new technique for constructing inequality constraints system for current solution on each iteration is considered. The stopping criterion of iterative process is defined.

2 - A Circle Covering approach to the Nesting problem

Pedro Rocha, INESC TEC, Faculdade de Engenharia, Universidade do Porto, 4200-465, Porto, Portugal, pmonteirorocha@sapo.pt, *Rui Rodrigues, A. Miguel Gomes*

Circle Covering (CC) problems aim to completely cover a region with the minimum number of circles. With an efficient coverage, the region can be accurately represented by the set of circles. In Nesting problems, pieces need efficient collision detection for their placement. We propose to solve Nesting problems with an approach based on circle covering to represent irregular shapes and non-linear models to compute placement positions.

3 - Packing spherical caps in high dimensional spaces

Cristiano Torezzan, School of Applied Sciences, University of Campinas, Brazil, cristiano.torezzan@fca.unicamp.br, *Sueli Costa*

We consider the problem of packing a large number of equal spherical caps on the surface of the unit sphere. This problem is closely related to the kissing number problem and applications have appeared in different areas. Although good approaches are known, most of them become infeasible when either the number of caps or the dimension grows. We present a new modeling which allows to reduce the problem to the one of packing circles in a box in the half of the dimension. Several examples are presented, some of them are the biggest known constructive solutions in high dimensions (e.g. 16, 24).

4 - A comparative study of 2D irregular object geometry modelling solutions for cutting and packing problems

Ozgur Kulak, Çorlu Engineering Faculty, Namık Kemal University, N.K.Ü. Çorlu Mühendislik Fakültesi, Silahtar Mahallesi, Sinan Dede Mevkii Çerkezköy Yolu 3. km, Çorlu, 59860, Tekirdağ, Turkey, okulak@nku.edu.tr

Industrially applicable packing and cutting solutions need to achieve both a tightly fitting irregular object geometry modeling and a fast placement optimization by computationally effective intersection, translation and rotation operations. Modeling scalability is also important for different approximation requirements of concurrent optimization algorithms. In this study, classical object boundary geometry modeling and alternative quad tree modeling technique are compared with respect to representation quality, scalability, processing time per intersection, rotation and translation operation.

the exact cost function and develop an algorithm to find the optimal policy, when order size is as a control parameter. We show that our algorithm is faster than the previous one.

2 - A single-period inventory placement problem for a supply system with the satisficing objective

Piotr Staliński, Department of Quantitative Methods in Management, WSB-NLU, ul. Zielona 27, 33-300, Nowy Sącz, Poland, piotr_stalinski@yahoo.com, *Chia-Shin Chung, James Flynn, Roelof Kuik*

Consider the inventory placement problem in an N-stage supply system facing a stochastic demand for a single planning period. Each stage is a stocking point holding some form of inventory that after a suitable transformation can satisfy demand. Stocking decisions are made before demand occurs. The objective is to maximize the probability of achieving a given profit level. We prove the existence of optimal stocking decisions that utilize at most three stages in the supply system. We characterize properties of the optimal stocking decisions and provide an efficient algorithm for computing them.

3 - An inventory model with partial backorders assuming uniform demand

Joaquín Sicilia, Dpt. de Estadística, Investigación Operativa y Computación, Universidad de La Laguna., Facultad de Matemáticas, Avda. Astrofísico Francisco Sánchez s/n, 38271, La Laguna. Tenerife., Canary Islands, Spain, jsicilia@ull.es, *Valentín Pando, Luis A. San-José, Juan García-Laguna*

In this work a stochastic inventory problem with additional order is studied. If the system is out of stock at the selling period, the vendor orders an extra lot size to satisfy a percentage of unmet demand. We assume the backorder rate depends on the amount of shortage and the fraction of demand served with delay is described by a co-sinusoidal non-increasing function of the unmet demand. Our objective consists of determining the optimal order size that maximizes the expected total profit when demand is uniformly distributed. Sensitivity analysis and numerical examples are also presented.

4 - Inventory Control Under The Carbon Emission Trading Scheme

Marthy Stivaliz García Alvarado, Departement of Automated Manufacturing Engineering, École de technologie supérieure, 1100, rue Notre-Dame Ouest, H3C 1K3, Montreal, Quebec, Canada, marthy-stivaliz.garcia-alvarado.1@ens.etsmtl.ca, *Marc Paquet, Amin Chaabane*

Inventories have proven to be crucial in logistics. While new trends force the integration of sustainable development into supply chain operations, the carbon emission trading scheme seems to be a good way to achieve sustainable development efficiently. This integration has raised new questions related to how inventory methods should be adapted to include carbon trading. In this talk will discuss the challenges of inventory modeling. Moreover, through a stochastic inventory model, we show the direct link between the sustainability objective and inventory control policies.

MD-10

Monday, 14:30-16:00

RB-Theta

Inventory Management 1

Stream: Production Management & Supply Chain Management (contributed)

Contributed session

Chair: *Amin Chaabane*, Departement of Automated Manufacturing Engineering, École de Technologie Supérieure, 1100, Notre Dame Street Ouest, H3C1K3, Montreal, Quebec, Canada, amin.chaabane@etsmtl.ca

Chair: *Marthy Stivaliz García Alvarado*, Departement of Automated Manufacturing Engineering, École de technologie supérieure, 1100, rue Notre-Dame Ouest, H3C 1K3, Montreal, Quebec, Canada, marthy-stivaliz.garcia-alvarado.1@ens.etsmtl.ca

1 - A Serial Inventory System with Information Exchange

Nima Yazdan Shenasi, University of Science and Culture, Iran, Islamic Republic Of, nimayazdanshenasi@alum.sharif.edu

A supply chain model consisting of one product, a supplier and a retailer is considered. Demands at the retailer are generated by a Poisson process. Not covered demands are backordered. The retailer carries inventory and replenishes stock according to a (Q, R) policy. Based on available information, the supplier's policy is defined. Recently, the optimal policy was obtained, where order size (Q) is given. We extend

MD-11

Monday, 14:30-16:00

RB-Iota

Traffic Management

Stream: Transportation and Logistics

Invited session

Chair: *Livia Mannini*, Dep. of Civil Engineering, Roma Tre University, Italy, lmannini@uniroma3.it

1 - Traffic management and emissions estimation in a within day dynamic framework

Simone La Spada, Department of Civil Engineering, Roma Tre University, 00146, Rome, Italy, Italy, slaspada@uniroma3.it, *Marialisa Nigro, Stefano Gori, Livia Mannini*

Reduction of vehicle emissions is related to the improve of life quality and sustainability. To estimate emissions on large scale urban network, approaches based on aggregated traffic estimates are followed, without considering temporal variations of traffic conditions. The study wants to develop a method to estimate pollutant emissions taking into account the within-day variations of traffic conditions and parameters related to the different state of vehicles and that can easily be applied to evaluate the results of off-line and on-line traffic management strategies in large urban network.

2 - Implementation of variable speed systems in an access road (c 31 n) to barcelona

M. Antonia de los Santos, Mechanical Engineering, UPC, Diagonal 647, 08028, Barcelona, Spain, tania.santos@upc.edu, *David Gallegos*, *Francisco Liesa*

The city of Barcelona was the first in Spain to introduce variable speed systems as a strategic tool to improve traffic management in 2009, in the roads C32 and C31S. The C31N is a main access road to Barcelona where these systems could be installed. The present work evaluates potential benefits that the implementation of these intelligent systems involves. In order to achieve this target, a virtual model of the road is created, analysing and defining the traffic flow running in the road. To check global potential benefits, 3 more cases are analysed including specific traffic jam situations.

3 - Green timing and scheduling: an approach based on genetic algorithms

Giulio Erberto Cantarella, Dept of Civil Engineering, University of Salerno, via Ponte Don Melillo, 1, 84084, Fisciano (SA), Italy, g.cantarella@unisa.it, *Roberta Di Pace*

This paper proposes an approach to traffic light optimization at a single junction through genetic algorithms. Decision variables are green times and their scheduling. Maximization of capacity and minimization of delay are considered as objectives, also taking into account maximum queue length constraints. This approach seems relevant since it can be extended to signal synchronization with optimization of green scheduling, differently from current practice. This research is a part of a project aiming at urban network design including optimization of traffic lights and street lane allocation.

4 - Estimation of traffic flow conditions through data fusion techniques

Livia Mannini, Dep. of Civil Engineering, Roma Tre University, Italy, lmannini@uniroma3.it, *Ernesto Cipriani*, *Stefano Gori*

Starting from the application of the procedure reported in Wang, Papa-georgiou (2005) based on the correction through the Extended Kalman Filter (EKF) of the second order traffic model, also probe vehicles measurements have been taken into account, added to the conventional fixed ones. Several simulations have been carried out with Matlab. Different data fusion techniques have been analyzed, specifically, the fusion of measurements, rather than the fusion of estimations, has revealed to be more effective in improving EKF estimation.

■ MD-12

Monday, 14:30-16:00

RB-Omicron

Decision-making and modelling under fuzziness

Stream: Fuzzy Sets and Soft Computing

Invited session

Chair: *Mario Fedrizzi*, Department of Computer and Management Sciences, Università di Trento, Via Inama 5, 38122, Trento, Italy, mario.fedrizzi@unitn.it

1 - Boundary properties of inconsistency indices in group preference relations

Matteo Brunelli, Åbo Akademi University, Finland, matteo.brunelli@abo.fi, *Michele Fedrizzi*

Consistency of preferences is usually a desirable situation in decision making processes based on preference relations, e.g. the AHP. A relatively large number of inconsistency indices has been proposed in literature in order to estimate inconsistency of preference. We propose a study of inconsistency with respect to consensus where we analyze how the inconsistency of the consensual preference relation is affected by the inconsistency of the single decision makers. In particular, we will reason and dwell on the positive effects of consensus on the consistency of preferences.

2 - Error based decision making on approximation methods under fuzziness

Svetlana Asmuss, Department of Mathematics, University of Latvia, Zellu street 8, LV-1002, Riga, Latvia, svetlana.asmuss@lu.lv, *Vecislavs Ruza*

We present a methodology of decision making on approximation methods under uncertainty given by fuzzy sets. We consider approximation of real valued functions when a set we approximate over is fuzzy, meaning that our interest is more focused at some parts of the set. In order to estimate the quality of algorithms, we introduce an appropriate fuzzy analogue of a norm using a fuzzy valued integral and describe a method of its evaluation. In this context, for approximation methods we obtain fuzzy valued error bounds for some classes of functions and discuss criteria of the error optimal decision.

3 - Indirect sociomapping

Cyril Höschl, QED GROUP, Czech Republic, cyril.hoschl@qedgroup.cz, *Radvan Bahbouh*

Indirect sociomapping enables comparison of people as to similarity of their data profiles. The degree of belonging to the fuzzy set of similarity is determined by the p-values for the statistical test comparing both of the individual data profiles. Results are represented in the form of a landscape, with the distances corresponding to the degree of similarity and the heights showing the overall similarity to the other units in the system. This landscape can be used as an interactive interface to formulate statistical tests and visualize their results.

4 - Sociomapping of communication

Radvan Bahbouh, QED GROUP, Czech Republic, radvan.bahbouh@qedgroup.cz, *Cyril Höschl*

Sociomapping makes it possible to analyse and visualise communications in teams and organizations. This method is based on representing the communication interconnectedness through the degree of belonging to the fuzzy sets of communication nearness. The obtained fuzzy models can be mutually compared; this allows capturing of stable communication patterns, as well as of developmental trends. Subsequently, the data are depicted in the form of a landscape. Sociomapping is used in preparing teams for foreign military missions, in experiments simulating flight to Mars, and in management teams, etc.

■ MD-13

Monday, 14:30-16:00

RB-Tau

Lot-sizing and Related Topics 4

Stream: Lot-sizing and Related Topics

Invited session

Chair: *Luis Guimarães*, Industrial Engineering and Management, Faculty of Engineering of Porto University, FEUP, Portugal, luis.santos.guimaraes@gmail.com

1 - The integrated lot sizing and scheduling problem in the brewery: model and MIP-based heuristic

Maristela Santos, Department of Applied Mathematics and Statistics, University of Sao Paulo, Av. Trabalhador São-carlense, 400 - Centro, Caixa Postal: 668, 13560-970, São Carlos, São Paulo, Brazil, mari@icmc.usp.br, *Tamara Baldo*, *Reinaldo Morabito*, *Bernardo Almada-Lobo*

This paper addresses the lot-scheduling problem in the brewery industry. This problem is composed of two stages: the preparation and bottling of the liquids. The first stage may span over several days due

to the fermentation process which complicates the synchronization of both stages. We propose a new mixed integer model for it considering multiple tanks and bottling lines. The model differs from those of the literature on the first stage decisions and requirements. A MIP-based heuristic is developed to obtain solutions capable of addressing the process and preliminary results are presented.

2 - Dynamic lot sizing problem with minimum order quantities and remanufacturing option

Irena Okhrin, Juniorprofessur in Information & Operations Management, European University Viadrina, Grosse Scharrnstrasse 59, 15230, Frankfurt (Oder), Germany, irena.okhrin@europa-uni.de, *Knut Richter*

We focus on a special uncapacitated lot sizing problem where a manufacturer can meet demand by either producing new items or by remanufacturing used items. Additionally, a minimum order quantity restriction, instead of the setup cost, guarantees a certain level of production lots. A general model of this problem is formulated and several useful properties of the optimal solution structure are investigated. Finally, we develop a one-dimensional dynamic programming procedure for the originally two-dimensional dynamic model that generates the optimal production plan for some special cases.

3 - Simultaneous production-distribution planning to coordinate multi-plant supply chains

Luis Guimarães, Industrial Engineering and Management, Faculty of Engineering of Porto University, FEUP, Portugal, luis.santos.guimaraes@gmail.com, *Diego Klabjan*, *Bernardo Almada-Lobo*

Inspired by a real case, we present a model and solution approach for production-distribution planning in multi-plant, multi-warehouse supply chains. The model assigns and schedules production lots to a set of machines, available at each plant, determining overtime, inventory and transportation quantities. The objective is to minimize overall cost while satisfying a deterministic demand triggered at the warehouses. The solution approach is based on the model using VNS to fix and improve lots allocation guided by the sensitivity analysis of the LP solved to determine the remaining decisions.

■ MD-14

Monday, 14:30-16:00

RB-Omega

Scheduling with variable parameters I

Stream: Scheduling under Resource Constraints
Invited session

Chair: *Mikhail Y. Kovalyov*, United Institute of Informatics Problems, National Academy of Sciences of Belarus, Surganova 6, 220012, Minsk, Belarus, kovalyov_my@yahoo.co.uk

Chair: *Adam Janiak*, Institute of Computer Engineering, Control and Robotics, Wrocław University of Technology, Janiszewskiego 11/17, 50372, Wrocław, Poland, adam.janiak@pwr.wroc.pl

1 - Complexity analysis of an assignment problem with controllable assignment costs and its implications in scheduling

Dvir Shabtay, Dept. of Industrial Engineering and Management, Ben-Gurion University of the Negev, POB 653, 81045, Beer Sheva, Israel, dvirs@bgu.ac.il, *Liron Yedidsion*, *Moshe Kaspi*

We extend the linear sum assignment problem to the case where the assignment cost is a function of the amount of resource allocated to the agent. A solution is defined by the assignment of agents to tasks and by a resource allocation vector. The quality of a solution is measured by two criteria: the total assignment cost and the total weighted resource consumption. We address these criteria via four problem variations and prove that three of them are NP-hard. In addition, we find that our problem is equivalent to a large set of scheduling problems whose complexity has been an open question.

2 - Parallel machine scheduling with a variable common due window

Mikhail Y. Kovalyov, United Institute of Informatics Problems, National Academy of Sciences of Belarus, Surganova 6, 220012, Minsk, Belarus, kovalyov_my@yahoo.co.uk, *Adam Janiak*, *Wladyslaw Janiak*, *Erhan Kozan*, *Erwin Pesch*

We study problems of scheduling jobs on identical parallel machines, with a common due window to be assigned to all jobs. The objective is to minimize the sum of job earliness, job tardiness, due window location and size costs, which are nondecreasing job independent functions. Solution properties are established and dynamic programming algorithms are derived. Polynomial algorithm is given for the single machine case, in which the due window size cost is a discretely convex or concave nondecreasing function and all the other cost functions are linear.

3 - Structural properties of time-dependent scheduling problems with the lp norm objective

Stanislaw Gawiejnowicz, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Umultowska 87, 61-614, Poznan, Poland, stgawiej@amu.edu.pl, *Wieslaw Kurc*

We consider structural properties of single-machine time-dependent scheduling problems with linearly deteriorating jobs and the lp norm objective. We prove that the V-shape property, previously known only for $p=1$, still holds for infinite many $p>1$, while the symmetry property does not hold for $p \gg 1$. We show that for $p>1$ the problems possess a kind of matrix convexity. Finally, we express the complexity of the problems as a function of index p of the norm.

4 - Scheduling jobs with values dependent on their completion times

Tomasz Krysiak, Institute of Computer Engineering, Control and Robotics, Wrocław University of Technology, Janiszewskiego 11/17, 50-372, Wrocław, Poland, tomasz.krysiak@pwr.wroc.pl, *Adam Janiak*

We consider two scheduling problems with job values and losses of job values (costs) dependent on job completion times. In the first problem, we consider scheduling jobs with stepwise values deteriorating over time. We prove strong NP-hardness of a single processor case and construct a pseudo-polynomial algorithm for a special case with unrelated processors. The second problem is a single processor one with piecewise linear losses of job values increasing over time. We prove strong NP-hardness of the problem and existence of a pseudo-polynomial algorithm for its special case.

■ MD-15

Monday, 14:30-16:00

RB-2101

Nonlinear Optimization and Applications 3

Stream: Nonlinear Programming
Invited session

Chair: *Max Demenkov*, Institute of Control Sciences, Lab 16, Russian Academy of Sciences, 65 Profsoyuznaya str., 117997, Moscow, Russian Federation, demenkov@ipu.ru

1 - Multistart Coupled with a Derivative-Free Filter Local Search for Locating Multiple Solutions

Florbela P. Fernandes, Department of Mathematics - ESTiG, Polytechnic Institute of Bragança, Bragança, Portugal, fflor@ipb.pt, *M. Fernanda P. Costa*, *Ana I. Pereira*, *Edite M.G.P. Fernandes*

A multistart technique coupled with a derivative-free filter local search algorithm for locating all the optimal solutions of a nonconvex constrained optimization is presented. To reach fast convergence to optimal solutions, the local search procedure is based on descent directions. The filter-set concept is introduced to handle the constraints of the problem. The direction vector is descent for the objective function if the point is feasible; otherwise, it is descent for the constraint violation. Numerical experiments with benchmark problems and a comparison with other methods are included.

2 - Bilevel optimization in stability analysis of nonlinear dynamical systems

Max Demenkov, Institute of Control Sciences, Lab 16, Russian Academy of Sciences, 65 Profsoyuznaya str., 117997, Moscow, Russian Federation, demenkov@ipu.ru

We consider region of attraction for a dynamical system - a set of points from which system trajectories go to a stable equilibrium. One can estimate it via the sublevel sets of a positive definite Lyapunov function, which is decreasing along any trajectory in the region. We formulate this task as a bilevel optimization over the function parameters and system state variables. On the lower level we have minimization of the function with nonconvex equality constraint. On the upper level a size estimation of a sublevel set needs to be maximized. Local improvement algorithm is discussed.

3 - Numerical solution of nonlinear optimal control problems, A comparative study

M. Navabi, Shahid Beheshti University, GC, Iran, Islamic Republic Of, civil.space.edu@gmail.com, E. Meshkinfam

The aim of this paper is to compare four different iterative numerical techniques using in determination the optimal control law. The methods are: Steepest Descent (SD), Variation of Extremals (VE), Quasilinearization (QL) and Collocation (CL).

The Maximum radius orbit transfer in a given time problem is solved utilizing these methods and comparisons are made in the terms of accuracy, the rate of convergence, sensitivity to initial guess and the time of computer processing. The results show that, CL method has the least error, VE has the most sensitivity to initial guess.

4 - Performance Analysis of Partial Use of Local Optimization Operator on Genetic Algorithm for TSP

Milan Djordjevic, UP DIST, UP FAMNIT, Glagoljaska 8, Slovenia, 6000, Koper, State, Slovenia, milan.djordjevic@student.upr.si, Andrej Brodник

We study the influence of hybridization of a genetic algorithm with a local optimizer on instances of a TSPLIB. In tests we applied hybridization at various percentages of genetic algorithm iterations. Less frequent application of hybridization decreased the average running time, whereas the quality of solution on average deteriorated only from 0.21% till 1.40% worse than the optimal solution. We studied at which iterations to hybridize. We applied it at random iterations, at the initial iterations, and the ending ones, and proved where being the best.

■ MD-16

Monday, 14:30-16:00

RB-2103

Uncertainty Analysis in Energy and Water Resources

Stream: Uncertainty and Perturbations in Optimization and in Environmental and Energy Modelling

Invited session

Chair: John Boland, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Blvd., 5095, Mawson Lakes, South Australia, Australia, john.boland@unisa.edu.au

1 - Reconciling rainfall modelling on differing time scales

John Boland, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Blvd., 5095, Mawson Lakes, South Australia, Australia, john.boland@unisa.edu.au, Julia Piantadosi

Rainfall perform well for the time scales on which they are produced but for other time scales, a model's performance can be erratic. Previous experience in estimating five minute variance of wind farm output derived from modelling ten second output series (Agrawal et al 2010) has led us to be able to perform a similar exercise with modelling daily rainfall series in a fashion that preserves the monthly variance. We develop an AR(3) model for daily rainfall (after multiplicative deseasoning), and through standard transformations for stationary time series, develop estimates for variances for monthly rainfall series that match the observed monthly variances.

2 - Catching uncertainty of wind

Yulia Gel, Statistics and Actuarial Science, University of Waterloo, 200 University Ave., N2L 3G1, Waterloo, ON, Canada, ygl@math.uwaterloo.ca

Sustainable wind energy has long been recognized as one of the most attractive options but its generation is still found to be much easier than its integration into liberalized electricity markets due to a highly volatile nature of wind. In this talk we propose a new approach to probabilistic wind power forecasting which delivers competitive forecasts while imposing minimal requirements on observed data. This is especially critical as lack of expertise and related costs in wind farm site selection still remain one of the key barriers to tapping wind resources in developing countries.

3 - SVM Models and Auction Protocols in Electricity Markets

Carlo Lucheroni, School of Science and Technologies, University of Camerino, via M. delle Carceri 9, 62032, Camerino (MC), Italy, carlo.lucheroni@unicam.it, Renato De Leone

Modelling of hourly electricity prices is mostly made by stochastic difference equations, assuming a causal relation between succeeding hours. Because of the power market structure, in fact this assumption is true only at the level of succeeding days, since un-causal autocorrelations can appear within each day, due to technical constraints enforcement by system operators. Support Vector Machines used as autoregressive estimators on daily price hourly profiles offer a new way for price modelling, able to take into account intra-day correlations without mixing them with inter-day correlation.

4 - Mathematical methods for rainfall modelling

Julia Piantadosi, Centre for Industrial and Applied Mathematics, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Campus, Mawson Lakes Boulevard, Mawson Lakes, 5095, Adelaide, South Australia, Australia, julia.piantadosi@unisa.edu.au

A major challenge for future management of water resources is to optimize economic, social and environmental outcomes subject to sustainable usage in a changing and highly variable climate. Historical records provide only one realisation and generation of realistic synthetic data is an important objective to assess the impact of rainfall variability on water systems. The aim of this work is to propose new mathematical models for rainfall simulation to inform analysis of current rainfall patterns and enable better projections for a comprehensive range of future scenarios.

■ MD-17

Monday, 14:30-16:00

RB-2105

Further Applications of Location Analysis

Stream: Applications of Location Analysis

Invited session

Chair: Mercedes Landete, Departamento de Estadística y Matemática Aplicada, University Miguel Hernández of Elche, Avda. del Ferrocarril s/n, 03202, Elche, Alicante, Spain, landete@umh.es

1 - Assessing Optimal Routes in the Natural Park of Doñana (Spain)

Eva Barrena, Applied Mathematics I, University of Sevilla, Avda. Reina Mercedes s/n, 41012, Sevilla, Spain, ebarrena@us.es, Francisco A. Ortega Riejos, Isabel Ternero, Miguel Angel Pozo

This paper explores the compatibility between a successful management of environmental conservation and a sustainable development through rural tourism by designing optimal routes along environmental units (cells) in a Natural Park. Two types of scenarios are assumed: Safaris route, where the objective is to minimize the total distance travelled during supervising all the cells (appropriate for ranger's route), and Zookeeper's route, where a representative sample of cells must be visited (for a touristic route) (supported by Spanish/FEDER projects MTM2009-14243 and P09-TEP-5022).

2 - A polyhedral study on location models with knapsack constraints

Roberto Javier Cañavate Bernal, Métodos Cuantitativos e Informáticos, Technical University of Cartagena (UPCT), Calle Real, 3, Facultad Ciencias Empresa, 30201, Cartagena, Murcia, Spain, r.canavate@upct.es, *Mercedes Landete*

In this paper we consider set packing location problems with knapsack constraints. We propose to study the intersection polyhedron of the two well-known problems: the classical knapsack problem (KP) and the set packing problem (SP). We give conditions for some valid inequalities of the KP polytope and the SP polytope to be facets for the KP-SP problem. The obtained results also generalize polyhedral properties of some knapsack related problems in the literature.

3 - Delocation Models for Closing and Resizing Redundant Branches during Bank Restructuring

Diego Ruiz-Hernandez, Quantitative Methods, CUNEF, c/ Serrano Anguita 9, 28004, Madrid, Spain, d.ruiz@cunef.edu, *David Delgado-Gomez*, *Laureano Fernando Escudero*, *Joaquín Lopez-Pascual*

During restructuring processes due to mergers, banks face the problem of redundant branches competing with each other for customers. As important as it is, the problem of closing down branches has not been fully addressed in the literature. In this paper we introduce a new branch closing and resizing model based on the capacitated facility location problem. The model considers closing down and costs, and addresses the problem of resizing open branches to accommodate customers displaced from closed branches. We motivate the problem with an example from the Spanish saving banks sector.

4 - Different ways of locating spanning trees in a network

Mercedes Landete, Departamento de Estadística y Matemática Aplicada, University Miguel Hernández of Elche, Avda. del Ferrocarril s/n, 03202, Elche, Alicante, Spain, landete@umh.es, *Alfredo Marín*

In this work we present different formulations for the ordered minimum spanning tree problem. We propose one formulation based on the flow variables and another based on the Miller-Tucker-Zemlin sub tour elimination constraints. We distinguish between positive and negative values for the elements of the weight function. Finally, we develop a computational study for comparing both formulations. It illustrates how much the difficulty of the problems differs depending on the weight function. The Conclusions section gives some advises for choosing the best formulation at each case.

■ MD-18

Monday, 14:30-16:00

RB-2107

Analysis of Price Dynamics and Herd Behavior

Stream: Financial Modelling & Risk Management (contributed)

Contributed session

Chair: *Frederik Druart*, MOSI, Vrije Universiteit Brussel, Twaalfmaandenstraat 9/12, 2000, Antwerpen, Belgium, fdruart@vub.ac.be

1 - Stock price dynamics and distribution of returns — before, during and after the financial crisis

Tibor Kis, Quantitative Methods in Economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, tbkis@yahoo.com, *Marija Cileg*, *Gabriela Vicko*

In this paper we study the characteristics of return distributions for a number of stocks between 1995-2011. The analysis relates to separate sub periods distinguishing the year(s) of the late-2000s financial crisis searching for a shift in skewness, kurtosis and autoregressive characteristics of return distributions in sub periods and between different stocks, particular sectors and stock exchanges. Return distribution characteristics are investigated on different time levels: daily, weekly and monthly.

2 - Herding behavior of agents as a background of financial fluctuations

Aleksejus Kononovicus, Institute of Theoretical Physics and Astronomy, Vilnius University, Lithuania, aleksejus.kononovicus@gmail.com, *Vyginas Gontis*, *Bronislovas Kaulakys*

We focus on the universal nature of herding behavior leading to the macroscopic description by nonlinear stochastic differential equations applicable to the finance and other complex systems. Approach with two groups of agents appears to be too crude to reproduce the details of financial markets. Thus we extend Kirman's model to include three groups of interacting agents. This improvement provides more opportunities to reproduce sophisticated power law statistics of return in financial markets.

3 - Bayesian statistical analysis of herding behaviour: an application to the Spanish equity mutual funds

Pilar Gargallo, Facultad de Economía y Empresa, Universidad de Zaragoza, Gran Vía 2, 50005, Zaragoza, Spain, pigarga@unizar.es, *Laura Andreu*, *José Luis Sarto*, *Manuel Salvador*

This paper proposes a Bayesian rolling window estimation procedure applied to the three factor model of Fama and French (1993) to analyse the herding behaviour in the style exposures of mutual funds. This procedure let dynamically select the length of the estimation window by means of weighted likelihood functions that discount the loss of information due to time. The method is very flexible and allows us to consider different approaches to detect herding behaviour by taking into account the uncertainty associated to the estimation of the style coefficients.

■ MD-19

Monday, 14:30-16:00

RB-2111

Financial Decision Making: Application of Mathematical Optimization

Stream: Operational Research and Quantitative Models in Banking

Invited session

Chair: *Katsumasa Nishide*, International Graduate School of Social Sciences, Yokohama National University, 79-4 Tokiwadai, Hodogaya-ku, 2408501, Yokohama, Japan, knishide@ynu.ac.jp

1 - Competition and the Bad News Principle in a Real Options Framework

Katsumasa Nishide, International Graduate School of Social Sciences, Yokohama National University, 79-4 Tokiwadai, Hodogaya-ku, 2408501, Yokohama, Japan, knishide@ynu.ac.jp, *Kyoko Yagi*

We consider the investment timing problem where each firm knows when the economic condition changes in advance. When firm faces an investment competition, the strategy significantly differs depending on whether the firm is a leader or a follower. More concretely, a follower firm follows the so-called bad news principle proposed by Bernanke(1983) near maturity, while a leader firm optimally invest in the project just based on the current and future economic conditions.

2 - Equilibrium in the Presence of Transaction Costs

Masaaki Kijima, Graduate School of Social Sciences, Tokyo Metropolitan University, 1-1 Minami-Ohsawa, 192-0397, Hachiohji, Tokyo, Japan, kijima@tmu.ac.jp

We consider an equilibrium model in the presence of transaction costs. Such problems have been considered quite extensively in the complete market setting (no transaction costs). In the presence of proportional transaction costs, however, we need to know the quantities of buying and selling assets. For the case of single risky asset, it will be shown that the buy price increases and the sell price decreases as the cost increases under some reasonable conditions. The trading volume is also decreasing with respect to the cost.

3 - Optimal Life Insurance Coverage and Annuities with Borrowing and a Leverage Constraint

Teruyoshi Suzuki, Graduate School of Economics, Hokkaido University, Nishi 7 Kita 9, Kita-ku, 060-0809, Sapporo, Hokkaido, Japan, suzuki@econ.hokudai.ac.jp

This paper presents the optimal policies of life insurance coverage and annuities for a retired agent using the investment/consumption model with borrowing. One of features in our model is imposing non-negativity constraints on the insurance coverage and annuities considering positive premium loading in the insurance market. It was found from our analytical result that there is an interval of the bequest intensity where the agent has no demand for both insurance and annuities.

4 - Robust Portfolio Optimization with Copulas

Iakovos Kakouris, Computing, Imperial College London, Imperial College London, Exhibition Road, SW7 2AZ, London, United Kingdom, iak05@ic.ac.uk, *Berc Rustem*

Conditional value-at-risk (CVaR) is widely used in portfolio optimization as a measure of risk. CVaR is clearly dependent on the underlying probability distribution of the portfolio. We show how copulas can be introduced to any problem that involves distributions and how they can provide solutions for the modelling of the portfolio. We use this to provide the copula formulation of the CVAR of a portfolio. Given the critical dependence of CVaR on the underlying distribution, we use a robust framework to extend our approach to Worst Case CVaR through the use of rival copulas.

■ MD-20

Monday, 14:30-16:00
RB-2113

Energy consumption and price forecasting

Stream: Data Mining in the Financial Sector
Invited session

Chair: *Richard Weber*, Department of Industrial Engineering, University of Chile, Republica 701, 2777, Santiago, Chile, rweber@dii.uchile.cl

■ MD-21

Monday, 14:30-16:00
RB-2115

Financial Mathematics and OR 4

Stream: Financial Mathematics and OR
Invited session

Chair: *Tansel Avkar*, Department of Mathematics, Middle East Technical University, 06531, Ankara, Turkey, tanselavkar@gmail.com

1 - A Parallel Procedure for Dynamic Multi-objective TSP

Weiqi Li, School of Management, University of Michigan-Flint, 303 East Kearsley Street, 48502, Flint, Michigan, United States, weli@umflint.edu

This paper proposes a new parallel search procedure for dynamic multi-objective TSP. We design a multi-objective TSP in a stochastic dynamic environment. The proposed procedure first uses parallel processors to identify the extreme solutions of the search space for each of k objectives individually at the same time. These solutions are merged into a matrix E . The solutions in E are then searched by parallel processors and evaluated for dominance relationship. The proposed procedure was implemented in two different ways: a master-worker architecture and a pipeline architecture.

2 - Foreign Direct Investment Trends and Comparative Analysis for Chosen Transition Countries

Snjezana Pivac, Faculty of Economics, University of Split, Department of Quantitative Methods in Economics, Matice hrvatske 31, 21000, Split, Croatia, spivac@efst.hr

Foreign direct investments (FDI) have high positive impact on economic impetus especially in transition countries. So in the focus of this paper are the structure and forms of FDI and their influence on crucial macroeconomic variables. In the FDI inflow analysis the country risk rating estimation has been essential. FDI efficiency analysis is enriched with correlation between Incremental Capital Output Ratio (ICOR) and GDP increase. Multivariate classification of ten transition countries has been carried out according to all regarding indicators.

3 - A mathematical solution to the Nigerian petroleum products supply crisis

Adewoye Olabode, mathematics, yaba college of technology, yaba, lagos, +234, yaba, lagos state, Nigeria, boka152002@yahoo.com

Nigeria is the largest oil exporter in Africa and rank sixth in the world. The country for more than two decades has found itself in petroleum products supply crisis. With thorough investigation, necessary parameter is developed to run the policy iteration techniques on continuous semi — Markov Decision Process. The solution to the model is obtained by selecting an arbitrary stationary policy that governs the problem.

4 - Stochastic Dominance in economic and financial context, overview and applications

Elena Almaraz Luengo, Estadística e Investigación Operativa, Facultad de Ciencias Matemáticas (UCM), c/Arroyo de la Media Legua 68, 2ºB, 28030, Madrid, Spain, ealmarazluengo@mat.ucm.es, *Eduardo Almaraz Luengo*

We analyze different types of Stochastic Dominance (SD) and its principal applications in different knowledge areas, with special interest in economic and financial context. Some points discussed are: SD concepts in connection with particular and interesting random variables in Economy; Consistency of Mean-Variance rules and its application in weighted random variables; SD in particular economical and financial stochastic processes; SD in context of assets valuation. We finish with the concept of Almost Stochastic Dominance and its possible applications in economic and financial context.

■ MD-23

Monday, 14:30-16:00
RB-Delta

Various Advances in Generalized Differentiation and Optimization

Stream: Generalized Differentiation and Optimization
Invited session

Chair: *Alexander Kruger*, School of Science, Information Technology & Engineering, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au
Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Interior Epigraph Method for Nonsmooth and Non-convex Optimization via Generalized Augmented Lagrangian Duality

Wilhelm Passarella Freire, Mathematics, Federal University of Juiz de Fora, Campus Universitário - Bairro Martelos, Juiz de Fora - MG, Brasil, 36036-900, Juiz de Fora, Minas Gerais, Brazil, wilhelmfreire@yahoo.com.br, *Regina Burachik*, *C Yalcin Kaya*

We propose a new method (IEM) for constrained nonsmooth and non-convex optimization which uses a generalized augmented lagrangian duality scheme. The new method takes advantage of the special structure of the epigraph of the dual function. We present numerical experiments by using test problems from the literature. In particular, we study several instances of the kissing number problem. Our experiments show that the quality of the solutions obtained by IEM is comparable with those obtained by other solvers.

2 - A Novel Approach for Solving the Geometric Distance Problem

Helder Venceslau, Federal University Rio de Janeiro - UFRJ, Brazil, helder.venceslau@gmail.com, *Leonardo Nascimento*, *Adilson Elias Xavier*, *Gerhard-Wilhelm Weber*

The geometrical distance problem in graphs is characterized by determining the nodes' positions in a Euclidian space, according to the given distances associated with the arcs. It is a non-convex and non-differentiable problem. It has a relevant application in the determination of proteins' geometrical structures. It is solved by the Hyperbolic Smoothing Technique connected to a speed-up extrapolation scheme. Computational results obtained in the resolution of large instances of a difficult canonic problem show the efficiency and robustness of the method.

3 - Generalized Solutions and Optimal Investment in Infinite Horizon Control Problem in Capital Accumulation Model

Marta Kornafel, Department of Mathematics, Cracow University of Economics, Poland, marta.kornafel@uek.krakow.pl

Control problem in capital accumulation model with vintage structure in Neoschumpeterian framework is presented. Model is described by transport equation on bounded domain. Coefficients of the state equation are allowed to be discontinuous functions, what differs our approach from the considerations in the existing literature. Problem of existence and uniqueness of solution for the state equation is discussed in our presentation. It is shown that among generalized solutions there exists viscosity one to the state equation on extended domain. Optimal investment is obtained via direct method

■ MD-24

Monday, 14:30-16:00

CC-A11

Pioneers in Operations Research

Stream: Pioneers in Operations Research
Invited session

Chair: *Graham Rand*, Dept. of Management Science, Lancaster University, The Management School, LA1 4YX, Lancaster, Lancashire, United Kingdom, g.rand@lancaster.ac.uk

1 - Von Neumann and Vazsonyi: OR pioneers born in Budapest

Graham Rand, Dept. of Management Science, Lancaster University, The Management School, LA1 4YX, Lancaster, Lancashire, United Kingdom, g.rand@lancaster.ac.uk, *Saul Gass*

The 2011 volume "Profiles in Operations Research", written, compiled and edited by A. Assad and S. Gass, provides biographies of 43 distinguished OR pioneers. Three of these were born in Budapest, but made their pioneering contributions elsewhere. This paper complements the following one by outlining the fascinating life and times of John von Neumann, who made seminal contributions to, inter alia, game theory, utility theory and simulation, and Andrew Vazsonyi, who was at the forefront of OR's move into business and industry after World War II.

2 - Steven Vajda, European OR pioneer

Jakob Krarup, Dept. of Computer Science, University of Copenhagen, Ydervang 4, DK-3460, Birkerød, Denmark, krarup@diku.dk

Several European OR pioneers are listed among the 43 distinguished scholars portrayed in the 2011 volume "Profiles in Operations Research", written, compiled and edited by A. Assad and S. Gass. These include Steven Vajda (1901-95), born in Budapest, but known as the British father of linear programming (LP) and the person who introduced LP to both Europe and Asia. An account of Steven's life and work is provided.

3 - U.S. OR Pioneers: Engagements in European OR

Arjang Assad, School of Management, University at Buffalo, SUNY, 160 Jacobs Management Center, Buffalo, 14260-4000, Buffalo, NY, United States, aassad@buffalo.edu

Early developments of Operational Research (OR) owed much to exchanges between OR pioneers in North America and Europe. This presentation focuses on key engagements of OR pioneers from the U.S. in European OR. Examples are drawn from the earliest periods through the 1980s to illustrate the different natures of these engagements and their impact on the field.

■ MD-25

Monday, 14:30-16:00

CC-A23

Renewable Energies

Stream: Energy, Environment and Climate 2
Invited session

Chair: *Mario Ragwitz*, FhG-ISI, 76139, Karlsruhe, Germany, mario.ragwitz@isi.fhg.de

1 - A new perturbing parameter for interior point methods applied to short term hydroelectric scheduling

Aurelio Oliveira, Computational & Applied Mathematics, State University Of Campinas, DMA IMECC Unicamp, C. P. 6065, 13081-970, Campinas, SP, Brazil, aurelio@ime.unicamp.br, *Lilian Carvalho*

The short term hydroelectric scheduling problem can be formulated as a network flow model and efficiently solved employing interior point methods. In this work, a new approach to compute the perturbing parameter in the primal-dual interior point method is presented. Numerical results for short term hydroelectric scheduling applied to IEEE test systems and actual Brazilian systems are presented and compared to those obtained early. The experiments show that both approaches are attractive for both: running time and robustness and that the new one requires less iterations to achieve convergence.

2 - Optimal Underground Pumped Hydroelectric Storage Design

Amir José Daou Pulido, Chair of Energy Systems and Energy Economics, Ruhr - Universität Bochum, IB 4 - 32, Universitätsstr. 150, 44801, Bochum, Germany, daoupulido@lee.rub.de, *Hermann-Josef Wagner*, *Marco K. Koch*, *Eugen Perau*, *Ulrich Schreiber*, *André Niemann*

Optimal design of utility scale energy storage systems has been strongly researched in the last decades. However, there are few studies addressing Underground Pumped Hydroelectric Storage (UPHS). In Germany, UPHS has become an interesting technology for both energy system flexibility and mining sector. We propose an optimization model for UPHS design, i.e., reservoirs, waterways and turbo machinery configuration. The model aims to find the UPHS design that maximizes long-term profit, given a certain power market development scenario.

3 - Investment Incentives under the Influence of Capacity Aggregation in Regulated Industries

Sabine Pallas, TU München, Germany, sabine.pallas@tum.de

The purpose of this paper is to investigate the influence of cost based remuneration on a regulated company's investment behavior when capacity aggregation occurs and investments overlap. To this end a discrete-time optimization model is solved analytically for both parties. For an expansion of renewable energy large investments in the grid are necessary. Network operators are subject to a governmental cost-based remuneration, which can set disincentives to invest. However, this effect has not been investigated for two-stage overlapping investments with stepwise capacity expansion.

4 - Pollution permits, Strategic Trading and Dynamic Technology Adoption

Luca Taschini, Grantham Research Institute, London School of Economics, Houghton St, WC2A 2AE, London, United Kingdom, l.taschini@lse.ac.uk

This paper analyzes the dynamic incentives for technology adoption in a transferable permits system, which allows for strategic trading on the permit market. Technology adoption and allowance prices are generated endogenously and are inter—dependent. It is shown that the non—cooperative permit trading game possesses a pure—strategy Nash equilibrium, where the allowance value reflects the level of uncovered pollution (demand), the level of unused allowances (supply), and the technological status. The proposed policy generates a price floor and restores the dynamic incentives to invest.

■ MD-26

Monday, 14:30-16:00

CC-A24

OR in Forestry I

Stream: OR in Agriculture, Forestry and Fisheries

Invited session

Chair: *Concepcion Maroto*, Applied Statistics, Operations Research and Quality, Universitat Politecnica de Valencia, Camino de Vera S/N, 46071, Valencia, Spain, cmaroto@eio.upv.es

1 - A comparison of multiple criteria methods for group decision making in forest management

Concepcion Maroto, Applied Statistics, Operations Research and Quality, Universitat Politecnica de Valencia, Camino de Vera S/N, 46071, Valencia, Spain, cmaroto@eio.upv.es, *Marina Segura Maroto*, *Concepción Ginestar*, *Baldomero Segura*, *Juan Uriol*

Analytic Hierarchy Process, Goal Programming and Outranking Methods have been the approaches most applied to problems of sustainable forest management. It is well known that the results depend on the method used and one of the main uses of these approaches is to obtain consensus or as negotiation tools. Thus, robust results or conclusions need to be derived from the use of several techniques. This paper presents a comparison of several methods for aggregating stakeholder preferences as applied to the regional planning of Mediterranean forest. Finally, we will discuss the results obtained.

2 - Multi-criteria optimization method for designing a harvesting and cableway layout for a given road network for wood extraction

Leo Bont, ETH Zurich, CH-8092, Zürich, Switzerland, leo.bont@env.ethz.ch, *Hans Rudolf Heinimann*, *Richard Church*

Cable-based technologies are a backbone when designing forest harvesting systems for steep slopes. However, layout and placement of the cableways is challenging. To guarantee that wood harvesting costs are minimized and that the process has the least environmental impact on the remaining forest, one must carefully locate both cable towers and cableways. We developed an approach of mixed integer linear programming for planning an optimal harvesting and cableway layout. The model delivered for terrain units up to 35 ha results within a reasonable timeframe.

3 - EcoForest — A fictive problem for teaching spatially-explicit, multi-objective optimization in forestry

Jochen Breschan, Department of Environmental Sciences, ETH Zurich, CHN K73.1, Universitaetstr. 22, 8092, Zurich, Switzerland, breschan@env.ethz.ch

We present the EcoForest problem, designed to teach spatially-explicit, multi-objective optimization. A fictive parcel of open land is represented as a grid raster of 8x8 cells. 40 cells must be re-forested such that the resulting pattern produces lots of ecological niches. Forest edges and forest core area indicate ecological niches. The corresponding (multi-objective Integer Linear) optimization model identifies the optimal pattern by concurrently maximizing forest edges and forest core area. Non-Inferior Set Estimation method is applied to compute an approximate Pareto-frontier.

4 - Impact of carbon sequestration over the optimum forest rotation problem

Yavuz Gunalay, Faculty of Economics and Administrative Sciences, Bahcesehir University, Besiktas, 34353, Istanbul, Turkey, yavuz.gunalay@bahcesehir.edu.tr, *Erhun Kula*

The threat of climate change, which is also backed by the Kyoto Protocol, has given rise to the importance of the forestry sector. One of the important problems of the sector is to determine the optimum rotation age the forest. The problem is first introduced in 1849 and still keeps its challenge among economists and silviculturists. Based upon Samuelson's work the optimum felling age occurs at a time when the net marginal benefits fall below the current rate of interest. We incorporate the carbon sequestration benefits and re-calculate the optimum cutting age using a multiple rotation model.

■ MD-27

Monday, 14:30-16:00

CC-A25

Agent-based Modeling of Diffusion Processes

Stream: Decision Processes

Invited session

Chair: *Christian Stummer*, Department of Business Administration and Economics, Bielefeld University, Chair of Innovation and Technology Management, PO Box 10 01 31, 33501, Bielefeld, Germany, christian.stummer@uni-bielefeld.de

1 - The impact of customer dissatisfaction and negative word-of-mouth on the diffusion of innovations and the repurchasing behaviour: an agent based simulation

Markus Günther, Department of Business Administration and Economics, Bielefeld University, Universitaetsstr. 25, 33615, Bielefeld, Germany, markus.guenther@uni-bielefeld.de, *Jana Sonnberger*

Customer expectations towards a new product, which are composed of individual demands, product information via personal communication and marketing measures, form the basis of customer satisfaction or discontent. We introduce an agent-based model which contributes to a better understanding of discontented clients communicating negative product information and their impact on the diffusion of an innovation. Additionally, repurchasing decisions, which differ from the initial adoption, positive network effects and individual agent traits like extraversion and neuroticism are taken into account.

2 - New product diffusion and supply chain production-sales policies: a comparative study

Tina Wakolbinger, WU (Vienna University of Economics and Business), Nordbergstraße 15, Vienna, Austria, tina.wakolbinger@wu.ac.at, *Mehdi Amini*, *Michael Racer*, *Mohammad G. Nejad*

This paper analyzes the impact of alternative production—sales policies on the diffusion of a new product and the generated NPV of profit. The key features of the ABMS model are: (i) supply chain capacity is constrained; (ii) consumers' new product adoption decisions are influenced by marketing activities as well as positive and negative word-of-mouth (WOM) between consumers; (iii) interactions among consumers taking place in the context of their social network are captured at the individual level; and (iv) the new product adoption process is adaptive.

3 - De-commoditization of a convenience product: an agent-based simulation of its market diffusion

Christian Stummer, Department of Business Administration and Economics, Bielefeld University, Chair of Innovation and Technology Management, PO Box 10 01 31, 33501, Bielefeld, Germany, christian.stummer@uni-bielefeld.de, *Elmar Kiesling, Markus Günther, Rudolf Vetschera, Lea M. Wakolbinger*

The de-commoditization of a convenience product poses an interesting challenge for innovation management that has to decide on proper strategies for advertising, pricing, and roll-out of the new product. In markets in which information is largely disseminated through word-of-mouth, an agent-based simulation may provide decision-makers with forecasts of the diffusion process. In this talk we will present such an approach and illustrate its application for the case of introducing a second generation biofuel on the Austrian market.

■ MD-28

Monday, 14:30-16:00

CC-A27

Nonsmooth Optimization II

Stream: Structured Optimization and Applications
Invited session

Chair: *Dominik Dorsch*, Dept. Mathematics, RWTH Aachen University, Templergraben 55, 52056, Aachen, NRW, Germany, dorsch@mathc.rwth-aachen.de

1 - Equilibrium investments in a common value auction environment with endogenous signals

Eleftherios Couzoudis, Economics, University of Zurich, Chair for Quantitative Business Administration, Moussonstrasse 15, 8044, Zurich, Switzerland, eleftherios.couzoudis@business.uzh.ch, *Markus Bürgi*

The presented normal form game is a common value auction where each bidder gathers an independent endogenous private signal about the offered good. We allow signal precision to be scaled continuously in correspondence to the investment. In addition the seller can offer a costly signal to the public, which leads to signal combinations. Through reformulation and the use of a Newton-type method this model is solved for more than two players. Furthermore, the implications of our findings can support the financial regulation and the policy-making process.

2 - Local models in equilibrium optimization

Vladimir Shikhman, Dept. Mathematics C, RWTH Aachen University, Templergraben 55, 52056, Aachen, Germany, shikhman@mathc.rwth-aachen.de, *Hubertus Th. Jongen, Dominik Dorsch*

We study equilibrium optimization problems (EOPs) from a structural perspective, i.e. up to the smooth coordinate transformations locally at their solutions. The latter equivalence relation induces classes of EOPs. We focus on the stable classes corresponding to a dense set of data functions. We prove that these "basic classes" are unique. Their simplest representatives are called local models. For particular EOPs basic classes and their local models are elaborated. The latter include bilevel optimization, general semi-infinite programming and Nash optimization.

3 - On the structure of Nash equilibrium sets

Dominik Dorsch, Dept. Mathematics, RWTH Aachen University, Templergraben 55, 52056, Aachen, NRW, Germany, dorsch@mathc.rwth-aachen.de, *Hubertus Th. Jongen, Vladimir Shikhman*

A Nash equilibrium problem (NEP) consists of simultaneous optimization of N players' objective functions under constraints. In a GNEP also each players' constraint functions might depend on the opposing players' choices. The number of these common constraints becomes crucial for a qualitative analysis of the solution sets: for GNEPs without common constraints and for classical NEPs we show that generically all Nash equilibria are jointly nondegenerate KKT points. Effects like kinks, boundary points, and nonclosedness might occur. Analytical results are given in detail.

4 - Existence of a pure strategy equilibrium in finite symmetric games where payoff functions are integrally concave

Takahiro Watanabe, Graduate School of Social Sciences, Tokyo Metropolitan University, Minamiosawa 1-1, Hachioji_city, 1920397, Tokyo, Japan, contact_nabe08@nabenavi.net, *Takuya Iimura*

In this paper we show that a finite symmetric game has a pure strategy equilibrium if the payoff functions of players are integrally concave (the negative of the integrally convex functions due to Favati and Tardella, 1990). Since the payoff functions of any two-strategy game are integrally concave, this generalizes the result of Cheng et al. (2004). A simple algorithm to find an equilibrium is also provided.

■ MD-29

Monday, 14:30-16:00

CC-A29

Selected Topics on Mixed-Integer Non-Linear Programming

Stream: Mixed-Integer Non-Linear Programming
Invited session

Chair: *Dennis Michaels*, Institute for Operations Research, ETH Zurich, Raemistrasse 101, 8092, Zuerich, Switzerland, dennis.michaels@ifor.math.ethz.ch

1 - Minimizing convex functions over integer points

Michel Baes, IFOR, ETH, HG.G.22.1, Ramistrasse 101,, 8092, Zurich, Switzerland, michel.baes@ifor.math.ethz.ch, *Alberto Del Pia, Yurii Nesterov, Shmuel Onn, Robert Weismantel*

We consider the problem of minimizing a smooth and strongly convex function over integer points in a polytope. We assume to have a black-box procedure that solves some special quadratic integer problems with a constant approximation factor. Despite the generality of our problem, we prove that we can find efficiently, with respect to some assumptions on the encoding of the problem, a feasible solution with an objective value close to the optimum. We describe a few situations where we can implement the needed black-box procedure efficiently.

2 - Solving MINLPs with SCIP

Stefan Vigerske, Mathematics, Humboldt University Berlin, Unter den Linden 6, 10099, Berlin, Germany, stefan@math.hu-berlin.de

We discuss recent extensions of the constraint integer programming framework SCIP for solving mixed-integer nonlinear programs. Non-linear constraints (convex or nonconvex) are handled within an LP-based branch-and-cut algorithm by reformulation, linear relaxation, and domain propagation. In an extensive computational study, we compare the performance of our implementation with state-of-the-art solvers for MINLP and analyze the impact of various solver components on the overall performance.

3 - RedNLP - Heuristic Approach to Large-Scale MINLPs in Gas Transportation

Ralf Gollmer, Mathematics, University of Duisburg-Essen, Forsthausweg 2, D- 47057, Duisburg, NRW, Germany, gollmer@math.uni-duisburg.de, *Rüdiger Schultz, Claudia Stangl*

Detecting feasibility of transportation orders (nominations) in gas networks is a problem of growing practical interest due to the unbundling of gas trading and network operating companies. Under planning aspects transport is viewed in steady state and can be modeled by large-scale non-convex MINLPs. This poses challenging mathematical questions. The talk addresses some structural properties of the constraints modeling the sets of admissible points and sketches a heuristic approach for the solution of the problem.

4 - Convex underestimation of edge-concave functions by a simultaneous convexification with multi-linear monomials

Dennis Michaels, Institute for Operations Research, ETH Zuerich, Raemistrasse 101, 8092, Zuerich, Switzerland, dennis.michaels@ifor.math.ethz.ch, *Martin Ballerstein*

We address the construction of tight convex underestimators for an edge-concave function over a box. In contrast to common relaxation methods we derive the underestimators by a simultaneous convexification of one edge-concave function together with the set of all multi-linear monomials. We show that the tightest underestimators are polyhedral and give a complete facet-description. A computational case study demonstrates the usefulness of the proposed relaxation technique in global optimization.

■ MD-30

Monday, 14:30-16:00

CC-A31

Emerging Applications in Logistics

Stream: Emerging Applications in Finance and Logistics

Invited session

Chair: *Paul Trodden*, School of Mathematics, University of Edinburgh, United Kingdom, paul.trodden@ed.ac.uk

1 - An MINLP approach to forming secure islands in electricity networks

Paul Trodden, School of Mathematics, University of Edinburgh, United Kingdom, paul.trodden@ed.ac.uk, *Waqwas Ahmed Bukhsh*, *Andreas Grothey*, *Ken McKinnon*

Intentional islanding is attracting an increasing amount of attention as a means of preventing large-scale blackouts in electricity transmission networks. In this talk, a mathematical formulation for islanding is presented, in which suspected unhealthy components of the network are isolated while the load shed is minimized. To achieve balanced, feasible islands, nonlinear AC power flow equations should be included, resulting in an MINLP. In the proposed MILP formulation, these terms are approximated by piecewise linear functions. The approach is demonstrated by results on test networks.

2 - Multiperiod Optimal Power Flow Using Cross Decomposition

Antonio Marmolejo, DAIC, INFOTEC, COPILCO 300, COYOACAN, 04350, CIUDAD DE MEXICO, DISTRITO FEDERAL, Mexico, marmolejo.antonio@hotmail.com

This work addresses Multiperiod Optimal Power Flow. The mathematical model is a Mixed Integer Non Linear Problem with binary variables. We use Generalized Cross Decomposition to exploit the problem structure and reduce the computational time. Original problem is divided into a primal subproblem (Non Linear Problem), a dual subproblem (Mixed Integer Non Linear Problem) and a Master Problem (Mixed Integer Problem). The approach is compared with Lagrangean Relaxation and Generalized Benders Decomposition. We present numerical results which show Cross Decomposition performance.

3 - Optimum Renewable Energy Portfolio for Regional Heating

Secil Ercan, Industrial Engineering, Istanbul Technical University, Turkey, ercansec@itu.edu.tr, *Zeynep Bektaş*, *Gulgun Kayakutlu*

This study analyses the renewable energy resources for constructing an energy portfolio that would best respond to the regional demand and conditions. Heating of an organized site of manufacturing SMEs (small and medium enterprises) is targeted. Because of the continuous and non-deterministic structure of the renewable energy sources, nonlinear programming (NLP) is used in optimization. The proposed model aims to maximize the energy capacity of renewable energy replacing the current fossil energy resources. The achievements will be guiding the policy makers in reducing energy dependence.

4 - Strategic Capacity Planning in Knowledge Intensive Organizations

Manuel Mateo, Departament Business Administration, Universitat Politècnica Catalunya, Avda Diagonal, 647, 7th, E-08028, Barcelona, Spain, manel.mateo@upc.edu, *Ernest Benedito*, *Rocio de la Torre*, *Amaia Lusa*, *Carne Martinez*, *Marta Mas*

Strategic capacity planning is a key decision in knowledge intensive organizations (KIOs). It is basically related to determining the size and composition of the workforce in the long term, which means taking decisions on hiring, firing, promotion, transfers and training of skilled people, considered as the main limiting factor. To the best of our knowledge, there are no formalized procedures to deal with strategic capacity planning in KIOs. The present study aims to define the problem, identify the most relevant characteristics and propose a classification scheme in order to later develop specific solving methodology and procedures.

■ MD-32

Monday, 14:30-16:00

CC-A34

Theoretical developments in Soft OR

Stream: Soft OR and Problem Structuring Methods

Invited session

Chair: *Jose-Rodrigo Cordoba-Pachon*, School of Management, Royal Holloway, University of London, Egham Hill, Egham, Surrey, United Kingdom, j.r.cordoba-pachon@rhul.ac.uk

1 - Comparing and Contrasting the formal modelling techniques from Soft Systems Methodology and JOURNEY Making

Giles Hindle, Management Systems, Hull University Business School, University of Hull, Cottingham Road, HU6 7RX, Hull, United Kingdom, giles.hindle@hull.ac.uk

Soft OR contains a family of approaches that support groups in a range of tasks including tackling complex problem situations and making strategy. Two popular approaches are Soft Systems Methodology (SSM) and JOURNEY Making. Both approaches use formal modelling techniques — purposeful activity system modelling in SSM and cognitive mapping in JOURNEY Making. This paper compares and contrasts these two modelling techniques. The techniques are found to have fundamentally different theoretical make-ups, whilst synchronously allowing overlapping modelling strategies in practice.

2 - Decision Structures in Project Management

Cathal Brugha, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

We use meta-theory to show how Project Management structures derive from four General Decision Activities: Proposition, Perception, Pull and Push. Project Development is shown to be made up of three Committing Phases: Analysis, Design and Implementation, each of which has three Convincing Others Stages: Self/Technical, Others/Contextual, World/Situational. These form nine stages, each of which is focused on one of Four Decision Drivers: Committing Self, Convincing Others, Adjusting Others and Adjusting Self.

3 - Critical awareness of worldviews in organisational change

Mike Yearworth, Systems Centre, University of Bristol, Queens Building, University Walk, BS8 1TR, Bristol, United Kingdom, mike.yearworth@bristol.ac.uk, *Charlotte Dunford*, *Darren York*, *Patrick Godfrey*

Systems Practice is the application of a particular way of perceiving and making sense of the world in order to aid understanding. We are concerned with the problem of organisational change that exists when attempting to improve the use of Systems Practice in response to meeting complex design challenges. However, relying on mandate is not sufficient. We reflect on how change needs to originate from practitioners that gain a critical awareness of their own worldview and achieve a crucial shift towards an appreciation of the different epistemological traditions underpinning Systems Practice.

■ MD-33

Monday, 14:30-16:00
CC-A37

OR for Energy and Resource Development in Developing Countries

Stream: OR for Development and Developing Countries

Invited session

Chair: *Javier Cano*, Rey Juan Carlos University, Spain, javier.cano@urjc.es
Chair: *Angel Udias*, Rey Juan Carlos University, Spain, angelluis.udias@urjc.es

1 - Expanding the Hydroelectric Power Capacity of the Kwanza River

Javier Cano, Rey Juan Carlos University, Spain, javier.cano@urjc.es, *Kiombo Jean Marie*, *David Rios-Insua*

The increasing demand and prices of crude oil and its derivatives are forcing authorities to use more efficiently the current sources of energy, and to invest in alternative sources and new infrastructures. We have analyzed the situation in Angola, proposing a strategic (and financially viable) planning for the expansion of the hydroelectric power capacity of the Kwanza River, in order to cope with different and realistic scenarios of future demands, avoiding the collapse of the Angolan Energy Reference System (ERS). The decision making problem includes mixed nonlinear-integer terms.

2 - Valorization of riverbanks in the urban area

Tomás Hanáček, PhD. Student, Faculty of architecture, STU, Institute of Urban Planning and Land-Use Planning, Lidická 3, 91101, Trenčín, Slovakia, hanacek.tomas@gmail.com

Degraded river waterfront areas become the subject of revitalization in many European cities. Many cities dispose of the attribute of the city on the water. How can we evaluate the potential of the area, which combines the natural with the artificial environment? Cultural benefit and historical reference of the point based on water mean added value in this mathematical equation. Analytical method SKETCH and GO searches opportunities how to optimize solutions for design urban space through multisensual perception of the environment. An important aspect of the method is its multidisciplinary applicability and possibility of comparison of each research element.

3 - Export Diversification and Resource-based Industrialization: The Case of Natural Gas

Olivier Massol, Center for Economics and Management, IFP School, 228-232 Avenue Napoléon Bonaparte, 92852, Rueil-Malmaison, France, olivier.massol@ifpen.fr

For a small economy, the ownership of natural gas resources is usually described as a blessing, but past performances reveal a curse caused by the large variability of export revenues. A modified mean-variance portfolio model is thus proposed to design a diversification strategy centered on resource-based industries. Using a time series model of commodity prices, this model is put to work, to analyze the efficient frontier, and evaluate the policies implemented in nine economies.

4 - Multicriteria Decision Aid for Equitable Water Distribution Network

Jose Luis Castaño Cabrales, Rey Juan Carlos University, 28943, Fuenlabrada, Spain, cabrales@web.de, *Angel Udias*, *David Rios-Insua*, *Javier Cano*, *Hocine Fellag*

This work describes an equitable problem, the multiobjective management (equity vs. efficiency) of water resources in the region of Kabila, in Algeria. External factors, as pumping operational schedules, strategic planning, pipes leakages, village's geographical location, and network constraints make difficult to distribute water fairly in a reliable and cost-efficient manner. We have developed a decision support system that implements different optimization algorithms (egalitarian, utilitarian, Kalai-Smorodinsky), to help water companies to take reliable and feasible decisions.

■ MD-34

Monday, 14:30-16:00
CC-A39

Assignment and multicriteria games

Stream: Cooperative Game Theory

Invited session

Chair: *Marina Nunez*, Mathematical Economics, University of Barcelona, Av Diagonal, 690, 08034, Barcelona, Spain, mnunez@ub.edu

1 - Z-Equilibrium for a Mixed Strategic Multicriteria Game

Arezki Ferhat, Laboratory of Modeling and Optimization of Systems (LAMOS), University of Bejaia, Algeria, University of Bejaia, Route de Targa-Ouzamour, 06000, Bejaia, Algeria, arezki.ferhat@gmail.com, *Mohammed Said Radjef*

In this paper, we study the Z-equilibrium for a mixed strategic multicriteria game. This concept is composed of two points: active equilibrium and the Pareto optimality of the active equilibrium. We give the existence conditions of this equilibrium which are weaker than those of the non-cooperative equilibrium for an n players normal form game. Indeed, we just need the compactness of the strategies sets and the continuity of the payoff functions to ensure the existence of the Z-equilibrium.

2 - Bilateral assignment games with the Monge property

Javier Martinez-de-Albeniz, Matematica Economica, Financera i Actuarial, Universitat de Barcelona, Av. Diagonal, 690, 08034, Barcelona, Spain, javier.martinezdealbeniz@ub.edu, *Carles Rafels*

We study bilateral assignment games where the assignment matrix satisfies the inverse Monge property. In this case, for any 2x2 submatrix the optimal matching is in its diagonal. Their cores are described by using only the central tridiagonal band of the elements of the matrix. We introduce a suitable notion of matrix monotonicity, called tridiagonal-monotonicity, and in this case we define the assortative assignment game, characterize its core in a parametric representation and give its extreme core points. We give a formula for the nucleolus and a description of the kernel.

3 - A geometric characterization of the nucleolus of the assignment game

Marina Nunez, Mathematical Economics, University of Barcelona, Av Diagonal, 690, 08034, Barcelona, Spain, mnunez@ub.edu, *Francesc Llerena*

Maschler et al. (1979) give a geometrical characterization for the intersection of the kernel and the core of a coalitional game: allocations in both sets are always the midpoint of certain bargaining range between each pair of players. In the case of the assignment game the kernel can be determined as those core allocations that satisfy a bisection property for each optimal pair. We now prove that the nucleolus of the assignment game can be characterized by requiring this bisection property be satisfied not only for optimally matched pairs but also for optimally matched coalitions.

■ MD-35

Monday, 14:30-16:00
CC-A41

DEA and Performance Measurement: Applications 10

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Paula Guimaraes*, Industrial Engineering, UFF, Paulo Silva Araujo number 95 apt 302, 20735230, Rio de Janeiro, Rio de Janeiro, Brazil, paulasguima@yahoo.com.br

1 - The Efficiency Measure Over Time with Undesirable Outputs: A Case of Auto and Auto Component Industry in Taiwan

Yi-Chiuai Lai, Business Administration, Providence University, 200 Chung-Chi Rd., Shalu District, 43301, Taichung, Taiwan, ylai@pu.edu.tw, *Chin-Min Hsu*

Operation performance is used to measure operation results of a decision making unit. A DEA model that measures efficiency according to undesirable outputs is proposed. Several factors are included in the model. Input items include fixed assets, current assets, R&D cost, and number of employees. The desirable output is net sales, and the undesirable output is defined as loss on inventories. Window analysis is used to discuss the efficiency change over time. Data were collected from auto and auto component industries in Taiwan. We identify various issues that affect the operation efficiency.

2 - An application of canonical correlation analysis for the econometric estimation of the stochastic production frontier

João Silveira, Applied Social Sciences, University Regional Integrated High Uruguay and Missions, URI - Santiago Campus - Brazil - RS, 97700-000, Santiago, RS, Brazil, joaotusi@hotmail.com, *Attus Moreira*

Since the stochastic frontier production model emerged in 1977, interest in econometric analysis of productive efficiency has been increasing. Yet this kind of analysis is troublesome with regards to multiple outputs. The multiple-equation approach is not well developed and the inlequequation approach is subject to special conditions that are not always fulfilled. A methodological alternative is proposed. The estimation process treats each one of the multiple outputs as a independent variable and can be estimated by canonical correlation analysis.

3 - Evaluation of the efficiency of investments in the host cities of the Olympic Games using Data Envelopment Analysis (DEA)

Paula Guimaraes, Industrial Engineering, UFF, Paulo Silva Araujo number 95 apt 302, 20735230, Rio de Janeiro, Rio de Janeiro, Brazil, paulasguima@yahoo.com.br, *Nissia Bergiante*

The main idea of the Olympic Games is to create an atmosphere of global solidarity. However, behind it there is a financial plan applied to the host cities to support generated impacts. As a result is expected an increment in the number of visitors providing a financial return from services related to tourism, in addition to the revenue generated by the games themselves. In this context, this study aims to evaluate the efficiency of the last five host cities using DEA. As input we chose the total investments and for outputs we included visitors (by plane), hotels capacity, and Games revenue.

4 - A holistic approach for assessing the performance of maternity and newborn services

Olga Li, Economics, UAAlg, Campus de Gambelas, 8005-139, Faro, Algarve, Portugal, leeolya@gmail.com, *Sérgio Santos*, *Carla Amado*

The integration of health care services as a potential solution to improve their efficiency has attracted considerable interest in recent years. This paper proposes a conceptual framework for integrated maternal and newborn services and explores the use of network data envelopment analysis to assess the performance of the holistic system proposed. By using data from several countries, an international comparison is discussed.

1 - The assessment of livability in European cities

Andreia Zanella, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-465, Porto, Portugal, andreia.zanella@fe.up.pt, *Ana Camanho*, *Teresa Galvão Dias*

In this study we address the assessment of livability in European cities. In a first stage, the cities were evaluated taking into account two components of livability: human well-being and environmental quality. The assessment is based on a Data Envelopment Analysis model specified with a Directional Distance Function. The second stage involves exploring the exogenous factors that may promote livability in an urban context. A decision tree is used to identify the main factors that characterize the cities and that may explain differences in performance.

2 - Towards sustainability in construction: a DEA assessment at an urban level

Isabel Horta, Faculdade de Engenharia, Universidade do Porto, R. Dr. Roberto Frias, 4200-465, Porto, Portugal, imhorta@fe.up.pt, *Ana Camanho*, *Teresa Galvão Dias*

The purpose of this research is to assess construction performance at a municipality level, focusing on resource consumption. The best and the worst practices are investigated using two types of DEA frontiers: the frontier of the production possibility set and an inverted frontier. In addition, the factors associated with good levels of performance are explored using truncated regression. In a second stage, the change in performance over time is analyzed applying the Malmquist index. To illustrate the methodology developed, the data related to Lisbon municipalities between 2002-2006 is used.

3 - An Application of Categorical Models of Data Envelopment Analysis

Luka Neralic, Faculty of Economics and Business, University of Zagreb, J. F. Kennedy 6, Stefaniceva 7, 10000, Zagreb, Croatia, lneralic@efzg.hr, *Dubravko Hunjet*, *Richard E. Wendell*

This paper studies the efficiency of 127 selected towns in the Republic of Croatia using categorical models of Data Envelopment Analysis (DEA). The towns, represented as Decision Making Units (DMUs), are characterized into four categories according to their respective populations. Using the number of employed workers and employed assets as inputs and income as an output, we consider a categorical input-oriented (output-oriented) model with constant (variable) returns-to-scale. The paper presents and analyses computational results on efficiency of the towns.

4 - Benchmarking in maintenance and repairing in electricity distribution networks using an additive DEA model with incorporation of preferences

Maria Gouveia, IPC/INESCC, Quinta Agricola - Bencanta, 3040-316, Coimbra, Portugal, mgouveia@iscac.pt, *Luis C. Dias*, *Carlos Henggeler Antunes*

Benchmarking studies provide a rational for quantifying the differences in performance, grasping the reasons for these differences, comparing with excellence targets, and developing ways the organization should follow to achieve them. This work uses a two-phase method based on the weighted additive model that explores links between DEA and Multi-Criteria Decision Analysis incorporating managerial preferences to perform a benchmark study of network areas of an electricity distribution company concerning maintenance and interruption repairing.

■ MD-36

Monday, 14:30-16:00

CC-A43

DEA and Performance Measurement: Applications 2

Stream: DEA and Performance Measurement
Invited session

Chair: *Luis C. Dias*, Faculdade de Economia / INESC Coimbra, INESC Coimbra, Rua Antero de Quental, 199, 3000-033, Coimbra, Portugal, lmcaldas@fe.uc.pt

■ MD-37

Monday, 14:30-16:00

CC-Act

Bioinformatics IV

Stream: Computational Biology, Bioinformatics and Medicine

Invited session

Chair: *Piotr Lukasiak*, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, Piotr.Lukasiak@cs.put.poznan.pl

1 - Protein structure quality assessment and modeling support framework

Maciej Antczak, Institute of Computing Science, Poznan University of Technology, Pl. Marii Skłodowskiej-Curie 5, 60-965, Poznan, Wielkopolska, Poland, mantczak@cs.put.poznan.pl, *Piotr Lukasiak*, *Jacek Blazewicz*, *Krzysztof Fidelis*

Protein structure prediction using computational tools is great interest of humanity. Moreover, reliable computational methods designed to evaluate protein models quality is relevant in the context of protein structure refinement as currently available computational models outnumber experimentally derived. The proposed method allows to identify and visualize possible stereochemical, folding, packing inconsistencies of protein structure. It is also particularly suited to assess applicability of the target sequence to structural template alignments, a major source of comparative modeling errors.

2 - OR applications for protein structure modelling and docking

Maciej Milostan, Poznan University of Technology, Pl. M. Skłodowskiej-Curie 5, 60-965, Poznan, Poland, maciej.milostan@cs.put.poznan.pl

We show a pathway paved by a number of computational extensive analysis that lead us through a forest of genomic and structural data towards successful models of DCL proteins from Arabidopsis Thaliana and their interactions with RNA. The applied protocol include database searches, to find potential homologous sequences, followed by multiple sequence alignments generation, identification of conserved regions, identification of structural templates in PDB, secondary structure prediction, MD simulations, protein-RNA docking and evaluation of structures. We put emphasis on OR techniques.

3 - Quality assessment methodologies in analysis of structural models

Piotr Lukasiak, Institute of Computing Science, Poznan University of Technology, ul.Piotrowo 2, 60-965, Poznan, Poland, Piotr.Lukasiak@cs.put.poznan.pl

Proteins and RNA are the most important molecules in all living organisms. In the crowded space of 3D structural models, the development and improvement of reliable computational methods designed to evaluate the quality of protein and RNA models is relevant in the context of tertiary structure refinement. The correct identification of good models and recognition of good methodologies against misleading ones generate higher level of confidence in results obtained by different methodologies. This aspect can influence the quality and usefulness of 3D structure prediction in the nearest future.

4 - Rule extraction for pre-eclampsia based on Genetic Algorithm

Shohreh Alimohammadi, Perinatology, Medical faculty of Hamedan, Hamedan, Hamedan, Iran, Islamic Republic Of, dr_alimohamadi@yahoo.com, *Amene Alimohammadi*, *Mahdi Ashrafi*

In this article data about pregnant women with pre — eclampsia and mothers without pre-eclampsia were studied in order to determine the rules of the disease with the help of Genetic Algorithms and to obtain understandable 1 knowledge on the disease areas. Information about the disease, including 543 cases was divided in three categories: healthy, low risk and high risk group. After pre-processing, Genetic Algorithms have been used for rule extraction of pre-eclampsia. The three rules with the help of Genetic Algorithms (for each disease class, a rule) for pre-eclampsia have been extracted.

■ MD-38

Monday, 14:30-16:00
HH-Colombus

Combinatorial Multiobjective Optimization

Stream: Multiobjective Optimization
Invited session

Chair: *Martin Josef Geiger*, Logistics Management Department, Helmut-Schmidt-University, Holstenhofweg 85, 22041, Hamburg, Germany, m.j.geiger@hsu-hh.de

1 - Pareto Set Approximation for the Multiobjective Set Covering Problem

Margaret Wieczek, Department of Mathematical Sciences, Clemson University, Martin Hall O-208, 29634, Clemson, SC, United States, wmalgor@clemson.edu

The Pareto set of the multiobjective set covering problem is approximated within a specified accuracy. Two methods are proposed: one based on the weighted-sum scalarization and the other based on the max-ordering. The algorithms approximate all (weakly) Pareto solutions with the accuracy resulting from the problem size and data. Computational results are included.

2 - Multiobjective combinatorial optimization for selecting treatment regimes in forestry

Dmitry Podkopaev, Dept. of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014, University of Jyväskylä, Finland, dmitry.podkopaev@jyu.fi, *Artti Juutinen*, *Kaisa Miettinen*, *Mikko Monkkonen*, *Pasi Reunanen*, *Olli-Pekka Tikkanen*

We consider an approach to managing large forest landscapes by selecting for each small forest stand an individual treatment regime, i.e., a set of management rules depending on forest's current characteristics. The impact of treatment on the forest is determined through simulation. We consider both economic and nature preservation aspects and formulate the problem of selecting treatment regimes as a combinatorial multiobjective optimization problem with linear and quadratic objectives. We present experiences of solving a computationally challenging real-life problem with 30K forest stands.

3 - A bi-objective approach to reschedule new jobs in a one machine model

Jacques Teghem, Mathro, Faculté Polytechnique/UMonss, 9, rue de Houdain, Rue de Houdain 9, 7000, Mons, Belgium, jacques.teghem@umons.ac.be, *Daniel Tuytens*

We consider a one machine scheduling model with a classical objective - either total completion time or maximal tardiness - and two sets of jobs: one with initial jobs already scheduled and one with new jobs which must be inserted in the schedule. As this reschedule can create a disruption, a second disruption objective is considered, which can be formulated in four different manners. In this paper the aim is to obtain the set of efficient schedules in regard of the two objectives. Algorithms are provided for the eight possible bi-objective problems.

4 - Immune Algorithm for Multi-Objective Schedule Optimization in Railway Transport

Anatoly Levchenkov, Riga Technical University, 1658, Riga, Latvia, anatolijs.levcenkovs@rtu.lv, *Ivars Alps*, *Mikhail Gorobetz*

This paper presents dual population immune algorithm for multi-objective optimization of railway transport schedule. The target is to minimize the risk of collisions between railway and auto transport to reduce the human factor and prevent accidents and to minimize idle time for road transport on level-crossing by increasing its capacity. Mathematical model and target function to prevent collisions and crashes in railway transport is presented. Immune algorithm is proposed for optimization problem solution. Algorithm is tested using computer model of the transport system.

■ MD-39

Monday, 14:30-16:00
HH-Cousteau

MADM Applications IV

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration, Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District, 11111, Taipei, Taiwan, ctlin@mail.mcu.edu.tw

Chair: *Chie-bein Chen*, International Business, National Dong Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien, Taiwan, cbchen@mail.ndhu.edu.tw

1 - The study of the university students consumer behavior tea-shops as example

Yuan-Du Hsiao, Department of Business Administration, Chungyu Institute of Technology, No.40, Yi7th Rd., Keelung, 20103 Taiwan, R.O.C., 20103, Keelung, Taiwan, R.O.C., Taiwan, yuduhsia@cit.edu.tw, Jen-Chia Chang, Mu-Hui Lai, Liang-Yuan Hsiung

This study main purpose are 1. To discuss the subjects who get drinks from consumer behavior. 2. Testing the difference from the consumer of tea-shops. The study finding 1. More than half consumer is choosing the shop criterion "important" of the project. 2. Consumer general does not costs at fixed shop. 3. The ones often go shopping at the noon. 4. Almost ones always go to "Dou Di Tea-shops". From findings, the suggestions for the tea-shop boss or studies experts reference related.

2 - The Study on Teachers' Willingness to Adopt Computer-Aided Instruction in Public Vocational High Schools

Jen-Chia Chang, Institute of Technology & Vocational Education, National Taipei University of Technology, 10608, Taipei, Taiwan, jc5839@ntut.edu.tw, Yuan-Du Hsiao, Mu-Hui Lai, Liang-Yuan Hsiung

The study with 126 sampled subject in mid-Taiwan. The reliability and validity of the questionnaire have been rendered positive, upon verification. The mean value of teachers' willingness to adopt CAI is 3.97, ranged as moderate. Teachers are generally dissatisfied with the CAI software, hardware facilities support and promote CAI in school; however, these three factors have no significant connection with teachers' willingness to apply CAI. The researcher is to offer various suggestions, based on this study, to schools and the education administrative departments.

3 - A study on relationship model among travel motivation, travel type, travel involvement, and travel benefit of Facebook users: A case of Taiwan domestic tourism

Pei-Ting Chen, Travel Management, National Kaohsiung University of Hospitality and Tourism, 81267, Kaohsiung, Taiwan, tober770831@hotmail.com, Tang-Chung Kan, Kuo Tzu-hsuan

This study aims to discuss the relation among travel motivation, travel involvement, and tourism benefit of Facebook users. It also uses travel type as the intervening variable to further explore its influence in relation to travel pattern, travel involvement and tourism benefit. We expect this research result will help understand Facebook users to understand characteristics of Taiwan domestic tourism. This study is expected to build an appropriate social networking users' travel behavior model to develop distinctive and customized community tourism products.

4 - Multi-Criteria Comparison of Catering Service Companies Using Grey Relational Analysis: The Case of Turkey

Alper Hamzadayi, Dokuz Eylul University, Turkey, alper.hamzadayi@deu.edu.tr, Simge Yelkenci Kose, Sener Akpinar, Atabak Elmi, Hanifi Okan Isguder

Catering is the business of providing food and beverage at a remote site or a site like business meetings and other social occasions. Selecting catering is an important multi-criteria decision making problem. In this study grey relational analysis (GRA) is used for the aim of selecting the best catering firm providing the most firm satisfaction. Due to the importance of criteria weights in decision making, Analytic Hierarchy Process is used to find best values of criteria weights in GRA process. A case study is demonstrated and evaluated using the developed multi-criteria methodology.

■ MD-40

Monday, 14:30-16:00

HH-Livingstone

MADM Applications VIII

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Chin-Tsai Lin*, Department of Business Administration, Ming Chuan University, 5F, No.130, Jihe Rd., Shihlin District, 11111, Taipei, Taiwan, cotlin@mail.mcu.edu.tw

Chair: *Chie-bein Chen*, International Business, National Dong Hwa University, 1, Sec. 2, Da-hsueh Rd. Shou-feng, 974, Hualien, Taiwan, cbchen@mail.ndhu.edu.tw

1 - A Radial Basis Function Neural Network (RBFNN) Approach for Multi-label Text Categorization Problems

Tai-Yue Wang, Dept. of Industrial and Information Management, National Cheng Kung University, 1 University Road., 70101, Tainan, Taiwan, tywang@mail.ncku.edu.tw, Hui-Min Chaing

This work presents an automatic text categorization model based on the RBFNN and utilizes valuable discriminative information in the training dataset and incorporates background knowledge during model learning. The Reuters 21,578 News dataset is utilized to demonstrate the application of the proposed model and to compare its performance with that of other models. The results vindicate that the performance of the proposed model is comparable to that of other models for different performance indices.

2 - Fuzzy MCDM technique for planning the wetland environment

Vivien Y.C. Chen, Institute of Leisure and Health Business, Taipei Chengshih University of Science and Technology, No. 2, Xueyuan Rd., Peitou, 112, Taipei, Taiwan, chen.vivien@gmail.com, Kuo Tzu-hsuan, Tang-Chung Kan

This paper presents a fuzzy multi-criteria analysis approach for selecting the best plan alternatives in wetland environment. A questionnaire was used to find out from three related groups comprising 15 experts. The subjectivity and vagueness is dealt with the criteria and alternatives for selection process by using fuzzy numbers with linguistic terms. Incorporated the decision makers' attitude towards preference, overall performance value of each alternative can be obtained based on the concept of Fuzzy Multiple Criteria Decision Making.

3 - Improving the quality of leisure and tourism for Theme Parks with a MCDM Model

Gwo-Hshiung Tzeng, College of Management, Hsinchu 300, National Chiao Tung University, Kainan University, Taoyuan 338, Taiwan, ghtzeng@cc.nctu.edu.tw, Vivien Y.C. Chen

The purpose of this paper is to probe how to use qualitative and quantitative measurements of Theme Parks to create plan indexes and criteria, as well as how to help these indexes achieve the optimal levels for each criterion. Previous efforts to measure leisure and tourism evaluations and plans have assumed that the criteria are independent, but this assumption does not hold in real-world applications. In this study, a hybrid multiple criteria decision-making model is used to address dependent relationships among various criteria.

4 - Using F-PROMETHEE for evaluating and ranking constructive projects contractors (A Case Study of Mehr Housing Project of Hashtgerd New City - Iran)

Mahdi Nasrollahi, no.82 dekhoda Ave. masjed St., 36161, hashtgerd new town, tehran, mahdi1484@yahoo.com

In this paper a model for evaluating and ranking constructive projects will be presented. This model is based on six key criteria (good history, Equipment, Management & technical staff, Economic - Financial, experience, and technical capabilities) and a conceptual framework. These criteria and their weights were derived from previous studies. The vagueness of the linguistic terms in the evaluation process required employment of fuzzy numbers. F-PROMETHEE was used for the ranking projects. To test the model and as a case study, contractors of housing projects in Iran were ranked.

■ MD-41

Monday, 14:30-16:00

HH-Heyerdahl

AHP/ANP 3

Stream: Analytic Hierarchy Process, Analytic Network Process

Invited session

Chair: *William Wedley*, Faculty of Business Administration, Simon Fraser University, 8888 University Drive, V5A 1S6, Burnaby, BC, Canada, wedley@sfu.ca

1 - Correct Derivation Of Ratio Scale Preference Values From Pairwise Comparison Matrices

Eng Choo, Faculty of Business Administration, Simon Fraser University, 8888 University Drive, V5A 1S6, Burnaby, BC, Canada, choo@sfu.ca, *William Wedley*

We consider the problem of deriving ratio scale preference values of n alternatives from pairwise comparison matrix elicited from the decision maker. We characterize the underlying ratio-relevant information. This leads to a necessary condition for using the ratio-relevant information in T correctly. The multiplicative form is shown to be the only simple row by row method that uses the ratio-relevant information in T correctly. The geometric mean method is the only well-known method that satisfies the necessary condition for using the ratio-relevant information in T correctly.

2 - Using Analytic Network Process (ANP) in Four Links Model

Ihsan Yüksel, Business Administration, Kirikkale University, Kirikkale University, IIBF, 71450, Kirikkale, Turkey, yuksel@kku.edu.tr, *Erdem Aksakal*, *Metin Dagdeviren*

The aim of this study is to evaluate the strategic environment of an organization within the framework of Lynch's Four Links analysis by using Analytic Network Process (ANP). In the study, firstly factors which have an impact on the organization performance were determined and then inner dependencies between models and factors were examined. The weights of factors were determined on the basis of these examined dependencies and weights were used for a case study to evaluate the strategic environment. As result it was seen that analyzing the strategic environment can be performed by ANP.

3 - A hybrid MCDM approach to assess the sustainability of students' preferences for university selection

Kabak Mehmet, Department of Industrial Engineering, Turkish Army Academy, Kara Harp Okulu Dekanlığı, End. ve Sis.Müh.Böl., 06654, Ankara, Turkey, mkabak@kho.edu.tr, *Metin Dagdeviren*

An integrated approach which employs ANP and PROMETHEE together is proposed. It is concerned with criteria influencing student choice in Turkey to establish a model for predicting students' preference for universities. The ANP is used to analyze the structure of the problem and to determine weights of the criteria, and the PROMETHEE is used to obtain final ranking, and to make a sensitivity analysis. The results indicate that three factors, future career prospects and opportunities, scholarship and university's social life, are at the top in the university selection.

4 - Ahp matrix convergence — a unit interpretation

William Wedley, Faculty of Business Administration, Simon Fraser University, 8888 University Drive, V5A 1S6, Burnaby, BC, Canada, wedley@sfu.ca, *Eng Choo*

Raising the paired comparison matrix to powers is efficient for calculating the principal eigenvector. The disadvantage is that higher order calculations are difficult to comprehend. This paper suggests a modification - to interpret convergence of cell values as the simple average of many conversion estimates. Invariance of ratios irrespective of the unit of measure is a trait of ratio scales. The eigenvector achieves this trait, as the geometric mean that is used in group aggregation and has many desirable properties, and the simple mean of unit sum columns has proved to be quite accurate.

■ MD-42

Monday, 14:30-16:00

BW-Amber

EEPA 2012 - 2

Stream: EURO Excellence in Practice Award 2012

Invited session

Chair: *Michel Bierlaire*, ENAC INTER TRANSP-OR, École Polytechnique Fédérale de Lausanne (EPFL), GC B3 454, Station 18, CH-1015, Lausanne, Switzerland, michel.bierlaire@epfl.ch

1 - SPRINT: Optimization of Staff Management for Desk Customer Relations Services

Daniele Vigo, DEIS, University of Bologna, Via Venezia 52, 47023, Cesena, Italy, daniele.vigo@unibo.it, *Claudio Caremi*, *Angelo Gordini*, *Sandro Bosso*, *Giuseppe D'Aleo*, *Beatrice Beleggia*

Staff Management (SM) is a critical issue in the design and management of modern Desk Customer Relation Services (DCRSs) due to the large amount of resources involved and the increasing pressure towards maintaining a very high level of service. We illustrate a Decision Support System for SM, called SPRINT, developed for a large multi-utility company in northern Italy. After one year of service SPRINT has introduced a considerable improvement in the process and achieved relevant savings in terms of resource consumption and very high level of service.

2 - Logistic planning using DSS FlowOpt

Mikael Rönnqvist, Département de génie mécanique, Université Laval, G1V 0A6, Québec, Canada, mikael.ronnqvist@nhh.no, *Patrik Flisberg*, *Mikael Frisk*

Skogforsk is the central research body for the Swedish forestry sector. Skogforsk has developed the decision support system FlowOpt. A central part is a powerful optimization engine which has been a key contribution to the success of the system. It makes use of a flexible network model with extensions including backhauling and cost sharing possibilities. The system has been used in many case studies and implementations during the last 10 years. It has been used to evaluate the performance and suggest improvements at single companies as well as several companies making collaborative schemes.

3 - Flood Prevention by Optimal Dike Heightening

Kees Roos, EWI, TU Delft, Mekelweg 4, 2628CD, Delft, ZH, Netherlands, c.roos@tudelft.nl, *Dick den Hertog*, *Ruud Brekelmans*, *Carel Eijgenraam*

The Dutch government is very much aware of the flooding risks that The Netherlands is exposed to. This research tries to answer the fundamental questions of when and how much to invest in which parts of the constituent segments of a dike ring protecting a certain area of land. This problem is solved by using Mixed-Integer Nonlinear Programming techniques. For homogeneous dike-rings explicit formulas for periodic solutions have been obtained. Dutch government agencies use the model to analyze the main dike rings and to propose new safety standards to be incorporated in the Dutch Water Act.

■ MD-43

Monday, 14:30-16:00

BW-Granite

Probabilistic Programming

Stream: Stochastic Programming

Invited session

Chair: *Tamas Szantai*, Institute of Mathematics, Budapest University of Technology and Economics, Muegyetem rkp. 3., 1111, Budapest, Hungary, szantai@math.bme.hu
Chair: *Andras Prekopa*, RUTCOR, Rutgers University, 640 Barholomew Road, 08854-8003, Piscataway, New Jersey, United States, prekopa@rutcor.rutgers.edu

1 - A probabilistic constrained stochastic programming problem, where the technology coefficients in the stochastic constraints are normally distributed random variables

Andras Prekopa, RUTCOR, Rutgers University, 640 Bartholomew Road, 08854-8003, Piscataway, New Jersey, United States, prekopa@rutcor.rutgers.edu, Tamas Szantai

A hybrid algorithm will be presented for the solution, where the (outer) supporting hyperplane algorithm is combined with a (inner) cutting plane method. We report about the numerical experience in connection with the solution method presented. Special emphasis will be put on the calculation of the function and gradient values.

2 - Solution of probabilistic constrained stochastic programming problems with discrete random variables and mixed decision variables

Kunikazu Yoda, RUTCOR, Rutgers Center for Operations Research, Rutgers University, 640 Bartholomew Rd, 08854-8003, Piscataway, NJ, United States, kyoda@rutcor.rutgers.edu, Andras Prekopa

We consider the probabilistic constrained stochastic programming problem where the decision variables are integers and the random right-hand side vector follows an r -concave discrete distribution. Useful formulations of related problems are presented with the concept of p -efficient points of a probability distribution. We present a cutting plane type algorithmic solution to the problem.

3 - Single commodity network design under probabilistic constraint with continuous random variables

Olga Myndyuk, Rutcor, Rutgers Center for Operations Research, Rutgers, The State University of New Jersey, 640 Bartholomew Rd, 08854, Piscataway, NJ, United States, olgamyn@eden.rutgers.edu, Andras Prekopa

We formulate and solve problems to find optimal node and arc capacities in a network, where demands are random, under probabilistic constraints that ensures reliability on a high level. After elimination of the redundant feasibility inequalities the problem is reduced to an LP that is solved by the combination of an inner and outer algorithm providing us with both lower and upper bounds for the optimum in each iteration. The possible applications include power systems, water supply, traffic, evacuation networks.

4 - Parallelisation of the so-called Cluster Benders Decomposition algorithm for solving two-stage stochastic linear problems

Francesc Solsona, Computer Science, University of Lleida, Jaume II, 69, 25001, Lleida, Catalunya, Spain, francesc@diei.udl.cat, LluisM Pla, Josep Lluís Lerida, Jordi Mateo

L-shaped is a decomposition method used to solve stochastic linear problems via scenario analysis. This algorithm is made up of three steps: the first solves the master problem, the second checks for feasible cuts and the third checks for optimality cuts. These cuts are sequentially added to the master problem to be solved whenever each new cut is appended. When there is no more cuts, the optimal solution is found. The cuts are identified by solving auxiliary submodels derived from the scenarios. In this paper we propose the parallelisation of the algorithm named Cluster Benders Decomposition

■ MD-44

Monday, 14:30-16:00
BW-Marble

Topics in Revenue Management

Stream: Revenue Management
Invited session

Chair: Fredrik Odegaard, Richard Ivey School of Business, University of Western Ontario, 1151 Richmond Street North, N6A 3K7, London, Ontario, Canada, fodegaard@ivey.uwo.ca

1 - Illustrating the need to integrate pricing and supply chain decision-making

Peter Bell, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

This presentation will use three cases that describe real company situations to illustrate the role of pricing in supply chain management. I will try to make the point that good pricing decisions make managing a supply chain much easier: often supply chain issues (such as bottlenecks, too much or too little inventory or capacity) can be resolved through more informed pricing.

2 - Optimal pricing and production decision in the presence of substitution

Sang Won Kim, College of Business Administration, University of Ulsan, 93 Univ. Road, Mugeo-Dong, Nam-Gu, 680-749, Ulsan, Korea, Republic Of, studyksw@yahoo.co.kr, Peter Bell

Many firms take into account the fact that the creation of price differences between market segments leads to price-driven substitution. This effect will impact the firms' price and production decisions. In this paper, we consider the impact of price-driven substitution on a firm's pricing and production decisions for a single period. We investigate the impact of the symmetrical and asymmetrical demand substitution on optimal prices, production levels and revenue.

3 - New results concerning probability distributions with increasing generalized failure rates

Mihai Banciu, School of Management, Bucknell University, 119 Taylor Hall, 17837, Lewisburg, PA, United States, mmb018@bucknell.edu, Prakash Mirchandani

The generalized failure rate is defined as the extension of the hazard rate of a continuous random variable. If the valuation distribution of a product has an increasing generalized failure rate (IGFR), then the associated revenue function is unimodal. Assuming the IGFR property is thus very useful in pricing applications. In this talk we prove closure of the property under truncations, propose an extension of the original definition of the property, provide a sufficient condition that guarantees closure of the IGFR property under convolution, and extend the concept to discrete distributions.

4 - Retail Selling with All-Pay Auctions

Fredrik Odegaard, Richard Ivey School of Business, University of Western Ontario, 1151 Richmond Street North, N6A 3K7, London, Ontario, Canada, fodegaard@ivey.uwo.ca, Chris Anderson

In the fixed list price channel consumers can purchase the item at p_1 . In the all-pay auction consumers place a bid b , which they forfeit regardless of the outcome, and the highest bid wins the item. We consider a modification where consumers can use their sunk bid as a credit and buy the item directly for p_2 . We characterize a symmetric equilibrium in the strategy and derive optimal prices p_1 and p_2 . We consider both the situation when there is only one seller operating both channels, and when there are two sellers operating the two channels.

■ MD-45

Monday, 14:30-16:00
BW-Water

Management accounting and management control 2

Stream: Simulation in Management Accounting and Management Control
Invited session

Chair: Stephan Leitner, Dept. for Controlling and Strategic Management, Alpen-Adria-Universität Klagenfurt, Universitätsstrasse 65-67, 9020, Klagenfurt, Austria, stephan.leitner@uni-klu.ac.at

1 - Dynamic pricing & seat control problem with cancellation and refund policy in airlines

Moon-Gil Yoon, Business Administration, Korea Aerospace University, 200-1 hwajun-dong, 471-712, Koyang-shi, Kyunggi-do, Korea, Republic Of, mgyoon@kau.ac.kr, *Hwi Young Lee*

Changing customer behavior and airline market environments in airline industries require a new mechanism for improving the revenue management. We consider a dynamic pricing and seat control problem for discrete time horizon with cancellation and refund policy in the context of the airline industry. Applying the linear approximation technique and given the price set for each time, we suggest a mixed Integer Programming model to solve our problem efficiently. From the simulation results, we can find our model makes good performance and can be expanded to other comprehensive problems.

2 - Product cost distortions in full cost accounting - A Monte Carlo simulation-based analysis

Catherine Grisar, Institute of Management Control and Accounting, Hamburg University of Technology, Schwarzenbergstraße 95 D, 20173, Hamburg, Germany, catherine.grisar@tu-harburg.de, *Matthias Meyer*

This paper presents a systematic approach to quantify the effect of alternative costing system designs on product costs. Starting with a stochastic full cost accounting system, we identify design parameters and their possible specifications that are within the scope of cost accountants. The impact of these parameters on product costs is investigated via simulation. Through experimental design, we can determine the main and interaction effect of each design parameter. This paper contributes to research and practice as it illustrates the interdependencies within a full cost accounting system.

3 - Interactions among biases in costing systems: A simulation approach

Stephan Leitner, Dept. for Controlling and Strategic Management, Alpen-Adria-Universität Klagenfurt, Universitätsstrasse 65-67, 9020, Klagenfurt, Austria, stephan.leitner@uni-klu.ac.at

This simulation study presents results on effects of distortions in raw accounting data on the quality of information provided by costing systems. Results give insights into interactions among biases and indicate that multiple biases do not necessarily affect information quality negatively. Surprisingly, in some setups interactions among multiple biases lead to mitigation, or even compensation among biases. Results indicate where (not) to tolerate biases and how to prioritize actions regarding data quality with respect to accuracy and cost of accuracy.

Monday, 16:30-17:30

■ ME-01

Monday, 16:30-17:30

Opera

Plenary Lecture: Professor Finn Kydland

Stream: Keynote, Tutorial and Plenary Lectures
Plenary session

Chair: *Marielle Christiansen*, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 3, N-7491, Trondheim, Norway, marielle.christiansen@iot.ntnu.no

1 - Dynamic Programming and Economics

Finn Kydland, University of California, Santa Barbara, United States, kydland@econ.ucsb.edu

All interesting phenomena in macroeconomics are dynamic in nature. An overstatement, perhaps, but only a slight one. As a consequence, over the past three or four decades, dynamic programming has been an essential tool, including in my own research. In quantitative aggregate economics, dynamic programming plays a key role from model formulation to model calibration to computation of model outcomes. In the process, for example, of calibrating a model economy, its steady-state relations are an essential part of what it takes to work backwards from empirical relations among variables to what the model parameters must be in order to be consistent with them. With advances in the development of theory and computers becoming much more powerful, the set of interesting questions that can be addressed with such models has expanded dramatically in the past decade or two. This is true especially for questions that dictate the inclusion of important heterogeneity across current generations and/or across individuals more generally.

In models with a role for the government, anticipated future policy affects economic behavior in earlier periods. For example, future tax policy affects investment behavior today. If we imagine policy to be selected so as to optimize an objective (welfare) function, the resulting policy, in the absence of a commitment mechanism, is generally time inconsistent. Aside from questions about its implementation, then, a consequence is that the formulation of the optimal-policy problem is not recursive. But one can generally convert such a model into a recursive structure by introducing an additional pseudo-state variable — a shadow price — which is subject to its own constraint implied by the model. Similar issues about recursivity, potentially resolved in an analogous manner, arise in many dynamic contracting environments.

Tuesday, 8:30-10:00

■ TA-01

Tuesday, 8:30-10:00

RB-Alfa

Tutorial Lecture: Professor Anita Schöbel

Stream: Keynote, Tutorial and Plenary Lectures

Tutorial session

Chair: *Gerhard Wäscher*, Fakultät für Wirtschaftswissenschaft, Otto-von-Guericke Universität Magdeburg, Postfach 4120, 39016, Magdeburg, Germany, gerhard.waescher@ww.uni-magdeburg.de

1 - Lines, Timetables, Delays: Models and Trends in Optimization of Public Transport

Anita Schöbel, Institute for Numerical and Applied Mathematics, Georg-August University Göttingen, Lotzestrasse 16-18, 37083, Göttingen, Germany, schoebel@math.uni-goettingen.de

The talk consists of two parts: In the first part, a state-of-the-art survey about finding lines and timetables in the strategic planning of a public transportation system will be provided, and the problem of delay management, i.e. how to update the system in case of delays will be explored. The second part will discuss ongoing research questions, namely how the routing of the passengers can be included in the planning phases, how an integration of the planning phases can be simulated, and how robustness issues can be integrated. Theoretical and experimental results on these topics will be shown.

Part 1 gives an overview on line planning, timetabling, and delay management. Given an existing public transportation network with its stops (or stations) and direct connections, the first step in the strategic planning of a transport system is to define lines and their frequencies. A line is a path in the public transportation network along which regular service is offered. We discuss various optimization models minimizing either the costs of the lines or maximizing the convenience for the passengers.

If the lines have been found, the next step is to design a timetable. There are two different models: Periodic timetables which are repeated on e.g. an hourly basis and aperiodic timetables. The usual aim is to minimize the traveling time for the passengers. Integer programming formulations will be provided for both problem types and algorithmic approaches for finding timetables will be reviewed.

Coming to the operational phase, the question of the delay management problem is how to react in case of delays such that the passengers' travel times do not increase too much. This concerns the decision if a punctual bus or train should wait for a delayed feeder bus or train or if it should better depart on time. In railway traffic also the limited capacity of the tracks has to be taken into account, i.e. priority decisions have to be made. Also here, the state-of-the-art of delay management will be presented.

The three problems discussed in Part 1 can be solved more or less efficiently. However, the algorithms and approaches are still not suitable for solving real-world problems. In part 2 we will hence discuss features that are missing, identify the resulting research questions and show some first solution approaches aiming at making the algorithms work in practice.

A first problem concerns the decision of the passengers. In many papers on line planning, time tabling, and delay management it is assumed that it is already known how the passengers travel, i.e. a passenger's weight is assumed to be known for every edge or activity in the system. This is an unrealistic assumption since the route choice of the passengers depends on the lines, the timetable and on the delay management strategy. We will discuss how the passengers' decisions may be integrated into the optimization process.

Another issue is robustness. It is not helpful to have an exact optimal solution that might get totally meaningless if a small disturbance occurs. Hence, the aim should be to have a robust transportation system which performs well even if the scenario or the input data changes. We exemplarily illustrate different concepts on how robustness can be integrated for the timetabling phase.

Specialized algorithms for every single planning phase in public transportation are known. However, the best line plan is not helpful if it only allows bad timetables. Hence, some effort should be made to find integrated solutions.

Using our toolbox LinTim we illustrate how decisions made in earlier planning steps can influence the subsequent planning phases. Among others we show how the quality of a timetable depends on decisions made in the line planning phase, how good the approximation of the passengers' weights fits to the real behavior of the passengers, and how the robustness of a public transport system may be simulated.

■ TA-02

Tuesday, 8:30-10:00

RB-Beta

Graph Models in Logistics and Scheduling

Stream: Scheduling

Invited session

Chair: *Maksim Barketau*, United Institute of Informatics Problems, Academy of Sciences of Belarus, 220012, Minsk, Belarus, barketau@mail.ru

1 - Minimizing maximal weight of subsets in a bipartite graph

Maksim Barketau, United Institute of Informatics Problems, Academy of Sciences of Belarus, 220012, Minsk, Belarus, barketau@mail.ru, *Erwin Pesch*, *Yakov Shafranskiy*

In a bipartite graph $G=(U,V,E)$ with weighted edges, set U of vertices is partitioned into disjoint subsets called components. The aim is to find a complete matching that minimizes the maximal weight of the component (sum of the weights of the edges that have ends in the component). We prove the strong NP-hardness of the problem and the absence of a polynomial approximation algorithm with a worst-case ratio less than 2 (unless $P=NP$). We develop heuristics that find solutions that are on average 2 percent away from the optimum. The problem is motivated by a production planning in a railway hub.

2 - Batch scheduling and transfer line design problems

Alexandre Dolgui, IE & Computer Science, Ecole des Mines de Saint Etienne, 158, cours Fauriel, 42023, Saint Etienne, France, dolgui@emse.fr, *Sergey Kovalev*, *Mikhail Y. Kovalyov*, *Jenny Nossack*, *Erwin Pesch*

We study a transfer line design problem, in which there are several types of operations to be assigned to stations. If a station is assigned at least one operation of a certain type, it induces a type dependent cost. Precedence relations on the set of operations are given by an arbitrary digraph. The primary objective is to minimize the number of stations and the secondary objective is to minimize the total type dependent cost. An equivalent batch scheduling model is presented. Obtained results include computational complexity, heuristics, ILP formulations and computer experiments.

3 - Periodic Scheduling for Wireless Access Networks to the Internet

Celia Glass, Cass Business School, City University, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, c.a.glass@city.ac.uk

Wireless Access Networks provide low cost internet and broadband access, but have distinct limitations for scheduling. The access points, used e.g. for WiFi, cannot multi-task. This disposes them to perfect periodic scheduling, which offers both reliability of service, and energy saving. We consider binary tree access networks with local transmission. We compare optimised and heuristic solutions, to demonstrate the difficulty of co-ordinating network transmissions without periodicity, and the efficiency of perfect periodic scheduling.

4 - New Bounds and Constraint Propagation Techniques for the Clique Partitioning Problem

Erwin Pesch, FB 5, University of Siegen, Hoelderlinstr. 3, 57068, Siegen, Germany, erwin.pesch@uni-siegen.de, *Florian Jaehn*

We consider the Clique Partitioning Problem that has several real life applications such as groupings in flexible manufacturing systems, in biology, in flight gate assignment, etc.. We present tighter upper bounds for each search tree node than those known from literature, improve constraint propagation techniques for fixing edges in each node, and present a new branching scheme. The theoretical improvements are reflected by computational tests with real life data.

■ TA-03

Tuesday, 8:30-10:00

RB-L1

Logistics, Transportation, Traffic - 2

Stream: Logistics, Transportation, Traffic
Contributed session

Chair: *Erwin van der Laan*, RSM Erasmus University, P.O.Box 1738, 3000DR, Rotterdam, Netherlands, elaan@rsm.nl

1 - The efficiency improving of traction drive test bench with supercapacitor energy storage system

Genadijs Zaleskis, Faculty of Power and Electrical Engineering, Institute of Industrial Electronics and Electrical Engineering, Riga Technical University, 1 Kronvalda Blvd., LV-1010, Riga, Latvia, genadijs.zaleskis@rtu.lv, *Viesturs Brazis*

In this article the results of computer modeling for the optimization of traction drive test bench with supercapacitor energy storage are described. Test bench operation is considered in cases of the energy storage system working at various selected supercapacitor initial voltages. Maximal increasing of possibility of vehicle test bench regenerative braking with minimal decreasing of autonomous power supply mode possibility is investigated. There is estimated the energy storage system efficiency improving measures dependence from supercapacitor operational voltage ranges.

2 - How to place products in a warehouse to minimize forklifts worktime — a simple data mining based algorithm

Grzegorz Tarczynski, Department of Operational Research, Wrocław University of Economics, ul. Komandorska 118/120, 53-345, Wrocław, Poland, grzegorz.tarczynski@ue.wroc.pl

Based on historical data, using data mining techniques, probability distributions and conditional probability distributions of goods purchase can be determined and used to plan the allocation of goods in the warehouse. The Volume-Based Storage Strategies focus on how to put goods with the highest rotation in locations most easily available to warehouseman. However, often customers buy goods in sets. This paper presents an algorithm that takes into account the most purchased product sets. The effectiveness of the algorithm was verified using simulation tool.

3 - How the NPV and average cost criterion lead to different decisions in the vending machine problem

Erwin van der Laan, RSM Erasmus University, P.O.Box 1738, 3000DR, Rotterdam, Netherlands, elaan@rsm.nl

The net present value (NPV) criterion is widely seen as an appropriate approach to deal with financial decision. In literature, however, it is mainly the average cost (AC) criterion that is used. We analyze the NPV and AC approach for the logistics of replenishing vending machines: every R time units the machine is inspected and replenished up to its capacity, where R should be chosen optimally. We show that there may be significant implications of using the AC criterion over the NPV criterion in terms of profit expectations and realizations.

■ TA-04

Tuesday, 8:30-10:00

RB-L2

Air Transportation and Propagation

Stream: Optimization in Public Transport
Invited session

Chair: *Claus Gwiggner*, Information Systems, FU Berlin, Garystr. 21, 14195, Berlin, Germany, claus.gwiggner@fu-berlin.de

1 - Optimizing the Staff Schedule for Airport Immigration

Phi Doan, Aeronautics and Astronautics, University of Tokyo, 4-6-1 Komaba, Meguro-ku, Rcast building 4, room 515, 153-8904, Tokyo, Tokyo, Japan, ppdoan@hotmail.com

The objective of this research is to shorten the waiting times at an international airport by optimizing the staff schedule. First, an arrival model predicts the arrival rates at the immigration desks by using the flight schedule. Second, a queuing model estimates the waiting times for given service times and staff schedule. Last, an optimization model that uses an evolutionary algorithm estimates the number of staff over the day with the goal of minimizing the staff hours while meeting a targeted maximum waiting time.

2 - Improvement of Static Runway Assignment Using Queueing Model

Ryota Mori, Air Traffic Mangement Department, Electronic Navigation Research Institute, 7-42-23, Jindaiji-Higashimachi, Chofu, 182-0012, Tokyo, Japan, r-mori@enri.go.jp

Congestion is a critical issue at most hub airports. This paper tackles this problem occurring at the airport with most passengers in Japan, i.e. Tokyo International Airport. It has four intersecting runways which interfere with each other. Although the runway an aircraft uses is determined by its destination or departure airport to reduce air traffic controllers' (ATC) workload, this general rule can increase aircraft waiting time. To make runway operations more efficient, a queuing model is implemented and the possible improvement is discussed with keeping minimum increase of ATC workload.

3 - Optimal Trajectory Design by Infinite Dimensional Optimization

Daniel Delahaye, French Civil Aviation University, 7 avenue Edouard Belin, 31055, Toulouse, France, delahaye@recherche.enac.fr, *Stephane Puechmorel*

Trajectories are infinite dimensional objects. There are mainly two classes of algorithms for trajectory design. The first class is based on optimization and the second one on propagation algorithms. In this work we present two examples of such algorithms for aircraft trajectory design. Both address the conflict resolution problem. The first one manipulates B-splines and the second one uses a light propagation analogy to generate optimal geodesic trajectories. Results are presented on a real day of traffic over France for which all conflicts are successfully solved.

4 - Sequencing and Swapping Probabilities for Traffic Synchronization

Sakae Nagaoka, Air Traffic Management, Electronic Navigation Research Institute, 7-42-23 Jindaiji Higashi-machi, Chofu-shi, 182-0012, Chofu, Tokyo, Japan, nagaoka@enri.go.jp, *Claus Gwiggner*, *Yutaka Fukuda*

In air traffic flow planning processes, estimated times of arrival are based on information from departure times at the origin airport. However, uncertainties about this information vary from aircraft to aircraft. We propose a probabilistic method for adjusting the scheduled time of arrival for aircraft pairs assuming that rough information on the distributions of estimation errors is available. We discuss the probability of swapping aircraft pairs and the conflict probability in relation to the size of the separation buffer often imposed to the separation minimum.

■ TA-05

Tuesday, 8:30-10:00

RB-L3

Maritime Transportation in Offshore Industry

Stream: Maritime Transportation

Invited session

Chair: *Irina Gribkovskaia*, Faculty of Economics, Informatics and Social Sciences, Molde University College - Specialized University in Logistics, Postbox 2110, 6402, Molde, Norway, irina.gribkovskaia@himolde.no

1 - A simulation study of the fleet sizing problem for offshore supply vessels

Yauhen Maisiuk, Faculty of Economics, Informatics, and Social Sciences, Molde University College - Specialized University in Logistics, Britvegen 2, 6411, Molde, Norway, yauhen.maisiuk@himolde.no, *Irina Gribkovskaia*

The supply vessels provide offshore installations with supplies from an onshore base according to weekly sailing plans. The goal is to decide the cost-optimal fleet of vessels on the long-term hire. The problem is stochastic as sailing speed and service time depend on uncertain weather conditions. Due to delays some installations may not be served within the planned route duration, and not received supplies have to be delivered later. We propose a discrete-event simulation model which evaluates alternative fleet size configurations depending on several strategies of later delivery of supplies.

2 - Routing and scheduling of offshore supply vessels with fuel consumption minimization through determining the best discrete value of sailing speed on each leg

Tatsiana Barysavets, Molde University College - Specialized University in Logistics, Norway, tatsiana.barysavets@himolde.no, *Irina Gribkovskaia*, *Mikalai Mikhailau*

We consider the offshore supply vessel routing and scheduling problem with incorporated speed decisions where the aim is to minimize the fuel consumption. The value of the vessel speed on each sailing leg is assumed to be taken from a given set. The problem is formulated as a MIP model. Two heuristic approaches are proposed: two-phase approach where the set of feasible voyages is generated a priori, and the problem is solved with a set partitioning like model; and a large neighbourhood search heuristic where the speed on each sailing leg is determined simultaneously with the vessels schedule.

3 - Routing of supply vessels to offshore installations with deliveries and pickups of multiple commodities

Eugen Sopot, Molde University College, Kirkebakken 27, 6413, Molde, Vestland, Norway, eugensopot@gmail.com, *Irina Gribkovskaia*, *Gilbert Laporte*

Offshore installations are dependent on periodic deliveries of various goods from an onshore supply base and continuously generate pickup demands. We consider the problem of routing supply vessels to offshore installations as a multi-commodity vehicle routing problem with pickups and deliveries. To guarantee the existence of a feasible solution to the problem it is assumed that each installation may be visited once or twice. We propose a variable neighborhood search heuristic algorithm for the single vessel variant of this problem.

4 - Speed strategies for green supply vessel planning

Ellen Karoline Norlund, Faculty of Economics, Informatics and Social Sciences, Molde University College - Specialized University in Logistics, Britvegen 2, 6402, Molde, Norway, ellen.k.norlund@himolde.no, *Irina Gribkovskaia*

We study how to reduce emissions in supply vessel activities through speed optimization when planning vessel schedules by solving a MIP model for a pre-generated set of voyages. Several speed strategies, determining speed for the entire voyage or optimizing speed for each voyage leg, are proposed. These strategies are applied either a priori during voyage generation or a posteriori to the voyages in the constructed

schedule. Results of tests on several real-life instances show that emissions can be significantly reduced when using speed optimization in supply vessel planning.

■ TA-06

Tuesday, 8:30-10:00

RB-Gamma

Engineering and Hybrid search

Stream: Metaheuristics

Invited session

Chair: *Said Hanafi*, ISTV2, LAMIH-SIADE, University of Valenciennes, Le Mont Houy, 59313, Valenciennes, France, said.hanafi@univ-valenciennes.fr

1 - Local search methods for conflict-free routing in a multi-processor system on chip

Marc Sevaux, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr, *Boureira Zerbo*, *André Rossi*, *Jean-Charles Creput*

We present a combinatorial optimization problem for conflict-free routing in a Network-on-Chip. Based on time division multiplexing and cyclic emission, the problem consists in finding a set of k-shortest paths, such that packets will never conflict through the network but can use shared communication links in an efficient way. On a time-expanded graph, a set of shortest paths computation operators are presented. Then, based on such operators, three iterated local search schemes are presented and compared to address the problem.

2 - A PSO-based Heuristic for energy-aware scheduling of Workflow applications on cloud computing

Sonia Yassa, Val d'oise, EISTI, Avenue du Parc, 95000, Cergy, France, sonia.yassa@eisti.eu, *Rachid Chelouah*, *Hubert Kadima*, *Bertrand Granado*

We investigate the problem of scheduling workflow applications on cloud computing infrastructures. The cloud workflow scheduling is a complex optimization problem which requires considering various scheduling criteria. Traditional researches mainly focus on optimizing the time and cost without paying much attention to energy consumption. We propose a new approach based on hybrid PSO heuristic to optimize the scheduling performance. Our method is based on dynamic voltage scaling (DVS) technique to minimize energy consumption. Simulation results emphasize the robust performance of our approach.

3 - Software Interfaces for Heuristic Solvers and the Future of Hyflex

Andrew J. Parkes, School of Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG9 1BB, Nottingham, United Kingdom, ajp@cs.nott.ac.uk, *Matthew Hyde*, *Gabriela Ochoa*, *Ender Özcan*

Stochastic local search is often highly effective; however, many practical applications remain unexploited, not because known algorithms would fail, but simply because the development cost is too high. We discuss recent Computer Science work at the University of Nottingham to address this challenge; and to support rapid prototyping and component-based development by increasing the modularisation of heuristic search tools. In particular, we will discuss future extensions to Hyflex, an API to separate adaptive search techniques from specific details of the problem domain.

4 - An Application of Electromagnetic Meta-Heuristic Method for Solving System of Nonlinear Fredholm Integral Equations

Hassan Taheri, Mathematics, Khayyam University, 91775-1159, Mashhad, Khorasan, Iran, Islamic Republic Of, taheri@math.um.ac.ir

In this paper we proposed an efficient algorithm for solving system of nonlinear Fredholm integral equations (SNFIEs) by using the Electro-magnetic Meta-Heuristic method (EM). First we choose an approximate solution for SNFIE. Then we will have a system of nonlinear of equations (SNEs). If we cannot compute this integral because of the integrands involves some unknowns, then we choose a value for each constant. But the question have is how do we select these values to achieve a good solution for the SNFIE? To ensure this question we try to solve the problem by EM method. For solving the SNEs we proposed a hybrid of the Newton-GMRES and EM methods.

■ TA-07

Tuesday, 8:30-10:00

RB-Eta

Vehicle routing in practical settings

Stream: New Trends in Vehicle Routing
Invited session

Chair: *Jorge E. Mendoza*, Institute of Applied Mathematics, Université Catholique de l'Ouest, 3 Place André Leroy, 49008, Angers, France, jorge.mendoza@uco.fr

Chair: *Victor Pillac*, Automatique - Productique, Ecole des Mines de Nantes, 4 Rue Alfred Kastler, La Chantrerie, 44300, Nantes, France, victor.pillac@gmail.com

1 - Solving an Industrial Waste Collection Problem using a Hybrid Column Generation Algorithm

Jesper Larsen, Department of Management Engineering, Technical University of Denmark, Produktionstorvet, Building 426, 2800, Kgs. Lyngby, Denmark, jesla@man.dtu.dk, *Kristian Milo Hauge*

We present a problem of collection industrial waste. In this problem waste collection is handled by a fleet of vehicles. Each vehicle can carry up to eight skip containers of which a maximum of two can be full at the same time. We present an approach to route the vehicles based on a combination of column generation (CG) and metaheuristics. The performance is assessed by comparing the results that it achieves to results achieved by an algorithm that is based purely on metaheuristics. The results show that the hybrid CG algorithm finds superior solutions than the purely heuristic algorithm.

2 - Multi-stage, multi-period distribution planning with inventory and routing considerations

Dmitry Ivanov, Supply Chain Management, Berlin School of Economics and Law, Germany, divanov@hwr-berlin.de, *Boris Sokolov*, *Alexander Pavlov*

A real case-study of distribution planning is considered. An original approach of combining static inventory-routing and optimal control models is proposed to optimal planning of a multi-stage, multi-commodity distribution network in the multi-period mode with adaptive update of demand, capacity, and supply information. Optimal distributions plans are calculated for optimistic and pessimistic scenarios. Subsequently, these plans are analyzed subject to different disturbances and regarding distribution network design and sourcing planning decisions.

3 - Extending the Periodic Vehicle Routing Problem: A Case Study in Beverage Logistics

Dominik Pfeiffer, Chair for Information Systems and Supply Chain Management, University of Münster, Leonardo-Campus 3, 48149, Münster, NRW, Germany, Dominik.Pfeiffer@ercis.de, *Bernd Hellingrath*

This paper deals with a variant of the Periodic Vehicle Routing Problem which allows multiple tours to be run per vehicle and day, delivering each customer no more than once a day, respecting driving time constraints, and distributing multiple deliveries to the same customer in the planning period as evenly as possible. We develop algorithms solving the instances of the case studied. The results are validated against historical data from the case at focus. We are able to realize considerable cost reductions and evaluate the algorithms with respect to the solution quality and efficiency.

4 - A real-life Inventory Routing Problem

Benoît Tricoire, Institut de Mathématiques Appliquées, Université Catholique de l'Ouest, 3 Place André Leroy, 49008, Angers, France, benoittr96@gmail.com, *Eric Pinson*

We focus on a real-life problem that integrates stock constraints into the VRP. This problem, motivated by routing problems faced by retail companies, can be related to Inventory Routing Problems. Our aim is to build a planning of pick-ups (to suppliers) and deliveries (to customers), deserved at minimum cost by a set of vehicle activities (routes verifying complex real-world operative constraints). We propose a three-step method for our problem, using Lagrangean relaxation, GRASP, column generation, and tabu search. We compare our results to those of end-users

■ TA-08

Tuesday, 8:30-10:00

RB-Epsilon

Supply Chain Design

Stream: Supply Chain Planning
Invited session

Chair: *Alparslan Serhat Demir*, Industrial Engineering, Sakarya University, Sakarya University Esentepe Kampusu Endustri Muh. Binasi M5 Kat 3-311, 54100, Sakarya, Turkey, alparslanserhat@hotmail.com

1 - Use of decomposition method in forest fuel supply chain

Amirhossein Sadoghi, Finance Department, Frankfurt School of Finance & Management, Sonnemannstraße 9-11, 60314, Frankfurt am Main, Germany, a.sadoghi@fs.de, *Helene Lidestam*

In this research, we address the capacitated, multi-commodity, multi-period, multi-stage facility location problem regarding production, distribution and allocation in the case that forest residues are to be converted into fuel. With increased number of facilities, products and time periods, the model becomes large and large scale optimization techniques are necessary to get a solution within limited time. A heuristic solution based on a computationally efficient decomposition method is proposed. Numerical results and comparison with other possible methods are presented.

2 - Modular Supply Chain Optimization in the Construction Industry: An Application

Pedro Rijo, DECivil, IST, Rua Comandante Cousteau, lote 4.04.02.B 3ºD, 1990-067, Lisboa, Portugal, pedro@rijo.me, *Amílcar Arantes*

Globalization and the need for product differentiation at a fair price made supply chain a particularly relevant issue for the construction industry. The companies have to look for decisions that optimize the supply chain system and integrate in the process their suppliers and clients. Issues like facility location, inventory and transport management must be considered. In this work we focus on the optimization of the supply chain of a complete prefabricated kitchen module using linear programming techniques. The results show guidelines concerning supply chain configurations and operations.

3 - Robust Supply Chain Network Design by Considering Different Risk Mitigation Strategies

Faeghe Mohamad Doost, industrial engineering, urmia university of technology, Band Ave, Urmia, Iran, Urmia, West Azarbayjan, Iran, Islamic Republic Of, mohamaddust_f@yahoo.com, *Shabnam Rezapour*

This paper develops a stochastic mathematical formulation for designing the network of a supply chain comprising several production facilities, distribution centers and retailers in markets under uncertainty. In this model, we consider reserving extra capacity, holding strategic stock and keeping substitutable facility strategies to mitigate the effects of possible disruptions. We use a path-based formulation that helps us consider supply-side uncertainties. We illustrate the model outputs and discuss the results through several numerical examples.

4 - Determining Multiple Warehouse Locations and Customers to be Served by Using Genetic Algorithm

Alparslan Serhat Demir, Industrial Engineering, Sakarya University, Sakarya University Esentepe Kampusu Endustri Muh. Binasi M5 Kat 3-311, 54100, Sakarya, Turkey, alparslanserhat@hotmail.com

In this study, distribution network of a tire manufacturing factory is addressed. In the distribution network, customers are at the different geographical locations and warehouses have to be established in different places to meet the product demand of customers. The problem is the determination of the locations where the warehouses are established and which warehouse will meet the customers' demands to minimize total transportation cost. The problem is modeled and solved by using genetic algorithm technique.

based on linear programming and some further amplification of the constraint propagation, which are followed by the results of experimental study.

4 - A biased random key genetic algorithm for the 2D and 3D bin packing problem

José Fernando Gonçalves, Faculdade de Economia do Porto, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt

In this paper we propose a biased random key genetic algorithm for the 2D and 3D bin packing problem. For each GA chromosome we construct a solution based on a maximal-space heuristic which packs the boxes according to the order supplied by chromosome. Two placement heuristics are considered and an improvement procedure is applied to the solution. Computational tests carried on a set of 854 benchmark instances taken from the literature validate the quality of the solutions and the approach. Supported by Fundação para a Ciência e Tecnologia (FCT) project PTDC/EGE/GES/117692/2010.

■ TA-09

Tuesday, 8:30-10:00

RB-Zeta

Cutting and Packing 5

Stream: Cutting and Packing

Invited session

Chair: *José Fernando Gonçalves*, Faculdade de Economia do Porto, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt

1 - A Comparison of Approaches for Solving the 3D Container Ship Loading Planning Problem by Representation by Rules

Anibal Azevedo, Production engineering, State University of Campinas, Rua dos Aimorés, 480, Apt. P.34, 13081-030, Campinas, São Paulo, Brazil, atanibal@yahoo.com, *Cassilda Ribeiro*, *Galeno Sena*, *Antônio Chaves*, *Luiz Salles Neto*, *Antônio Moretti*

The proposed paper presents two contributions: A new 3D Container Ship Loading Planning Problem modeled as a bi-objective framework that minimizes two criteria: the number of movements and also the instability measure computed as the distance between gravity and geometric center. A new representation that allows a compact and efficient encoding which enables the solution of large-scale problems proper related with real-life scenarios. For example, an instance problem which demands a total of 40,545,000 binary variables will need only 30 variables with the proposed approach.

2 - A global optimization approach for three dimensional rectangular packing problems

Pei-Chun Wang, Graduate Institute of Industrial and Business Management, Taipei University of Technology, No. 1, Sec. 3, Chung Hsiao E. Road, Taipei 106, Taiwan, 106, Taipei, Taiwan, t5749005@ntut.edu.tw

The problem addressed in this paper aims to pack a set of rectangular boxes into a large rectangular container in such a way that the occupied volume space is minimized. The boxes can be any rectangular stackable objects with different sizes and may be rotated. This paper transforms the packing problem into a mixed-integer linear program by an improved piecewise linearization technique which uses fewer extra 0-1 variables and constraints. The reformulated model can be solved to obtain a global optimum and is more computationally efficient than previous studies with deterministic approaches.

3 - Constraint programming approaches, search strategies and bounds in problems of orthogonal packing.

Marat Mesyagutov, Numerical Mathematics, Dresden University of Technology, Zellescher Weg 12 - 14 (C 319), 01069, Dresden, Germany, mmesyagutov@googlemail.com, *Gleb Belov*, *Guntram Scheithauer*

Constraint programming is an effective approach for discrete optimization problems. Since it allows the non-linear modeling, we consider some known higher dimensional approaches within that new paradigm. In the talk we discuss different know and new strategies, pruning rules

■ TA-10

Tuesday, 8:30-10:00

RB-Theta

Inventory Management 2

Stream: Production Management & Supply Chain Management (contributed)

Contributed session

Chair: *Farouk Yalaoui*, Institut Charles Delaunay, ICD LOSI, University of Technology of Troyes, 12, Rue Marie Curie BP 2060, 10000, Troyes, France, farouk.yalaoui@utt.fr

Chair: *Christian Larsen*, Economics, CORAL, Aarhus School of Business, Aarhus University, Fuglesangs Alle 4, DK-8210, Aarhus V, Denmark, chl@asb.dk

1 - Dynamic supply chain inventory management: a generic mathematical programming approach

Joaquim Jorge Vicente, CEG - IST, Portugal, joaquim.jorge.vicente@gmail.com, *Susana Relvas*, *Ana Paula Barbósa-Póvoa*

Inventory management plays an important role in supply chains. This is explored in the present work where a flexible Inventory Management (IM) policy is modeled through a mixed-integer linear programming model. This dynamically optimizes a multi-period, multi-warehouse/retailer and multi-product supply chain under deterministic and uncertain demands. Continuous and Periodic Review policies are also modeled and tested over the same system for comparison. The results show that the proposed IM policy outperforms the others leading to lower operational costs.

2 - The relationship between purchasing strategy, manufacturing performance and financial performance

Ahmed Attia, business management, damanhour university, elgomohoria st., 000, damanhour, elbehera, Egypt, ahmed-attia2005@hotmail.com

Purchasing is one of the logistics activities playing a major role for getting a competitive advantage through reducing the total cost, reducing the number of suppliers, building partnership with the suppliers, etc. The purchasing strategy will be the effective tool for achieving such benefits. The current study examines the direct effect of the purchasing strategy on the financial performance of the company, and also the indirect effect through manufacturing performance.

3 - Spare parts sharing with joint optimization of maintenance and inventory policies

Christian Larsen, Economics, CORAL, Aarhus School of Business, Aarhus University, Fuglesangs Alle 4, DK-8210, Aarhus V, Denmark, chl@asb.dk, *Hartanto Wong*, *Lars Relund Nielsen*

We consider a collaborative arrangement where a number of companies are willing to share expensive spare parts, required for both failure replacement and preventive maintenance purposes. We develop a discrete-time Markov decision model for the joint optimization of maintenance and spare parts inventory policies for both a single- and a multi-company problem. The cost savings obtained as a result of sharing are evaluated. A number of cost allocation schemes, making all the companies involved being better off by sharing the spare parts rather than acting independently, are developed.

■ TA-11

Tuesday, 8:30-10:00

RB-Iota

Transport Networks

Stream: Transportation and Logistics

Invited session

Chair: *Anna Sciomachen*, DIEM, University of Genova, Via Vivaldi 5, 16126, Genova, Italy, sciomach@economia.unige.it

1 - Feeder bus network design problem: a new solving procedure and real size applications

Francesco Ciaffi, Dipartimento di Scienze dell'Ingegneria Civile, Università Roma Tre, Via Vito Volterra 62, 00146, Roma, Italy, fciaffi@uniroma3.it, *Ernesto Cipriani*, *Marco Petrelli*

The present research deals with a methodology for solving the feeder bus network design problem in a real size large urban area. The solving procedure is articulated in 2 phases: generation of two different and complementary sets of feasible routes, using a heuristic algorithm, and the optimal network design using a GA, calculating simultaneously optimal routes and frequencies, in order to provide a good balance between maximization of the service coverage area and minimization of the overall travel time. The proposed procedure has been applied on two real-life networks, Winnipeg and Rome.

2 - Delivery splitting problem with multiple origins

Tomas Subrt, Dept. of Systems Engineering, Czech University of Life Sciences, Kamycka 129, 165 21, Prague 6 - Suchbát, Czech Republic, subrt@pef.czu.cz

This problem deals with logistic network design issues and is focused on optimal splitting of deliveries from multiple sources to multiple destinations. It is supposed to have a logistic network where the summary supply of all destinations can be satisfied by sources' capacities. Every arc of such network is weighted by cost per item shipment function. Due to the common effect of flow scale economies such function is generally concave. This article demonstrates possible solution methods and results implementation using mathematical programming tools.

3 - Freight terminal location in multimodal networks

Anna Sciomachen, DIEM, University of Genova, Via Vivaldi 5, 16126, Genova, Italy, sciomach@economia.unige.it, *Daniela Ambrosino*

In this work we present a heuristic method for evaluating possible locations for freight intermodal terminals, that are dry ports. Aspects coming from both classical simple plant location problems and shortest path ones on multimodal graphs are combined in a two phase procedure. We first select the possible dry ports by analysing their position in the network and their communication capabilities with the other nodes by using a multimodal connectivity criterion. Then we apply a heuristic algorithm for finding optimal multimodal O-D routes in network. Preliminary results are given

■ TA-13

Tuesday, 8:30-10:00

RB-Tau

Semiconductor and Pharmaceuticals Production

Stream: Manufacturing and Warehousing

Invited session

Chair: *Lars Moench*, FernUniversität in Hagen, 58097, Hagen, Germany, lars.moench@FernUni-Hagen.de

1 - Stochastic Programming for New Product Introduction in the Pharmaceutical Industry

Klaus Reinholdt Nyhuus Hansen, Section for Supply Chain Management and Production, TU Munich, Arcisstrasse 21, 80333, Munich, Germany, klaus.hansen@tum.de, *Martin Grunow*

Due to limited patent protection, pharmaceutical companies are focusing more on the new product introduction process and addressing the risks found prior to product launch. Where the widespread pipeline and capacity planning models address R&D risks, we here focus on exogenous risks arising from the negotiations with the authorities such as e.g. delayed market authorization. We present how these risks can be addressed via two-stage stochastic modeling for effective launch planning and also how capacity can be improved to consider these risks.

2 - Enhancing standard mid-term planning in semiconductor manufacturing

Phillip Kriett, Technical University Munich, Germany, phillip.kriett@tum.de, *Martin Grunow*

Enterprise-wide tactical planning determines a capacity-feasible product mix. State-of-the-art tactical planning frameworks aggregate resource information and neglect the assignment of jobs to machines. Yet, certain semiconductor manufacturing steps such as testing can be performed on flexible, parallel, and in particular non-identical resources. Here, this aggregation results in low capacity utilization and infeasible production plans. We propose an exact solution approach which captures resources and is compatible with current software. The approach is tested on real-world data.

3 - Order release planning by iterative linear programming and simulation: An analysis of the underlying coordination mechanism

Hubert Missbauer, Information Systems, Production and Logistics Management, University of Innsbruck, Universitätsstrasse 15, 6020, Innsbruck, Austria, hubert.missbauer@uibk.ac.at

We deal with order release planning algorithms in manufacturing planning and control that allow time-varying lead times by iterating between a release models with fixed lead times and a simulation model that updates the lead times. Convergence is a critical issue here, and a theoretical foundation has not been provided up to now. We present an analysis of the theory behind this iterative mechanism that should help to explain the convergence problems and to improve the methods. The analysis is performed using a single-stage order release model in discrete and continuous time.

4 - A Scheduling Approach for Complex Job Shops with Transportation

Lars Moench, FernUniversität in Hagen, 58097, Hagen, Germany, lars.moench@FernUni-Hagen.de, *Rene Driessel*

We consider a scheduling problem for complex job shops with automated material handling systems (AMHS). Scheduling problems of this type are important in semiconductor manufacturing. The performance measure is the total weighted tardiness. We present a modified shifting bottleneck heuristic for the integrated scheduling problem. The heuristic is applied in a rolling horizon setting. We study the performance using simulation. In addition, we change the number of vehicles to see the impact of the capacity of the AMHS on the overall performance.

■ TA-14

Tuesday, 8:30-10:00

RB-Omega

Scheduling with variable parameters II

Stream: Scheduling under Resource Constraints
Invited session

Chair: *Yakov Shafransky*, United Institute of Informatics Problems, National Academy of Sciences of Belarus, Surganov str. 6, 220012 Minsk, Belarus, 220012, Minsk, Belarus, shafr-04@yandex.ru

Chair: *Stanislaw Gawiejnowicz*, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Umultowska 87, 61-614, Poznan, Poland, stgawiej@amu.edu.pl

1 - Minimizing Maximum Lateness for Single Machine under Uncertain Due Dates and Precedence Constraints

Dzmitry Sledneu, Lund University, Sweden, dzmitry.sledneu@gmail.com, *Yakov Shafransky*

Problem of minimizing maximum lateness for one machine under precedence constraints is considered. For each due date we have an interval of its possible values and the due date may take any value from this interval regardless of the will of the decision maker. A feasible schedule is called globally optimal schedule if it remains optimal under any possible values of the due dates. We formulate necessary and sufficient conditions for a schedule to be globally optimal and propose an algorithm for constructing such a schedule. As a by-product, we formulate necessary and sufficient conditions for the optimality of a schedule for the deterministic version of the problem.

2 - Scheduling precedence-constrained jobs with mixed processing times and maximum cost criterion

Marek Dębczyński, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Umultowska 87 Street, 61-614, Poznań, Wielkopolskie, Poland, mdeb@amu.edu.pl, *Stanislaw Gawiejnowicz*

We consider single-machine scheduling problems with arbitrary precedence constraints and maximum cost criterion. We show how to solve the problems in polynomial time when job processing times are variable and mixed, i.e. some of them are fixed, while the other ones are variable and take into account the effects of learning, ageing or job deterioration.

3 - Scheduling jobs on unrelated parallel machines with general positional deterioration to minimize the total processing cost

Yakov Shafransky, United Institute of Informatics Problems, National Academy of Sciences of Belarus, Surganov str. 6, 220012 Minsk, Belarus, 220012, Minsk, Belarus, shafr-04@yandex.ru

Set of independent jobs is to be processed on unrelated parallel machines. The processing time of a job is the product of its basic processing time and a deterioration coefficient that depends on the job, on the machine and on the position of the job in the job sequence on this machine. Each of the coefficients is a non-decreasing function of the position number. For each machine, we have a cost of processing a job for one time unit on the machine. The aim is to construct a schedule that minimizes the total cost of processing all the jobs. We propose a polynomial algorithm to solve the problem

4 - Multicriteria optimisation of construction project schedules

Grzegorz Ginda, Faculty of Materials and Environment Sciences, University of Bielsko-Biała, INSTITUTE OF TEXTILE ENGINEERING AND POLYMER MATERIALS, Pl.Fabryczny 5, 43-300, Bielsko-Biała, Poland, gg.ginda@gmail.com, *Mirosław Dytczak*, *Tomasz Wojtkiewicz*

Complexity of optimal construction project scheduling results from numerous feasible orders of technological operations, availability of different operation realisation modes and possible concurrency among

operations due to limited availability of resources. Efficient approach is discussed which allows identification of the most suitable project schedule instances. It applies simultaneous generation and evaluation of representative population of schedule instances. A criteria hierarchy is applied with this regard. The approach also facilitates identification of desirable schedule features.

■ TA-15

Tuesday, 8:30-10:00

RB-2101

Semi-infinite methods and applications

Stream: Semi-Infinite Optimization
Invited session

Chair: *Ana I. Pereira*, Department of Mathematics - ESTiG, Polytechnic Institute of Braganca, Campus de Sta Apolonia, Apartado 134, 5301-857, Braganca, Portugal, apereira@ipb.pt

1 - Strong duality in robust linear semi-infinite programming

Miguel Goberna, Estadística e Investigación Operativa, Universidad de Alicante, Ctra. San Vicente s/n, 03080, San Vicente del Raspeig, Alicante, Spain, mgoberna@ua.es

In this talk, we propose a duality theory for semi-infinite linear programming problems under uncertainty in the constraint functions, the objective function, or both, within the framework of robust optimization. We show that robust duality holds whenever a robust moment cone is closed and convex. We then show that robust moment cone is closed and convex if and only if robust duality holds for every linear objective function of the program. We also give robust forms of the Farkas lemma for systems of uncertain semi-infinite linear inequalities.

2 - General semi-infinite programming

Vladimir Shikhman, Dept. Mathematics C, RWTH Aachen University, Templergraben 55, 52056, Aachen, Germany, shikhman@mathc.rwth-aachen.de, *Hubertus Th. Jongen*

We consider general semi-infinite programming (GSIP) from a topological point of view. We focus on the description of the closure of the feasible set, the Symmetric Mangasarian Fromovitz Constraint Qualification, the Nonsmooth Symmetric Reduction Ansatz, appropriate notion of Karush-Kuhn-Tucker points and critical point theory.

3 - Reduction method with multistart technique for semi-infinite programming problems

Ana I. Pereira, Department of Mathematics - ESTiG, Polytechnic Institute of Braganca, Campus de Sta Apolonia, Apartado 134, 5301-857, Braganca, Portugal, apereira@ipb.pt, *Florbela P. Fernandes*, *M. Fernanda P. Costa*, *Edite M.G.P. Fernandes*

Semi-infinite programming problems can be efficiently solved by reduction type methods. In this work a new global reduction method for semi-infinite programming is presented. The multilocal optimization is carried out with a multistart technique and the reduced problem is approximately solved by a primal-dual interior point method combined with a two-dimensional filter line search strategy. The filter strategy is used to promote the global convergence of the algorithm. Numerical experiments with a set of well-known problems are shown and comparisons with other methods are presented.

4 - Study of optimization problems with analytic constraint functions

Tatiana Tchemisova, Departamento de Matemáticas, University of Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, tatiana@ua.pt, *Olga Kostyukova*

For convex SIP problems with analytic constraint functions, we apply our approach based on the notion of immobile indices and their immobility orders. Implicit Optimality Criterion proved for the general case of problems with 1-dimensional index set allows to replace testing optimality in the convex SIP by testing in a special nonlinear problem. We study some specific properties of this problem and prove new optimality conditions. Special attention is paid to the case when the constraints of the original SIP are presented by analytic functions and do not satisfy the Slater condition.

■ TA-16

Tuesday, 8:30-10:00

RB-2103

Asset management applied to energy and the environment

Stream: Uncertainty and Perturbations in Optimization and in Environmental and Energy Modelling
Invited session

Chair: *Thomas Archibald*, Business School, University of Edinburgh, 29 Buccleuch Place, EH8 9JS, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk

1 - Long-term asset maintenance optimization at Scottish Water

Travis Poole, Scottish Water, United Kingdom, Travis.Poole@scottishwater.co.uk, *Thomas Archibald*, *Robert Murray*

A Knowledge Transfer Partnership between Scottish Water and the University of Edinburgh has produced an asset maintenance optimization tool which produces long-term (25-year) maintenance plans for Scottish Water's assets. The optimizer implements a number of optimization techniques, and addresses a set of different planning scenarios. By using a common currency for risks and costs, it is able to consider multiple asset types simultaneously. Scottish Water spends over £700m maintaining assets each year, so even a modest improvement in efficiency of plans will lead to significant savings.

2 - Practical Issues in Asset Management within UK Water Industry

Jake Ansell, Business Studies, The University of Edinburgh, 29 Buccleuch Place, EH4 1ET, Edinburgh, United Kingdom, J.Ansell@ed.ac.uk

Water companies are large complex organisations which deliver fresh water to households and industry, and take away waste water from both. The paper will review many aspects of managing within this context including the nature of the data, intervention actions, the possibilities of implementing optimal maintenance actions and impact of delays. It will explore issues around condition grade and time based models.

3 - Modelling Asset Deterioration using Structured Expert Judgement

Graeme Blair, Scottish Water, United Kingdom, Graeme.Blair@scottishwater.co.uk, *Deborah Gee*, *Matthew Revie*, *Lesley Walls*

This work is motivated by an industry problem; a utility seeks to model asset deterioration to predict future failures. Model estimates inform strategic investment and are subject to scrutiny by the regulator. A model is developed for an asset class which has limited historical statistical records. Modelling deterioration with respect to time or state is explored. Using the theory of structured expert judgement, a process for eliciting probabilities is designed. The model validation approach and the value of a subjective, state-based approach to asset deterioration modelling are described.

■ TA-17

Tuesday, 8:30-10:00

RB-2105

Covering Models

Stream: Applications of Location Analysis
Invited session

Chair: *Ioannis Giannikos*, Business Administration, University of Patras, University of Patras, GR-26500, Patras, Greece, I.Giannikos@upatras.gr

1 - Multi-criteria covering-based location of volunteer fire departments

Brigitte Werners, Management and Economics, Ruhr-University Bochum, Universitätsstr, 44780, Bochum, Germany, or@rub.de, *Dirk Degel*

Timeliness is one of the most important objectives that reflect the quality of emergency services such as firefighting systems. Sufficient firefighting facilities must be established and located to provide high quality services over a wide area with spatially distributed demands. To optimize their location, the objectives minimizing the average travel time and minimizing the longest travel time are in conflict with minimizing costs. Different multi-criteria methods are used to compare solutions for an urban area with several volunteer firefighting departments.

2 - Non-full coverage facility location problems

Maria Cortinhal, Quantitative Methods, ISCTE- CIO, Av. das Forças Armadas, 1649-026, Lisbon, Portugal, mscc@iscte.pt

We present new discrete facility location problems. These new models broaden the generic setting for the single source facility capacitated problem and for the single source modular facility capacitated problem by allowing a non-full coverage of customer demands. Additionally, it is considered a penalty function that allows doing a cost-full coverage trade-off. For each problem, two models are suggested. Computational experiments with CPLEX showed that reformulated models give better results. To enhance the quality of the results, some valid inequalities were developed and tested.

3 - Locating Undesirable Facilities

H.a. Eiselt, University of New Brunswick, P.O. Box 4400, E3B 5A3, Fredericton, NB, Canada, haeiselt@unb.ca, *Vladimir Marianov*

We locate undesirable facilities for nonhazardous materials, such as landfills, given an objective that minimizes a combination of costs and pollution. In contrast to most models that consider the effects of pollution only near the facilities, we assume that there are undesired effects on wider areas, as those caused by trucks transporting the waste. Our model includes not only locations, but also facility sizes as parameters. The model is formulated, its properties are investigated, and some preliminary computational evidence is presented.

4 - Using Clustering Heuristics to Solve a Family of Demand Covering Models

Ioannis Giannikos, Business Administration, University of Patras, University of Patras, GR-26500, Patras, Greece, I.Giannikos@upatras.gr, *Basilis Boutsinas*, *Antiopi Panteli*

We discuss demand covering models to determine locations for servers that optimally cover a given set of demand points. Our clustering heuristic processes the input data to determine clusters that result in smaller problems. It is based on the concept of bi-clusters, which are special sub matrices of a given coverage matrix. The algorithm starts by identifying appropriate bi-clusters of the coverage matrix and then combines them to define an aggregate solution, which is improved with a local search heuristic. The proposed algorithm is tested in a series of widely known test problems.

■ TA-18

Tuesday, 8:30-10:00

RB-2107

Advances in Location Modeling

Stream: Network and Discrete Location
Invited session

Chair: *Dmitry Krass*, Rotman School of Mgmt, University of Toronto, 105 St. George st., M5S 3E6, Toronto, Ontario, Canada, krass@rotman.utoronto.ca

1 - Prepositioning of Supplies in Preparation for a Hurricane with Forecast Information Updates

Rajan Batta, Industrial and Systems Engineering, University at Buffalo (SUNY), 208 F Davis Hall, 14260, Buffalo, New York, United States, batta@buffalo.edu, *Gina Galindo*

Given a foreseen hurricane, it is possible to use prediction models in order to obtain periodic forecasts about its main characteristics such as its path, wind force and time of landfall. We present a dynamic model for pre-positioning supplies in such a setting. Our model has two distinguishing features: the possible destruction of supply points during the disaster event and the use of forecast information updates in order to strategically modify and improve the pre-positioned quantities and locations.

2 - Organization of a public service through the solution of a Districting Problem

Carmela Piccolo, Department of Business and Management Engineering, University of Naples Federico II, via Cristoforo Colombo 19, 80030, Castello di Cisterna, Italy, carmela.piccolo@unina.it, *Giuseppe Bruno*

A districting problem consists in subdividing a region into districts on the basis of an objective function. Districting models can also be used to describe problems when a service has to be organized in a region. The decision about the number of districts and the allocation of the users can be performed considering the conflicting objectives of two actors: the planner aiming at minimizing the total costs and the users interested to reduce a measure of accessibility. We propose a general mathematical formulation and an application to a real case study. The results are analyzed and discussed.

3 - Inventory Location and Transshipment Problem

Dmitry Krass, Rotman School of Mgmt, University of Toronto, 105 St. George st., M5S 3E6, Toronto, Ontario, Canada, krass@rotman.utoronto.ca, *Oded Berman*, *Alex Shlakhter*

We analyze an inventory location problem where facilities are allowed to satisfy some of the demand by transshipping available inventory between each other and customers may change the shopping patterns based on stock availability at the facilities. These features make the model much more difficult than either the inventory location or transshipment models in the literature. By applying Infinitesimal Perturbation Analysis (IPA) algorithm — a form of approximate dynamic programming we show how realistic-size versions can be solved and obtain some interesting managerial insights.

■ TA-19

Tuesday, 8:30-10:00

RB-2111

Pension Funds

Stream: Actuarial Sciences and Stochastic Calculus
Invited session

Chair: *Elena Vigna*, Dipartimento di Scienze Economico-Sociali e Matematico-Statistiche, Università di Torino and Collegio Carlo Alberto, corso Unione Sovietica 218 bis, 10135, Torino, Italy, elena.vigna@econ.unito.it

1 - A risk-based premium: What does it mean for DB plan sponsors?

An Chen, Department of Economics, University of Bonn, Adenauerallee 24-42, 53113, Bonn, NRW, Germany, an.chen@uni-bonn.de, *Filip Uzelac*

This paper develops a risk-based valuation model for pension insurance provided to defined benefit (DB) plans by the Pension Benefit Guaranty Corporation (PBGC). It takes account of investment policies of the pension fund and of the DB plan sponsor. In addition, our model accounts for the premature termination of the pension fund caused by the underfunding of the plan sponsor, so-called distress termination. To obtain realistic estimates of the PBGC premium and to examine our valuation formula, we calculate risk-based premiums for 25 prominent DB plan sponsors.

2 - Mean-variance optimization in DC plan with stochastic interest rate

Elena Vigna, Dipartimento di Scienze Economico-Sociali e Matematico-Statistiche, Università di Torino and Collegio Carlo Alberto, corso Unione Sovietica 218 bis, 10135, Torino, Italy, elena.vigna@econ.unito.it, *Francesco Menoncin*

We solve a mean-variance optimization problem of a defined contribution pension scheme in the accumulation phase. The financial market consists of: (i) the risk-free asset, (ii) a risky asset following a GBM, and (iii) a bond driven by a stochastic interest rate whose dynamics follows a mean-reverting process. We solve the associated Hamilton Jacobi Bellman PDE and find a closed-form solution for the optimal investment strategy. Numerical applications show how the proportions of bond and risky asset decrease when retirement approaches.

3 - Optimal consumption, investment and life insurance with surrender option guarantee

Morten Tolver Kronborg, Department of Mathematical Sciences, University of Copenhagen, Copenhagen, Denmark, mtk@atp.dk

We present the optimal consumption, investment and life insurance strategy for an investor, endowed with labor income, searching to maximize his utility over cumulative consumption, bequest upon death and terminal wealth when he is restricted to fulfill a binding capital constraint of an American type. The optimal strategy combines a long position in the optimal unrestricted allocation with an American put option. In order to stay self-financing, the investor changes his budget constraint for the unrestricted allocation whenever the constraint is active.

4 - Allowing for Tail Risk, and Aversion to Tail Risk, in Optimal Portfolios for Long-Horizon Investors

Iqbal Owadally, Faculty of Actuarial Science and Insurance, Cass Business School, City University, London, EC1Y 8TZ, London, United Kingdom, M.I.Owadally@city.ac.uk, *Zinovy Landsman*

Asset return distributions are heavy-tailed and investors, particularly nearing retirement, are sensitive to extreme market events in the tail of these distributions. The tail mean-variance model proposed in insurance risk management involves a criterion focusing on the risk of rare but large losses. It does not satisfy the property of positive homogeneity, and the optimal solution typically requires numerical methods. We use a convex optimization method and a mean-variance characterization to find an explicit and easily implementable solution with and without a risk-free asset.

■ TA-20

Tuesday, 8:30-10:00

RB-2113

Multicriteria Analysis for Investment Decision Making

Stream: Decision Making Modeling and Risk Assessment in the Financial Sector

Invited session

Chair: *Luiz F. Autran M. Gomes*, Management, Ibmecc/RJ, Av. Presidente Wilson, No. 118, Room 1110, 20030020, Rio de Janeiro, RJ, Brazil, autran@ibmeccrj.br

1 - Frameworks of Strategic Decision Behavior on Investment and Risk Management

Mei-Chen Lo, National United University, 360, Miaoli, Taiwan, meichen_lo@yahoo.com

Effective investment and risk management, as the part of financial system, has strong impact on the performance of the enterprises. In this study, the strategic decision behaviors are discussed, and two MCDM methods were used: 1. Analytic Hierarchy Process method for setting the weights of dimensions criteria; 2. Technique for Order Preference by Similarity to Ideal Solution for assessment the relative performance viewed by different groups of experts. The procedures help to find the improvement directions through the study of the strategic behaviors on the investment and risk management.

2 - An Approach to Multicriteria Sorting within the Verbal Decision Analysis Paradigm

Eugenia Furems, Decision Making, Institute for System Analysis, 9, Prospect of 60 let Octyabrya, 117312, Moscow, furems-em@mtu-net.ru

Multicriteria sorting (MS) is often used inter alia as a model for investment alternatives assessment, where a class is the subset of alternatives with equivalent feasibility. Verbal Decision Analysis (VDA) is one of approaches for MS problem solving. A number of VDA-based methods use DM's preferences as the only source of information and ensure obtaining the completeness and consistency of classification rules, while avoiding the exhaustive search. A new dialogue strategy for such methods is proposed to reduce a DM's cognitive load and to enhance the ways of rules consistency providing.

3 - Comparing decisional maps

Valérie Brison, Mathematics and Operational Research, UMONS, Belgium, valerie.brison@umons.ac.be, *Marc Pirlot*

The purpose of this work is to provide models to compare maps representing the state of a region at different stages of its evolution. We formulate three mathematical models all based on several axioms that make sense in some geographic contexts. We start with a simple one, which doesn't take into account any geographic aspect. In the second one, we introduce one geographic aspect and then we generalize this model to take into account any finite number of geographic aspects.

4 - Using the Choquet-extended TODIM method for a multicriteria analysis of improvements in a major road in the Southeastern Region of Brazil: the Paraty-Cunha Highway

Luiz F. Autran M. Gomes, Management, Ibmecc/RJ, Av. Presidente Wilson, No. 118, Room 1110, 20030020, Rio de Janeiro, RJ, Brazil, autran@ibmeccrj.br, *Maria Augusta Machado*

Once significantly improved, Paraty-Cunha Highway will be the major road linkage between Paraty and its hinterland of Brazil. A key motivation behind investing on the improvement of that highway has to do with the fact that Paraty is dangerously close to Angra dos Reis. We formulate the investment decision making problem in a multicriteria framework. A behavioral multicriteria decision model is used. The analysis is based on the paradigm of cumulative prospect theory. A synthesis of the analysis leads to recommendations to decision makers.

■ TA-21

Tuesday, 8:30-10:00
RB-2115

Financial Mathematics and OR 5

Stream: Financial Mathematics and OR
Invited session

Chair: *Tansel Avkar*, Department of Mathematics, Middle East Technical University, 06531, Ankara, Turkey, tanselavkar@gmail.com

1 - Using the coverage data structure to solve a bi-criteria constructive model aiding to identify non-dominated portfolios

Javier Pereira, Escuela de Ingeniería Informática, Universidad Diego Portales, Avenida Ejército 441, Santiago, Chile, javier.pereira@udp.cl, *Fernando Paredes*

We previously proposed a bi-criteria constructive model to find the non-dominated portfolios, a problem formulated in terms of satisfaction of a given set of technical requirements. We argued that this is applicable in situations where early and detailed business information is poor. Solution was based on a preference-programming model found in literature. Here, we improve this approach considering the structure of the project-requirement matrix, which is not treated on traditional portfolio modeling. Numerical examples show that this improves the pruning process of the original algorithm.

2 - An EPQ Model for Deterioration Items and Exponential Demand Rate Taking into Account the Time Value of Money

Vikram jeet Singh, MATHEMATICS, Lovely Professional University, Jalandhar-Delhi G.T Road(NH-1), 144402, Phagwara, Punjab, India, vikram31782@gmail.com

In this study we develop an inventory model with exponential demand with Time Value of Money. Deterioration occurs as soon as the items are received into inventory and it follows two parameter Weibull distributions. There is no repair or replacement of deteriorating items during the replenishment cycle. Product transactions are followed by instantaneous cash flow Shortages are allowed and partially backlogged. The system operates for a prescribed period of a planning horizon. Production rate is demand rate dependent. The problem is discussed under the inflationary environment.

3 - Pricing fx forwards in OTC markets - new evidence for the pricing mechanism when faced with counterparty risk

Stefan Stöckl, FIM Research Center Finance & Information Management, University of Augsburg, 86135, Augsburg, Bavaria, Germany, stefan.stoeckl@wiwi.uni-augsburg.de, *Alexander Leonhardt*, *Andreas Rathgeber*, *Johannes Stadler*

In line with existing empirical results, this paper demonstrates, using daily foreign exchange (fx) market data for five currencies (CHF, EUR, GBP, USD, YEN), that, since the beginning of the financial crisis, market pricing of fx forwards does not match the pricing formula derived from the covered interest rate parity (CIP). Therefore, the CIP leads to systematic mispricing in relation to future fx spot rates. Overall, four statistically significant factors for this mispricing were identified. The high significance of the counterparty risk demonstrates that pricing models should be reviewed.

4 - Qualitative multi-attribute model for evaluating companies' interoperability

Borka Jerman Blazic, Laboratory for Open Systems and Networks, Jozef Stefan Institute, Jamova cesta 39, 1000, Ljubljana, Slovenia, borka@e5.ijs.si, *Vladislav Rajkovic*, *Arnas Bareisis*, *Ausra Kentrait*

In the paper a model to support enterprises in improving interoperability will be presented. The methodology considers conceptual, organizational and technological maturity of an enterprise regarding business strategy, processes, services and data. For the evaluation we propose a qualitative hierarchical multi-attribute model. The model is implemented within a DEX framework and will be illustrated by examples.

■ TA-22

Tuesday, 8:30-10:00
RB-2117

Institutional and Technological Changes in Market and Transitional Economies

Stream: Mathematical Models in Macro- and Microeconomics
Invited session

Chair: *Ludmilla Koshlai*, Systems analysis and OR, Institute of Cybernetics, Gonchar str.,65-a,apt.20, 01054, Kiev, Ukraine, koshlai@ukr.net

Chair: *Jean-Francois Emmenegger*, Quantitative Economics, University of Fribourg, Bd de Pérolles 90, F440, 1700, Fribourg, Fribourg, Switzerland, Jean-Francois.Emmenegger@unifr.ch

1 - DSS for technological planning

Oleksandr Pylypovskyi, Radiophysical, Taras Shevchenko National University Of Kyiv, 252187, Kyiv, Ukraine, o.pylypovskyi@gmail.com, *Ludmilla Koshlai*, *Petro Stetsyuk*

We consider a software for decision support for structural-technological changes based on intersectorial optimization models developed by Prof. M. Mikhalevich. Optimization models are nonlinear

programming problems (NLP) with two objective functions for maximization: final consumer incomes and multiplier "cost-value of production". Solutions for NLP are based on r-algorithm, programs are written on Octave language. MiSTC is developed using Qt library and provide tools for analysis of input/output data for intersectorial models. The protocol of interaction with user is recorded in HTML.

2 - Modeling the Returns of Securities on the Financial Markets

Jean-Francois Emmenegger, Quantitative Economics, University of Fribourg, Bd de Pérolles 90, F440, 1700, Fribourg, Fribourg, Switzerland, Jean-Francois.Emmenegger@unifr.ch

A reason of the recent turbulences (since 2007) on the international financial markets is the under evaluation of risks and the over evaluation of expected returns. How can these return series be modeled? Bachelier's (1900) idea was to construct a random-walk model, for security and commodity markets. The empirical evidence shows that Bachelier's idea does not hold, as Mandelbrot and Fama (1963) showed. This paper continues this discussion and proposes data-based methods to calculate more efficient financial risk indicators.

3 - Forecasting Ukrainian cargo transport system indicators

Elena Pervukhina, Dept. of Information Systems, Sevastopol National Technical University, Universitetskaya Str., 33, 99053, Sevastopol, Crimea, Ukraine, elena@pervuh.sevastopol.ua, Jean-Francois Emmenegger, Victoria Golikova

The paper addresses forecasting of transport volumes based on empirical econometric models. The peculiarity of transitional economy is taken into account. Therefore the data generating processes of cargo volumes has to be modeled with special care. The present analysis considers the forecast performance of multivariate time series models, comprising different modes of the Ukrainian cargo transport system. Two forecast methods are proposed. Both results illustrate the lack of correspondence of the transport industry with respect to the European standards.

4 - Peculiarities of Labour Market in a Transition Economy

Ludmilla Koshlai, Systems analysis and OR, Institute of Cybernetics, Gonchar str.,65-a,apt.20, 01054, Kiev, Ukraine, koshlai@ukr.net

The labour market of official sectors of economy in transition is considered as the typical example of imperfect market. Therefore, we assume that monopsony and oligopsony are the main kinds of competition, producing the impact on wages during the transition. We consider optimization models for the case of monopsony and oligopsony. Existence conditions formulated for optimal strategies of employers and properties of these strategies are analyzed. Investigations demonstrate that dependence between wages and demand for employers' production in oligopsony is similar to dependence in the case of monopsony.

■ TA-23

Tuesday, 8:30-10:00

RB-Delta

Regularity in Nonsmooth Analysis

Stream: Generalized Differentiation and Optimization
Invited session

Chair: Alexander Kruger, School of Science, Information Technology & Engineering, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au

Chair: Marco A. López-Cerdá, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es

1 - An inverse function result and some applications to sensitivity of generalized equations

Gabor Kassay, Mathematics, Babes-Bolyai University, 1 M Kogalniceanu 1, 400084, Cluj, Romania, kassay@math.ubbcluj.ro

We extend an inverse function theorem to set-valued case in metric spaces. Defining a condition number and the concept of well conditioning for parametric generalized equations at a certain initial value of the parameter, our inverse function theorem allows us to determine how much the initial problem can be perturbed in order to preserve its well conditioning. An application to the framework of vector optimization problems is then given. Finally we identify a special class of well conditioned set-valued mappings.

2 - Extensions of Metric Regularity

Alexander Kruger, School of Science, Information Technology & Engineering, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au, Andrei Dmitruk

The presentation is devoted to some extensions of the metric regularity property for mappings between metric or Banach spaces. Several new concepts are investigated in a unified manner: uniform metric regularity, metric multi-regularity for mappings into product spaces (when each component is perturbed independently), as well as their Lipschitz-like counterparts. The properties are characterized in terms of certain derivative-like constants. Regularity criteria are established based on a set-valued extension of a nonlocal version of the Lyusternik—Graves theorem due to Milyutin.

3 - Frechet and proximal Regularity of perturbed distance functions at points in the target set in Banach spaces

Messaoud Bounkhel, Department of Mathematics, King Saud University, College of Science, PO Box: 2455, 11451, Riyadh, Saudi Arabia, bounkhel@ksu.edu.sa

This talk is devoted to study the Frechet and proximal Regularity at points in the target set of perturbed distance functions $dJ_S(\cdot)$ determined by a closed subset S and a Lipschitz function $J(\cdot)$. Also, we provide some important results on the Clarke subdifferential of $dJ_S(\cdot)$ at those points in arbitrary Banach space.

4 - Some recent contributions to convex calculus

Marco A. López-Cerdá, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es

In this talk we present a general formula for the optimal set of a relaxed minimization problem in terms of the approximate minima of a given data function. This formula is used for deriving explicit characterizations of the subdifferential mapping of the supremum function of an arbitrarily indexed family of functions, exclusively in terms of the data functions. We also discuss on possible alternative approaches and applications to subdifferential calculus.

■ TA-24

Tuesday, 8:30-10:00

CC-A11

Demand Forecasting

Stream: Forecasting
Invited session

Chair: Aris Syntetos, Centre for Operational Research and Applied Statistics - Salford Business School, University of Salford, Maxwell Building, The Crescent, M5 4WT, SALFORD, United Kingdom, a.syntetos@salford.ac.uk

1 - Grouping seasonality and the formation of groups

Aris Syntetos, Centre for Operational Research and Applied Statistics - Salford Business School, University of Salford, Maxwell Building, The Crescent, M5 4WT, SALFORD, United Kingdom, a.syntetos@salford.ac.uk, John Boylan, Mona Mohammadipour

Estimating seasonality based on individual seasonal indices (ISI) often leads to unsatisfactory results. An alternative is to use the knowledge of demand at some aggregate/group level to improve forecasts at the individual level. This approach is usually referred to as group seasonal indices (GSI); an important assumption in its application is that a grouping mechanism is available. Our work provides empirical evidence on the comparative merits of ISI & GSI and the issue of choosing between them. The formation of seasonal groups is also explicitly addressed and linked to performance results.

2 - Forecasting in production planning by adaptive exponential smoothing methods

Frank Herrmann, Innovation and Competence Centre for Production Logistics and Factory Planning, University of Applied Sciences Regensburg, PO box 120327, 93025, Regensburg, Germany, Frank.Herrmann@HS-Regensburg.de

Demands of customers for products and of the production for parts are being forecasted quite often within the operational production planning and control by IT Systems (PPS systems) like the SAP system via exponential smoothing. There parameters need to be changed if the characteristics of the time series has changed. Since a manual change is very time consuming, industrial practice is interested in adaptive exponential smoothing methods. There state of the art, there limitation in terms of unstable forecasts, there performance in empirical studies and there usage in PPS systems are presented.

3 - Forecasting Intermittent Demand by Hyperbolic-Exponential Smoothing

Armagan Tarim, Management, Hacettepe University, Beytepe, 06800, Ankara, Turkey, armtar@yahoo.com, *Steven Prestwich*, *Roberto Rossi*, *Brahim Hnich*

Croston's method is superior to exponential smoothing when demand is intermittent, but is known to be biased. Variants of the method remove the bias, but only the recent variant called TSB addresses the problem of demand obsolescence. We describe a new forecasting method called Hyperbolic-Exponential Smoothing that handles obsolescence by decaying hyperbolically when demand is zero. In a full factorial design experiment on various smoothing factors, demand distributions and intermittencies, it has similar bias to TSB and even better forecast accuracy.

4 - Stochastic models for time-dependent intermittent demand

Clint Pennings, Rotterdam School of Management, Erasmus University, Netherlands, cpennings@rsm.nl, *Jan van Dalen*, *Erwin van der Laan*

Intermittent demand is characterized by several subsequent periods without demand. Croston developed a popular method for forecasting by assuming independence between inter-arrival time and quantity demanded. However, this seems unnatural in many practical situations (preventive or corrective maintenance) and has been empirically proven to be unrealistic. We developed a stochastic model to forecast demand that explicitly takes into account the time dependency and assessed the potential for performance improvement in inventory management relative to other popular frameworks.

We investigate the stability of a cartel gathering the non-OECD natural gas exporting countries. Our analysis is based on a deterministic, discrete-time, finite-horizon oligopoly model of investment and production equilibrium strategies. We implement a feedback information structure to solve the dynamic inconsistency of the open loop Stackelberg dynamic game. The model is calibrated to represent the world natural gas market under a "business as usual" scenario (projections of economic growth, demography, oil price) and used to formulate some policy recommendations for gas importing countries.

2 - Expectation Formation on Future Markets and Boom-and-Bust Cycles in Electricity Markets: Evidence from an Agent-Based Simulation

Daniel Ziegler, Chair for Management Sciences and Energy Economics, University Duisburg-Essen, Universitaetsstrasse 12, 45117, Essen, Germany, daniel.ziegler@uni-due.de

Agent-based simulations have the potential to provide insights how risks and disequilibria affect investments and may induce investment cycles. We present a modular agent-based model for the long term analysis of interrelated wholesale electricity markets. A future market translates expectations and spot market outputs into noisy price signals, which serves as inputs. First results indicate that the dynamics of investment cycles strongly depend on the way market participants form their expectations.

3 - Decision problems including limited liquidity in energy markets

Oliver Woll, Universitaet Duisburg-Essen, UniversitaetsstraÙe 12, 45117, Essen, Germany, oliver.woll@uni-due.de, *Christoph Weber*

In most energy markets, the liquidity of products with long-term maturity is limited. Standard models for corporate hedging do not cope with this situation. This paper provides an analytical approach for solving the problem by including a liquidity function into the standard mean-variance model going back to Markowitz. The paper then analyses optimal hedging strategies for power generators. It is shown that the optimal hedging strategy not only depends on price volatility and market liquidity but also on the size of the initial open position and on the remaining planning horizon.

4 - Planning of Energy Supply Chains based on Domestic Energy microgeneration

Georgios Kopanos, Department of Chemical Engineering, Centre for Process Systems Engineering, Imperial College London, Roderic Hill Building, South Kensington Campus, SW7 2AZ, London, London, United Kingdom, g.kopanos@imperial.ac.uk, *Michael Georgiadis*, *Efstratios Pistikopoulos*

This work addresses an emerging non-classical Energy Supply Chain (ESC) based on decentralized energy production via microgeneration. In particular, several domestic microgenerators are connected so as to form an energy micro-grid that allows residents to interchange energy among each other. Thermal and electrical energy demand of every household must be satisfied, while excessive electricity production can be sold to the macro-grid. A new mathematical programming framework for the energy production planning of this new type of ESC is proposed, and a representative case study is presented.

■ TA-25

Tuesday, 8:30-10:00

CC-A23

Modelling Markets with Imperfections

Stream: Energy, Environment and Climate 2

Invited session

Chair: *Christoph Weber*, Universität Essen, Universitätsstr. 11, 45117, Essen, Germany, Christoph_Weber@uni-duisburg-essen.de

1 - Cartelization in the natural gas industry, a model-based analysis

Albert Banal Estanol, Universitat Pompeu Fabra, 08002, Barcelona, Spain, albert.banalestanol@upf.edu, *Steven Gabriel*, *Olivier Massol*

■ TA-26

Tuesday, 8:30-10:00

CC-A24

Optimization in Design of Water Systems

Stream: OR in Water Management

Invited session

Chair: *Elcin Kentel*, Department of Civil Engineering, METU, Orta Dogu Teknik Universitesi, Universiteler Mahallesi, Dumlupinar Blv. No:1, 06800, Ankara, Turkey, ekentel@metu.edu.tr

Chair: *Halil Önder*, Civil Engineering, Middle East Technical University, Middle East Technical University, Department of Civil Engineering, 06800, Ankara, Turkey, onde@metu.edu.tr

1 - An improved decomposition-based heuristic for the pressurized water irrigation network design problem

Margarida Pato, ISEG (Technical University of Lisbon), CIO (University of Lisbon) and ISEG (Technical University of Lisbon), Rua do Quelhas, 6, 1200-781, Lisboa, Portugal, mpato@iseg.utl.pt, *Graça Gonçalves*, *Luis Gouveia*

Designing a pressurized water distribution network for irrigation purposes (WDNP) is a highly complex problem that aims at minimizing costs while obeying many technical constraints. A mixed binary non-linear programming model for WDNP will be presented along with an improved decomposition heuristic based on a linearization of the model. The computational results obtained from the heuristic with instances simulating a real application will be shown and compared to results from standard software. We conclude that the heuristic is a solid approach to the WDNP.

2 - Use of spreadsheet optimization for management in groundwater engineering

Halil Önder, Civil Engineering, Middle East Technical University, Middle East Technical University, Department of Civil Engineering, 06800, Ankara, Turkey, onde@metu.edu.tr

This work presents a groundwater management model that combines analytical solutions of the groundwater flow equation with linear programming to determine the best pumping scheme and optimum configuration for the dewatering system to drain groundwater in a construction site. It is based on spreadsheet application and it is a relatively low cost and rapidly applicable methodology. Using spreadsheets for optimization problem will be beneficial in closing the technology transfer gap between the development of optimization technique and their acceptance and practical use by practicing engineers.

3 - Estimation of aquifer parameters in groundwater management using spreadsheet optimization as an inverse problem

Elcin Kentel, Department of Civil Engineering, METU, Orta Dogu Teknik Universitesi, Universiteler Mahallesi, Dumlupinar Blv. No:1, 06800, Ankara, Turkey, ekentel@metu.edu.tr, *Halil Önder*, *Cüneyt Taşkan*

A spreadsheet optimization using a non-linear error function is utilized for estimation of aquifer parameter as an inverse problem based on an analytical solution of groundwater flow. The values of transmissivity and storage coefficient are determined from measured drawdown values at observation wells. Spreadsheet optimization provides the practitioners, educators, and researchers an efficient and convenient method for determining coefficients of aquifer, and a practical platform for routine evaluations. The proposed development is a relatively low cost and rapidly applicable methodology.

4 - A hybrid model for forecasting the streamflow data

Alpaslan Yazar, Civil Engineering, Selcuk University, Turkey, ayazar@selcuk.edu.tr, *Mustafa Onucyildiz*, *Hülya Yazar*

In this study, a hybrid model, Wavelet-Neuro Fuzzy (WNF), has been used to forecast the streamflow data of 5 Flow Observation Station (FOS), which belong to Sakarya Basin in Turkey. In order to evaluate the accuracy performance of the model, Linear Regression (LR) model has been used with the same data sets. The comparison has been made by Root Mean Squared Errors (RMSE) of the models. Results showed that hybrid WNF model forecasts the streamflow more accurately than LR model.

1 - Combining equity and utilitarianism in a mathematical programming model

Hilary Paul Williams, Operational Research, London School of Economics, Houghton Street, WC2A2AE, LONDON, United Kingdom, h.p.williams@lse.ac.uk, *John N. Hooker*

We show how equity and utilitarianism may be combined in a mathematical programming model, which applies particularly to the provision of health care. When the disparity in the cost of care of a particular group exceeds a threshold level the objective gradually moves from one of equity to one of utilitarianism. The resulting formulation, in its unmodified form, is non-convex and its hypograph is non MIP representable. When reformulated the model is easily solved and demonstrates interesting results on a dataset based on some US and UK data.

2 - Equitable preferences: representation and use in practical problems

Nikolaos Argyris, Management, Operational Research Group, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, n.argyris@lse.ac.uk

We consider the problem of centralized inequality-averse resource allocation. We first discuss a set of axioms that may characterize 'equitable' preferences over allocation profiles. We show that, under mild conditions, an equitable preference ordering over a finite set of allocations can always be represented by a symmetric, non-decreasing and concave function. Further, we show that the set of all such representations compatible with a set of revealed preferences has a succinct polyhedral representation. Finally, we discuss how these results may be used in choice and ranking problems.

3 - Incorporating preference information in multicriteria problems with equity concerns

Ozlem Karsu, Management, London School of Economics, Houghton Street, WC2A 2AE, LONDON, United Kingdom, ozlemkarsu@yahoo.co.uk, *Alec Morton*

We consider Multi Criteria Decision Making (MCDM) problems involving equity concerns which are highly encountered in real life, especially in public sector. From a modelling point of view, preference for equity can be handled by imposing person anonymity and quasi-concavity conditions on the model of the DM's preferences. One solution approach for MCDM problems is based on taking into account value judgments which the Decision Maker (DM) has provided. We suggest such an approach for problems with equity concerns and introduce substantial new theory.

4 - Aversion to health inequalities in healthcare prioritisation: a multiobjective mathematical programming perspective

Alec Morton, Management/ Operational Research, London School of Economics, Houghton St, London, wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk

We discuss the prioritisation of healthcare projects where there is a concern about health inequalities. Our analysis begins with a standard welfare economic model of healthcare resource allocation. We show how the problem can be reformulated as one of finding a particular subset of the class of efficient solutions to an implied multiobjective optimisation problem. Algorithms for finding such solutions are readily available, and we demonstrate our approach through a worked example of treatment for clinical depression.

■ TA-27

Tuesday, 8:30-10:00

CC-A25

Inequality Averse Decisions

Stream: Decision Processes

Invited session

Chair: *Alec Morton*, Management/ Operational Research, London School of Economics, Houghton St, London, wc2a2ae, London, England, United Kingdom, a.morton@lse.ac.uk

Chair: *Nikolaos Argyris*, Management, Operational Research Group, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, n.argyris@lse.ac.uk

■ TA-28

Tuesday, 8:30-10:00

CC-A27

Hierarchical Optimization

Stream: Structured Optimization and Applications

Invited session

Chair: *Eleftherios Couzoudis*, Economics, University of Zurich, Chair for Quantitative Business Administration, Moussonstrasse 15, 8044, Zurich, Switzerland, eleftherios.couzoudis@business.uzh.ch

1 - A poisson input queueing system for threshold policy of machine repair problem with degraded failure

Rekha Choudhary, Mathematics Dept., Govt. Engg. College, 110, Swarn Jayanti Nagar, 321001, Bharatpur, Rajasthan, India, rekharparth2003@yahoo.co.in

This investigation deals with the study of Optimal threshold policy for machine repair problem with R heterogeneous removable repairmen. The first repairman turns on for repair only when K1 failed units are accumulated and starts repair after a setup time, which is assumed to be exponentially distributed. The life time and repair time of failed units are assumed to be exponentially distributed. To obtain steady state queue-size distribution, recursive technique is used. Various performance measures are established using steady-state probabilities. A cost function is also deduced.

2 - Expansion Planning of Storage Technologies in Renewable Generation Systems

Christian Kraemer, Institute of Power Systems and Power Economics, RWTH Aachen University, Schinkelstr. 6, 52064, Aachen, Germany, ck@iaew.rwth-aachen.de, *Andreas Schäfer*, *Manuel Jäkel*, *Albert Moser*

Rising amounts of renewables and the age structure of European generation systems require the planning of new generation units. Storage technologies are supposed to play a significant role for storing renewable energy and providing flexibility. Expansion planning (EP) of storage units needs to consider time-dependencies in order to evaluate future benefits. It is shown that the long-term and large-scale EP problem can be broken down to its most important constraints. The derived model simulates the development of thermal and storage units under all relevant technical and economic constraints.

3 - The Optimality Antisymmetrical rank function in poset

Zahra Yahy, SEGC-LMD, Béjaia University, Faculty of Economic, Management and Trade Sciences, Algeria, zahrayahi@yahoo.fr, *Sadek Bouroubi*

In studying the optimality rank function, several results are given. A sufficient condition is given by Alexiv. The optimality of the rank function depends also on the type of the poset; e.g., for the rank function about a distributive poset, a normal poset is optimal. Our objective are studies of optimality of the Antisymmetrical rank function in a particular poset. We give some sufficient condition of the Antisymmetrical rank function and some results in relation with the optimality of the rank function in poset.

■ TA-29

Tuesday, 8:30-10:00

CC-A29

MINLP in Airline and Air Traffic Management applications

Stream: Mixed-Integer Non-Linear Programming
Invited session

Chair: *Sonia Cafieri*, Lab. MAIAA, Dept. de Mathématiques et Informatique, Ecole Nationale d'Aviation Civile, 7 Ave. Edouard Belin, 31055, Toulouse, France, sonia.cafieri@enac.fr

Chair: *Claudia D'Ambrosio*, LIX, CNRS - Ecole Polytechnique, route de Saclay, 91128, Palaiseau, France, dambrosio@lix.polytechnique.fr

1 - On solving the collision avoidance problem for ATM by solving a Mixed 0-1 nonlinear optimization model heuristically

Laureano Fernando Escudero, Dept. de Estadística e Investigación Operativa, Universidad Rey Juan Carlos, c/Tulipan, S/n, 28933, Mostoles (Madrid), Spain, laureano.escudero@urjc.es, *Antonio Alonso-Ayuso*, *F. Javier Martin-Campo*

A mixed 0-1 nonlinear optimization model is presented to solve the Collision Avoidance for Air Traffic Management Problem. We give a new configuration for each aircraft such that every conflict situation is avoided. If some aircrafts violate the safety distances, a conflict situation occurs. Due to the difficulty to solve the problem by MINLP engine software in short time, a heuristic way is developed for obtaining good solutions in short time. The main results will be reported by comparing the exact solutions with the heuristic ones for short-scale problems.

2 - Conflict resolution by minor speed adjustments

David Rey, LICIT, IFSTTAR, Bron, France, david.rey@inrets.fr, *Christophe Rapine*, *Rémy Fondacci*, *Nour-Eddin El Faouzi*

We present a reformulation of a nonlinear optimization problem encountered in Air Traffic Management (ATM). A current challenge in ATM is to increase airspace capacity to deal with a growing traffic demand. One way to address the capacity problem is to smoothly regulate the traffic flow by performing minor adjustments on aircraft speeds. To guarantee the required safety standards in ATM, one needs to prevent potential conflicts from occurring. This speed regulation framework can be modeled as a nonlinear optimization problem which we propose to reformulate as a Mixed Integer Linear Program.

3 - Airline tail assignment optimization: the impact of aircraft heterogeneity

Patrícia Ribeiro, Technical University of Lisbon, Lisbon, Portugal, patricia.ribeiro@ist.utl.pt, *Susana Relvas*, *Nuno Leal*

Operating with low margins in a competitive industry, airlines seek strategies to minimize operating costs and improve operational efficiency. One possible strategy consists in considering heterogeneity among aircraft tails when assigning them to the planned flights. We aim to optimize the tail assignment process of the Airline TAP Portugal by taking into account the different characteristics and performances of each aircraft. The savings achieved by optimizing a mixed integer linear programming model integrating the re-design of lines of flights and the tail assignment process are presented.

4 - Aircraft conflict avoidance: a mixed-integer nonlinear optimization approach

Sonia Cafieri, Lab. MAIAA, Dept. de Mathématiques et Informatique, Ecole Nationale d'Aviation Civile, 7 Ave. Edouard Belin, 31055, Toulouse, France, sonia.cafieri@enac.fr

Detecting and solving aircraft conflicts, which occur when aircraft sharing the same airspace are too close to each other according to their predicted trajectories, is a crucial problem in Air Traffic Management. We focus on mixed-integer optimization models based on speed regulation. We first solve the problem to global optimality by means of an exact solver. The problem being very difficult to solve, we also propose a heuristic procedure where the problem is decomposed and it is locally exactly solved. Computational results show that the proposed approach provides satisfactory results.

■ TA-30

Tuesday, 8:30-10:00

CC-A31

Modeling Approaches and Solution Algorithms

Stream: Emerging Aspects of Production Planning in Continuous Process Industries: Theory, Optimization, and Practice

Invited session

Chair: *Christoph Schwindt*, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de

1 - Heuristic decomposition and LP-based scheduling in make-and-pack production

Norbert Trautmann, Department of Business Administration, University of Bern, Ordinariat für Quantitative Methoden der BWL, Schützenmattstrasse 14, 3012, Bern, BE, Switzerland, norbert.trautmann@pqm.unibe.ch, *Philipp Baumann*

We deal with the short-term scheduling of make-and-pack production processes. The planning problem consists in minimizing the production makespan while meeting a given demand subject to a large variety of technological constraints. The problem size of real-world instances requires the usage of heuristics.

We propose to schedule groups of batches iteratively using a continuous-time MILP formulation; the assignment of the batches to the groups and the scheduling sequence of the groups are determined using a priority rule. We report on computational results for a real-world production process.

2 - Modeling Formulation and Solution Approach for a Continuous Process Problem

Krystina Bakhrankova, Applied economics, SINTEF - Technology and society, Box 4760 Sluppen, S. P. Andersens veg 5, 7465, Trondheim, Norway, krystina.bakhrankova@sintef.no, *Truls Flatberg*

Production planning of continuous systems is less covered in the process industry literature relative to their batch counterparts. This work presents a modeling formulation and a corresponding solution approach for a real-world optimization problem, where bulk chemicals are produced via a completely continuous non-intermittent process. It also provides relevant analysis with respect to model properties and solution times as well as potential economic benefits of applying the proposed methodology in practice.

3 - Planning of a continuous production process in the printing industry

Philipp Baumann, Department of Business Administration, University of Bern, IFM, AP Quantitative Methoden, Schützenmattstrasse 14, 3012, Bern, Switzerland, philipp.baumann@pqm.unibe.ch, *Norbert Trautmann*

Offset printing is a common method to produce large amounts of printing matter. We consider a real-world offset printing process that is used to imprint customer-specific designs on napkin pouches. The planning problem consists in allocating printing-plate slots to the designs such that a given customer demand is fulfilled, all technological requirements are met and the total printing cost are minimized. We formulate this planning problem as a mixed-integer linear program, and we report on computational results for industrial problem instances.

4 - Comparing models for operational production planning and scheduling in single-stage continuous processes: Process Systems Engineering vs. Operations Research

Ana Paula Barbósa-Póvoa, Dept. De Engenharia e Gestao, IST, Av. Rovisco Pais, 1, 1049-001, Lisbon, Portugal, apovoa@ist.utl.pt, *Pedro Amorim, Bernardo Almada-Lobo, Tânia Pinto_Varela*

Several researchers from the two communities, Operational Research and Process Systems Engineering, have focused on mathematical formulations for the simultaneous lot-sizing and scheduling of single-stage continuous processes with complex set-up structures. This problem arises in the glass, beer, and dairy production. Although recent research has been performed by both mentioned communities, there is no intense communication between these research efforts. This work attempts a systematic analysis of the recent formulation developments to narrow the gap between both communities on this problem.

cial Intelligence

Contributed session

Chair: *Takashi Onoda*, System Engineering Lab., CRIEPI, 2-11-1, Iwado Kita, Komae-shi, 201-8511, Tokyo, Japan, onoda@criepi.denken.or.jp

Chair: *Anastasia Motrenko*, Applied mathematics and management, MIPT, Moscow, Russian Federation, pastt.petrovna@gmail.com

1 - An evaluation of the Generalized Additive Neural Network spam filtering approach

Tiny Du Toit, School of Computer, Statistical and Mathematical Sciences, North-West University, North-West University, 11 Hoffman Street, 2531, Potchefstroom, North-West, South Africa, Tiny.DuToit@nwu.ac.za, *Hennie Kruger*

The performance of a Generalized Additive Neural Network on a publicly available corpus is investigated in the context of statistical spam filtering. The impact of different feature set sizes on an automated construction algorithm is studied using cost-sensitive measures. Experiments show high performance where legitimate e-mails are assigned the same cost as spams. Applications where legitimate e-mails are allocated a much higher cost than spams should be avoided. This decrease in performance is caused by the aggressive feature dimension reduction required by the algorithm.

2 - Applying hybrid models to analyze the adoption intention of mobile applications

Yang-Chieh Chin, International Business, Asia University, 500, Lioufeng Rd., Wufeng, 41354, Taichung, Taiwan, jerry110888@gmail.com, *Chiao-Chen Chang*

Mobile applications are one of the most rapidly growing segments of the software market. The goal of this study is to gain insight into the factors that affect user intention to adopt mobile applications. Firstly, a dominance-based rough set approach (DRSA), a rule-based decision-making technique, is used to determine the adoption intentions associated with decision rules in mobile applications. The second phase of the project uses formal concept analysis (FCA) to infer decision rules and variables. Practical and research implications are also offered.

3 - Semantic Web services composition with query rewriting under constraints

Khaled Sellami, LMA Laboratory, Bejaia University / EISTI France, 06000, Bejaia, Algeria, skhaled36@yahoo.fr, *Mohamed Ahmed-Nacer, Rachid Chelouah, Hubert Kadima, Nadia Halfoune*

The concept of "Web services" is essentially an application available on the Internet by a service provider, and accessible by customers through standard Internet protocols. Examples of services currently available are the booking travel online, banking or the implementation of the management of the supply chain. The purpose of this work is to present, in one hand, a model of semantic annotations for describing the Web services and the user request and in another hand, an algorithm which discovers and composes the Web services using the query rewriting under constraints.

4 - Logical analysis of data for a study of proverbs

Jorge Santos, Matemaatica, Univ Evora, Rua Romão Ramalho, 59, 7000-671, Évora, Portugal, jorgensantosp@gmail.com, *Luís Cavique, Armando Mendes*

A case study of proverbs is presented as a part of a wider project, based on data collected by thousands of interviews and involving a set of thousands Portuguese proverbs. We search the minimum information needed to identify the birthplace of an interviewee in a database with inconsistencies. An approach to data reduction is given by the Logical Analysis of Data (LAD). LAD handicaps, like the inability to cope with the contradiction and the limited number of classification classes, will be overcome in this version of Logical Analysis of Inconsistent Data.

■ TA-31

Tuesday, 8:30-10:00

CC-A33

Data Mining: Web and Social-Oriented Applications

Stream: Data Mining, Knowledge Discovery and Artificial

■ TA-32

Tuesday, 8:30-10:00

CC-A34

Soft OR case studies

Stream: Soft OR and Problem Structuring Methods
Invited session

Chair: *Giles Hindle*, Management Systems, Hull University Business School, University of Hull, Cottingham Road, HU6 7RX, Hull, United Kingdom, giles.hindle@hull.ac.uk

1 - Extending WASAN — Case Study of a UK Police Force

Chris Smith, OIM Group, Aston University, Aston Business School, Aston Triangle, B4 7ET, Birmingham, West Midlands, United Kingdom, smithcm2@aston.ac.uk, *Duncan Shaw*

This paper extends the theoretical and practical application of Waste and Source Matter Analysis (WASAN) methodology beyond its initial conception. Applying WASAN in a case outside of the environment it was designed for begins to show that WASAN has generic properties and can be used in a number of different problem situations. To successfully apply WASAN in the new case significant development of the methodology was required. The development of the methodology will take an action research approach operationalised in a case study environment. This paper will form part of the researchers PhD.

2 - The secret's in the mix: using OR to inform learning and teaching developments

Jo Smedley, Centre for Excellence in Learning and Teaching, University of Wales, Newport, Lodge Road, Caerleon, NP18 3QT, Newport, Wales, United Kingdom, jo.smedley@newport.ac.uk

Problem structuring methods help to structure complex problems to gain a common understanding among a group and progress on a committed course of action. This paper illustrates how a combination of soft and hard OR approaches supported the design, development and implementation of an organisational learning and teaching initiative across a UK University. OR as a collaborative learning "language" across disciplines and topics supported effective and efficient engagement helping to achieve successful outcomes and inform continuing developments.

3 - A conceptual modelling framework for Public Health economic modelling

Hazel Squires, ScHARR, University of Sheffield, Regent Court, 30 Regent Street, S1 4DA, Sheffield, South Yorkshire, United Kingdom, h.squires@sheffield.ac.uk, *Jim Chilcott*, *Ron Akehurst*, *Jennifer Burr*

Commonly used methods for health economic modelling are often directly applied to Public Health (PH) interventions. However, an inadequate understanding of these complex PH problems and the resulting implications for model development means that inappropriate model structures may be used. We present a conceptual modelling framework (CMF) to facilitate model development within PH economic modelling, developed from (i) a review of key challenges of PH economic modelling, (ii) a review of CMFs and (iii) qualitative research to understand modellers' experiences developing PH economic models.

4 - Participatory Decision Processes in Rural Communities in Tanzania

Joe Kakeneno, Management Systems, Tanzania Ports Authority, P.O Box 9184, Dar es Salaam, N/A, Dar es Salaam, N/A, Tanzania, United Republic Of, joekakeneno@yahoo.co.uk, *Cathal Brugha*

We discuss the usability of the Structured Multi-Criteria Decision-Making (MCDM) methodology in participatory decision processes for selecting suitable irrigation methods to be implemented by rural communities in Tanzania. An MCDM framework which could be integrated into existing community participatory decision making processes was developed and used to arrive at community preferences. The framework could be used to support distributed decision making in various problem contexts and situations.

■ TA-33

Tuesday, 8:30-10:00

CC-A37

OR and Transportation: Applications in Developing Countries

Stream: OR for Development and Developing Countries

Invited session

Chair: *Youssef Masmoudi*, University of Sfax, Hight School of Commerce of Sfax, BP 954, 3018, Sfax, Tunisia, youssef.masmoudi@gmail.com

Chair: *Habib Chabchoub*, LOGIQ, Institut Supérieur de Gestion Industrielle, 3018, Sfax, Sfax, Tunisia, Habib.chabchoub@fsegs.rnu.tn

1 - Static multiclass truck assignment model: an application to Nigeria

Precious Ikem, Civil Engineering, imperial, Skempton Building, sw7 2az, London, United Kingdom, pi06@imperial.ac.uk, *Michael Bell*

This paper reports on the development of a traffic model built to estimate the potential impact of a dry port solution on traffic congestion in Lagos. It outlines a conceptual framework for assigning import freight traffic to a road network while considering the characteristics of the freight haulage industry in developing countries, particularly Nigeria. The use of a static multiclass user equilibrium assignment model with an inter-zone container flow survey data is proposed. The classes represent containerized cargo categorized by the type of vehicle carrying the container or its contents.

2 - New approach to the Single Track Railway Scheduling Problem

Maya Laskova, The Institute of Control Sciences V. A. Trapeznikov Academy of Sciences, Moscow, Russia, Russian Federation, laskovayamaya@moscow-index.ru, *Alexander Lazarev*, *Elena Musatova*

We consider the single track railway scheduling problem with two stations. Two subsets of trains are given, where trains from station one go to station two, and trains from station two go to station one. All trains have the same speed. At most one train from station one or two can be on the track at any time. We consider the single track railway scheduling problem with two stations with optimization criteria of minimizing additional completion time for each trains. We propose a heuristic approach to The Single Track Railway Scheduling Problem.

3 - Humanitarian Operations Research in Southern Africa

Hildah Mashira, Applied Mathematics, National University of Science and Technology, 14407 Inkhaka Circle, Selbourne Park, Bulawayo, Zimbabwe, hilda.mashira@gmail.com

The HIV/AIDS pandemic has reached an unprecedented scale in South Africa. The burden that this has placed on the country is already restricted health care resources place a greater emphasis on the value of Anti Retroviral drug distribution. The aim of my project is to design a distribution model for the department of health in the Limpopo province. This will seek to present major stages applicable to building effective models and routes that are cost effective and ensure that drugs are delivered to almost every part of the province.

■ TA-34

Tuesday, 8:30-10:00

CC-A39

Environment and Sustainable Development - Green Teachers

Stream: Optimization for Sustainable Development
Invited session

Chair: *Azizah Hanim Nasution*, Graduate School of Natural

Resources and Environment Management, University of Sumatera Utara, Indonesia, nazizahhanim@yahoo.com

1 - A Markov-based model in managing coordination relationship of school communities to achieve environmental behaviour

Azizah Hanim Nasution, Grad.School of Env. Manag & Natural Resources, University of Sumatera Utara, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, azizahhanimn@yahoo.com, *Herman Mawengkang*

The world today concerns with environmental problems. Most of the problems might be caused by human behavior. The most effective way to enhance environmental behavior is through education. The communities involved in the educational system of a school can be regarded as a multi agent system. In this paper we use Markov-based dynamic influence diagram to model the coordination relationships such that agents are able to both represent and infer how their activities affect other agents' activities in a way to achieve the environmental behavior objective.

2 - A decision analysis approach model to maximize students' cognition of environmental problems

Hidayati Hidayati, Environmental Protection Board, Government of North Sumatera Province, Jl. Diponegoro, Medan, Indonesia, hidayati6817@yahoo.com, *Azizah Hanim Nasution*

A learner is a cognitive system that develops by his/her information and knowledge-processing activities. To maximise the learner's cognitive development, knowledge-intensive environments are essential particularly for achieving environmental knowledge. This paper proposes a model based on a decision analysis approach evaluating students' cognitive development toward environmental problems.

3 - A Stochastic Programming model for Sustainable Production Planning of Crude Palm Oil Industry

Hendaru Sadyadharma, Grad.School of Env. Manag & Natural Resources, University of Sumatera Utara, PSL USU, 20155, Medan, North Sumatera Province, Indonesia, sadyadharma@yahoo.com, *Herman Mawengkang*

This paper addresses a multi-objective stochastic programming model of the sustainable production planning of crude palm oil. The model takes into account conflicting goals such as return and financial risk and environmental costs. The uncertainty comes from the price of crude palm oil. Starting from it two single objective models are formulated: a maximum expected return model and a minimum financial risk (pollution penalties) model. We transform the stochastic programming model into a deterministic multi-objective model using sampling average approach.

■ TA-35

Tuesday, 8:30-10:00
CC-A41

Pricing and Supply Chain Management

Stream: Operations/Marketing Interface
Invited session

Chair: *Kathryn E. Steck*, University of Texas at Dallas, United States, KStecke@utdallas.edu

1 - Impact of Returns Policies on Retail Assortment and Pricing Decisions

Alex Grasas, Economics and Business, Universitat Pompeu Fabra, Ramon Trias Fargas 25-27, 08005, Barcelona, Spain, alex.grasas@upf.edu, *Aydin Alptekinoglu*

We analyze a retailer's assortment, pricing and return policy (fraction of price refunded upon return) decisions. The retailer must choose its assortment from an arbitrary set of products, and determine the price and refund amount for every product. We model the consumer choice behavior using a nested-MNL-based choice model, and derive a simple metric to rank products, which reveals the optimal assortment quite efficiently. We compare the optimal policies for this integrated model to the case when the return policy is exogenous, driven by category- or store-wide considerations.

2 - Dynamic Pricing of Fashion Products: The Effects of Demand Learning and Strategic Consumer Behavior

Yossi Aviv, Olin Business School, Washington University in Saint Louis, Campus Box 1133, 1 Brookings Drive, 63130, Saint Louis, MO, United States, aviv@wustl.edu

We propose a dynamic-pricing model of a retailer that sells a product to strategic consumers. The seller learns about the market size through sales observations. This raises an interesting phenomenon: consumers can influence the seller's perception about the market size. We will discuss the latter point, and examine the effectiveness of price commitment strategies. We will also consider a model of a retailer that does not incorporate learning from early sales. This leads to an interesting question: is it better to become sophisticated (capable of learning) when facing strategic consumers?

3 - The study of a time-dependent Freight Transportation Problem

Xiang Song, School of Mathematics, University of Portsmouth, Lion Gate Building, Portsmouth, United Kingdom, xiang.song@port.ac.uk

Freight transportation is a major component of the supply chain management. We aim to study a "time-dependent" freight transportation problem, which takes varied time between two locations into consideration. The main methodology we adopt is a number of dynamic programming state space relaxation techniques and their applications to solving the time-dependent Freight Transportation Problem. The simulated data from a software-development company, which provides vehicle routing and scheduling solutions to UK-based customers, will be used for evaluating our result.

4 - An Integrated Approach to Green Product and Supply Chain Design

Cornelia Schoen, GISMA Business School, Leibniz University Hannover, Germany, schoen@wiwi.uni-hannover.de

In many industries, product design increasingly requires to integrate economic objectives with environmental thinking - driven by raising ecological concerns, regulatory pressures, and the potential to create a marketing edge through sustainable operations. A major challenge of green design is that it must not only embrace a product's key features from a consumer perspective but also all underlying supply chain processes that determine a product's 'greenness'. We present an integrated optimization approach for green product and supply chain design along with applications.

■ TA-36

Tuesday, 8:30-10:00
CC-A43

DEA and Performance Measurement: Applications 3

Stream: DEA and Performance Measurement
Invited session

Chair: *Emmanuel Thanassoulis*, Aston Business School, Aston University, Operations and Information Management, B4 7ET, BIRMINGHAM, United Kingdom, e.thanassoulis@aston.ac.uk

1 - Prioritizing project activities via DEA methodology

Yossi Hadad, Industrial Engineering and Management, SCE - Shamoon College of Engineering, Balik Bazel, 8 Peretz Lasker St., Beer Sheva 84519, Israel, 84100, Beer Sheva, Israel, yossi@sce.ac.il, *Baruch Keren*, *Lea Friedman*

Ranking project activities by importance, and then clustering the activities into subgroups that require additional attention is very important. Ranking project activities may assist project managers in identifying the most significant activities, and thus allocate resources effectively. A multi-criteria ranking based on several indexes may provide better rankings than those based on a single index. This research proposes a method for ranking project activities, where each activity is evaluated by several indexes. The proposed method applies DEA methodology and the Super Efficiency model.

2 - Cognitive Effects of DEA on Performance Assessment

Nadia Vazquez Novoa, Institute of Management Control and Business Accounting, TU Braunschweig, Pockelsstraße 14, 38106, Braunschweig, Lower Saxony, Germany, n.vazquez-novoa@tu-bs.de, *Heinz Ahn*

Psychological evidence suggests that the use of DEA efficiency scores may lead to significant cognitive biases. An experimental study considering the representativeness and anchoring effects of DEA scores was conducted. The findings not only confirm that DEA scores act as a strong performance marker when deciding on which DMUs should be awarded for their non-financial performance, but also show that the scores may significantly influence a posterior financial assessment. These results have practical consequences for planning, reporting, and controlling processes that incorporate DEA scores.

3 - More New Features of Data Envelopment Analysis Online Software (DEAOS)

Mohammad-Reza Alirezaee, School of Mathematics, Iran University of Science and Technology, Hengam St., Resalat Sq., 16846, Tehran, Iran, Islamic Republic Of, mralirez@yahoo.com, *Ali Niknejad*, *Nassrin Alirezaee*

DEAOS has been presented as a professional web application for data envelopment analysis (DEA) including several available models, multiple time periods facilities, useful features, user friendly interface and reporting, importing data, exporting results and easy to use on internet. Here more new features, added to DEAOS, including categorical selection, analytical hierarchy process (AHP) analysis, and many other items will be presented. DEAOS is available at www.DEAOS.com.

4 - Data Envelopment Analysis software for the advanced users

Ali Emrouznejad, Aston Business School, Aston University, B4 7ET, Birmingham, United Kingdom, a.emrouznejad@aston.ac.uk, *Emmanuel Thanassoulis*

This paper presents software that takes its features closer to the latest developments in the DEA literature. The new software addresses a variety of issues such as: Assessments under a variety of possible assumptions of returns to scale including NIRS and NDRS; undesirable input/output variables, slack-based measures, truly unlimited number of assessment units (DMUs); analysis of groups of data by estimating automatically separate boundaries by group; Malmquist Index and its decompositions; Super efficiency; Cross efficiency; Allocative efficiency and Bootstrapping.

2 - A simulation-based optimization tool for patient allocation to clinical studies

Stephan Tiesler, University of Jena, Faculty of Business and Economics, Chair of Business Informatics, Carl-Zeiss-Straße 3, 03643, Jena, Thuringia, Germany, stephan.tiesler@uni-jena.de, *Johannes Ruhland*

In all sorts of clinical studies, patient enrolment and recruitment constitutes both a critical success factor and a scarce resource. In large project settings numerous studies with diverse intake requirements and due dates are carried out simultaneously, creating competing demand for a patient "supply" that is stochastic and subject to numerous legal, structural and medical restrictions. We develop a simulation based optimization tool that will allow for optimal allocation of patients to studies in real time and that can also be used to guide strategic issues of study planning.

3 - Using decision analytic modeling for the optimal dichotomization of diagnostics

Gimon de Graaf, Epidemiology, University Medical Center Groningen, Hanzeplein 1, P.O. Box 30 001, 9700 RB, Groningen, Netherlands, g.de.graaf@umcg.nl, *Douwe Postmus*

The chosen cut-off on a diagnostic test for clinical decisions has far-reaching consequences on costs and health effects. Surprisingly, this cut-off is almost never chosen based on such downstream consequences, but rather on an arbitrarily chosen balance between false positives and false negatives. We describe how an optimal cut-off based on downstream consequences can be identified with help of multi-state modeling of a patient's disease progression. We illustrate this method by means of a case study of a diabetes screening program.

4 - Custom contract and the role of Group Purchasing Organizations (GPOs) as information intermediaries

Vera Tilson, University of Rochester, 14627, Rochester, United States, vera.tilson@simon.rochester.edu, *Abraham Seidmann*, *Rajib Saha*

Many hospitals in the US join GPOs in order to get deeper group discount contracted by the GPOs. However, some members further negotiate directly with the same vendors. The common perception is that hospitals benefit from such directly-established "custom contracts" as they yield lower prices. Using a game-theoretic model, we find that the provision for custom contracts, in fact, benefits vendors at the expense of hospitals. We show, how with the provision for custom contracts, GPOs expectedly act as demand aggregators for small hospitals, and as information intermediaries for the rest.

■ TA-37

Tuesday, 8:30-10:00

CC-Act

OR in Health & Life Sciences 1

Stream: OR in Health & Life Sciences (contributed)
Contributed session

Chair: *Abraham Seidmann*, University of Rochester, 14627, Rochester, NY, United States, seidmannav@simon.rochester.edu

1 - Utility of quantitative methods in strategy — making process for blood donation system — logistics approach

Sebastian Twaróg, Department of Business Logistics, University of Economics in Katowice, 1 Maja 50, 40-287, Katowice, Poland, sebastian.twarog@ue.katowice.pl, *Anna Ojrzyńska*, *Grażyna Trzpiot*, *Jacek Szoltysek*

An effective blood donation system is centrepiece to assuring health care in every country. Improvement of such a system is an important task for logistician. This paper aims to point out the possibility of applications of chosen quantitative methods in developing the blood donation system. An important part of our research was multivariate and spatial differentiation of discussed issues. Verified was the usefulness of multivariate method data mining and spatial autocorrelations. Those results are prerequisite for creating a blood donation system model.

■ TA-38

Tuesday, 8:30-10:00

HH-Colombus

Interactive Multiobjective Optimization: Methods and Applications

Stream: Multiobjective Optimization
Invited session

Chair: *Kaisa Miettinen*, Dept. of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014, University of Jyväskylä, Finland, kaisa.miettinen@jyu.fi
Chair: *Jussi Hakanen*, Dept. of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014, University of Jyväskylä, Finland, jussi.hakanen@jyu.fi

1 - Interactive Gradient Projection and Reference Point Approach for Multiobjective Performance Planning

Dong-Ling Xu, Manchester Business School, The University of Manchester, F37 MBSE, Booth Street West, M15 6PB, Manchester, England, United Kingdom, L.Xu@mbs.ac.uk, *Jian-Bo Yang*

In the paper, equivalence relationships are explored between data envelopment analysis (DEA) and multiple objective linear programming

models, leading to a hybrid approach in which the two functions of performance assessment and planning can be integrated where DM's preferences can be taken into account in an interactive fashion. It is proved that the input-oriented DEA dual models are identical to reference point minimax models, both of which can be used for conventional efficiency analysis, whilst the latter can be used to conduct trade-off analysis for performance planning based on a gradient projection approach. A case study for a supplier performance assessment problem is explored in detail.

2 - Decision making in a multi-objective paper mill design problem

Ingrida Steponavice, Dept. of Mathematical Information Technology, University of Jyväskylä, FI-40100, University of Jyväskylä, Finland, ingrida.steponavice@jyu.fi, *Sauli Ruuska*, *Kaisa Miettinen*

Application of interactive multiobjective optimization to support decision making in industry where modern production processes necessitate increasingly complex and computationally costly models imposes challenges. A computationally expensive integrated control and design problem concerning both flexibility in design and amount of capital invested in paper is considered. A computationally inexpensive surrogate problem is prepared with the PAINT method while the interactive IND-NIMBUS tool is used to direct a search in finding the most satisfactory solution according to the DM's preferences.

3 - Consistent parametric representation of Pareto optimal solutions via geometric criteria

Alberto Lovison, Dipartimento di Metodi e Modelli Matematici, Università degli Studi di Padova, 35121, Padova, Italy, lovison@math.unipd.it, *Markus Hartikainen*

In many practical multiobjective optimization problems, the set of Pareto optimal (PO) solutions exhibits non trivial manifold structures both in objective and decision spaces. In particular, for nonconvex objective functions, different branches of the set of PO solutions can be mapped one onto the other, causing serious problems to approximation algorithms. We propose an algorithm based on geometrical criteria which can discriminate among different branches and produce consistent parametric representations of the set of PO solutions, as is shown by examples.

4 - Parameterized achievement scalarizing functions based approach to solve multicriteria median location problem

Olga Karelkina, Mathematics, University of Turku, Turun Yliopisto, 20014, Turku, Finland, volkar@utu.fi

This research addresses interactive optimization techniques based on parameterized achievement scalarizing functions (ASFs). A decision making process is simulated for multicriteria median location problem to illustrate the way how synchronous usage of ASFs may reduce the number of iterations in an interactive process and speed up its convergence to the most preferred solution. Numerical experiments are performed for the case of three objectives.

■ TA-39

Tuesday, 8:30-10:00

HH-Cousteau

MCDAs: New Approaches and Applications in Financial Markets

Stream: MCDAs: New Approaches and Applications
Invited session

Chair: *Gabriela Fernández Barberis*, Quantitative Methods, San Pablo CEU University, 23, Julián Romea St., 28003, Madrid, Spain, Spain, ferbar@ceu.es

1 - Multiple Criteria Decision Aid Methods with New Generalized Criteria: an application to the financial markets

Gabriela Fernández Barberis, Quantitative Methods, San Pablo CEU University, 23, Julián Romea St., 28003, Madrid, Spain, Spain, ferbar@ceu.es, *María del Carmen Escribano Ródenas*, *María Del Carmen García Centeno*

We propose New Types of Generalized Criteria which gives the decision maker the chance to express his preferences more easily. To illustrate the relevance of the preference functions introduced in the analysis we applied the PROMETHEE Methods with New Generalized Criteria to order the preference between the daily financial returns of some Stock Market Indexes of different countries. In the financial market, the volatility is an essential variable. We have used different econometric models to estimate the stochastic volatility.

2 - Towards a new classification of Spanish Saving Banks: application of multicriteria decision aid methods

Milagros Gutiérrez Fernández, Financial Economy and Accounting, University of Extremadura, Av, University s/n, 10071, Cáceres, Spain, mgutierrezf@unex.es, *Gabriela Fernández Barberis*, *Ricardo Palomo Zurdo*

The objective of this paper is to propose a classification of the Spanish Saving Banks under a criterion of integration that takes into account economic and social variables. We have study 45 saving banks in the period 1999-2009. Multicriteria decisions methods belong to the family of Outranking Relations that have proved to be a tool which is very important in this type of analysis.

■ TA-40

Tuesday, 8:30-10:00

HH-Livingstone

Dynamic Pricing

Stream: Revenue Management
Invited session

Chair: *Mikhail Nediak*, School of Business, Queen's University, 143 Union Street, K7L 3N6, Kingston, Ontario, Canada, mnediak@business.queensu.ca

1 - Revenue Management with Lifetime Value Considerations: Balancing Customer Acquisition and Retention Spending for Firms with Limited Capacity

Anton Ovchinnikov, University of Virginia, Darden School of Business, 100 Darden Blvd, 22903, Charlottesville, VA, aovchinnikov@darden.virginia.edu

This paper discusses the interaction between revenue management (RM) and customer relationship management (CRM) for a firm that operates in a customer retention situation but faces limited capacity. We present a dynamic programming model for how the firm balances investments in customer acquisition and retention, as well as retention across multiple customer types. We characterize the optimal policy and discuss how the policy changes depending on capacity limitations. We then contrast the modeling results with those of a behavioral experiment.

2 - Use of exact algorithms for Partially Observable Markov Decision Processes in solving a Dynamic Pricing problem

Shahin Abbaszadeh, School of Management, University of Southampton, University of Southampton, University Road, SO17 1BJ, Southampton, United Kingdom, sa14g10@soton.ac.uk

We use Partially Observable Markov Decision Processes (POMDP) to find optimal dynamic pricing policies for a retailer of short-life-cycle products with no replenishment during the season. The objective is to maximize expected profit using predefined prices during the season. We show our problem has a Convex and Piecewise Linear value function and employ three exact POMDP algorithms that make use of that property. We analyse performance of these methods in comparison to common practices and strategies such as myopic pricing and discuss managerial insights and potential future research.

3 - Name-Your-Own-Price sales channels: Can strategic consumers improve their performance with information exchange or collaboration?

Mikhail Nediak, School of Business, Queen's University, 143 Union Street, K7L 3N6, Kingston, Ontario, Canada, mmediak@business.queensu.ca, Tatsiana Levina, Yuri Levin, Jeff McGill

Supplier reluctance to openly advertise large discounts lead to the creation of opaque name-your-own-price channels, where firms can sell discounted products in generic categories without revealing their identity until a purchase is completed. Prices in these channels are concealed and bid-sampling is restricted. Consumers responded by developing social networking practices aimed at exploiting these services. In this work, we explore several robust bidding strategies and the value of collaboration among consumers in the form of exchange of bid history, coordinated bidding, and risks-pooling.

■ TA-41

Tuesday, 8:30-10:00

HH-Heyerdahl

AHP/ANP 4

Stream: Analytic Hierarchy Process, Analytic Network Process

Invited session

Chair: Y. Ilker Topcu, Industrial Engineering, Istanbul Technical University, Istanbul Teknik Universitesi, Isletme Fakultesi, Macka, 34357, Istanbul, Turkey, ilker.topcu@itu.edu.tr

1 - Applying ANP to Select Strategic Alliances for International Tourist Hotels in Taiwan

Su-Chuan Shih, Business Administration, Providence University, 200 Chung Chi Road, Business Administration, 43301, Taichung City, Taiwan, Taiwan, seshih@pu.edu.tw

International tourist hotels often adopt strategic alliance to increase their competition advantage. This study employs Analytic Network Process to select strategic alliance types. The result shows the most important key criterion is the performance goal of the alliance. Under the key criterion, the index of profit rate is weighted more than the others. The preference alliance types are ordered as: the complex activities, the electronic channels, and the physical shops.

2 - An Integrated Multi-Criteria Approach for the Evaluation and Control of Strategic Options

Ralf Kaspar, Chair of Managerial Accounting, University of Osnabrueck, 49069, Osnabrueck, Germany, ralf.kaspar@uni-osnabrueck.de

The evaluation and control of strategic options within the strategic management process is fundamentally complicated by multiple and mutually influencing objectives, internal and external factors, lack of transparency, complexity and conflicts of interest. To cope with these difficulties a suitable multi-criteria decision support approach is required. Research has led to the development of an ANP based framework. Supported by a case study it is a contribution to an improved evaluation of strategic options incorporating advanced SWOT-Analysis, BOCR modeling and group decision making.

3 - A Multi-Criteria Based Evaluation of "Innovation Strategy Selection"

Ozge Surer, Industrial Engineering, Istanbul Technical University, ITU Isletme Fakultesi, Macka, 34357, Istanbul, Turkey, surer@itu.edu.tr, Sezi Cevik Onar, Y. Ilker Topcu

Innovation is a crucial tool for firms to compete, thus it is necessary to define the factors which affect this process. Containing interrelations among the related factors, a multi criteria approach utilizing network models should be used. In accordance with the iterative steps of Analytic Network Process, innovation strategy types and related factors are identified by opinions of experts and the literature survey. Relations among these factors are revealed and their relative importance and the priorities of the strategies are assessed, based on the pairwise comparison answers of the experts.

■ TA-42

Tuesday, 8:30-10:00

BW-Amber

Simulation Models and Decision Analysis

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science

Invited session

Chair: Erik Kropat, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: Silja Meyer-Nieberg, Department of Computer Science, Universität der Bundeswehr München, 85577, Neubiberg, Germany, silja.meyer-nieberg@unibw.de

Chair: Sonia De Cosmis, School of Science and Technology, Università di Camerino, via Madonna delle Carceri 9, 62032, Camerino (MC), ITALY, Italy, sonia.decosmis@studenti.unicam.it

1 - Modelling a Distribution Operation Using Discrete Event-Based Simulation

Amílcar Arantes, Civil Engineering-DECivil, IST/Technical University of Lisbon, Av. Rovisco Pais, 1049-001, LISBOA, Portugal, amilcar.arantes@civil.ist.utl.pt

This work considers the development of a simulation model and its applications to a case-study based on realistic inputs from a distribution company. It considers the activities and resources involved in the distribution process and the chain configuration. The model was developed after a literature review and interviews, which were essential for problem characterization and to get realistic data. The results show that event based simulation and the SIMUL8 can work as a valid design distribution chain decision tool, especially because it can cope with the real world inevitable randomness.

2 - Generation of EPC based Simulation Models

Christian Mueller, Dep. of Management and Business computing, TH Wildau, Bahnhofstrasse, D-15745, Wildau, Germany, christian.mueller@th-wildau.de

In this paper, we present an approach, where business processes are formulated in EPC notation with some extensions about simulation relevant data. For EPC modeling Bflow, an Eclipse plugin is used. From this EPC model we generate a DesmoJ simulation model. A DesmoJ model contains a set of Java classes that use the DesmoJ simulation framework. Based on the Java programming language, the generated models can be extended in all directions. The generation mechanism supports a technique, so that the modeling extensions are not lost by regeneration. Bflow and DesmoJ, are both open source projects.

3 - Rare-Event Estimation for Density Dependent Models

Adam Grace, Mathematics, University of Queensland, University of Queensland, St Lucia, 4072, Brisbane, QLD, Australia, adam.grace@uqconnect.edu.au

Many complex systems in chemistry, biology and engineering can be modeled via density dependent models. Applications include chemical reactions, population dynamics and traffic flow in telecommunication networks. Rare-event estimation and simulation for such models can be difficult. We present an alternative approach to this problem which utilizes the limiting behavior of density dependent models. We demonstrate this method requires fewer samples than current methods, and is also more robust to correlation issues.

4 - Adding adaptability to Discrete Event Simulation through parameterisation

Francesco Aggogeri, Department of Mechanical Engineering, University of Brescia, Via Branze 38, 25123, Brescia, Italy, francesco.aggogeri@ing.unibs.it, Gian Mauro Maneia, Marco Mazzola, Angelo Merlo

A novel approach is proposed aiming to facilitate simulation of manufacturing processes by fast modelling and evaluation. Architecture and validation of a DES-based parametric model are presented. The model consists on a flexible and adaptable solution enabling to simulate either manufacturing cells and complex lines with same structure. So a user can tailor the model on his processes without specific knowledge of simulation software. The authors acknowledge the support of the European Commission through the project COPERNICO (CP-IP 229025-2).

■ TA-43

Tuesday, 8:30-10:00

BW-Granite

Stochastic programming in energy

Stream: Stochastic Programming

Invited session

Chair: *Asgeir Tomasgard*, Applied economics and operations research, Sintef Technology and society, Trondheim, Norway, asgeir.tomasgard@sintef.no

1 - The value of storage at household level: A smart grid perspective

Stein W. Wallace, Management Science, Lancaster University Management School, LA1 4YX, Lancaster, United Kingdom, stein.w.wallace@lancaster.ac.uk

As the percentage of wind power increases, storage of energy will be needed. The purpose of this work is to understand the question of storage bottom-up. Is there any value in storage at residential level, and if so, what is the value? We do not assume behavioural changes, only that the building uses its storage capabilities optimally.

2 - Gas Network Topology Extension for Multiple Scenarios

Jonas Schweiger, Optimization, Zuse Institute Berlin (ZIB), Takustr. 7, 14195, Berlin, Germany, schweiger@zib.de

Due to the European regulation gas networks have to become more flexible. Investments are needed to allow the network operator to fulfill different demand scenarios. We developed a model for the network extension problem for multiple demand scenarios. That is, we search cost-optimal network extensions such that a variety of demand scenarios can be realized. The problem is described by a two-stage stochastic program. We propose a decomposition along the scenarios and solve the problem by a Branch&Bound-algorithm. Non-convex MINLP are used to model the gas network and solved as subproblem.

3 - A Bilevel Programming Approach to Modeling of Transmission Capacity Planning

Paolo Pisciella, Department of Information Technology and Mathematical Methods, University of Bergamo, Italy, paolo.pisciella@unibg.it, *Marida Bertocchi*, *Maria Teresa Vespucci*

We introduce a model intended for the analysis of the upgrade of the national transmission grid. The problem is modeled as a bilevel program with mixed integer structure in both, upper and lower level. Upper level is defined by the transmission company problem which has to decide on how to upgrade the network so to avoid congestions. Lower level models the reactions of generating companies, which take a decision on new facilities and power output, and market operator which strikes a new balance between demand and supply providing new zonal prices.

4 - Long-term expansion of the European Power System Under Various Emission Mitigation Scenarios

Christian Skar, Department of Electric Power Engineering, Norwegian University of Science and Technology, 7491, Trondheim, Norway, christian.skar@ntnu.no, *Asgeir Tomasgard*, *Gerard Doorman*

This paper will present an analysis of optimal expansion of generation and transmission capacity for a country-level power system model of Europe. Important driving factors for investments in new infrastructure like annual demand, fuel prices and prices for CO₂ emissions, are taken directly from the Global Change Assessment Model (GCAM). As electricity demand in GCAM is only calculated for two regions, Western Europe and Eastern Europe, a disaggregation based on statistical data is used to get country-wise demand. The expansion problem is formulated as a two-stage stochastic linear program.

■ TA-44

Tuesday, 8:30-10:00

BW-Marble

Computer vision (1)

Stream: Machine Learning and its Applications

Invited session

Chair: *Teofilo deCampos*, Center for Vision Speech and Signal Processing, University of Surrey, GU2 7XH, Surrey, United Kingdom, t.decampos@surrey.ac.uk

Chair: *Fei Yan*, Center for Vision Speech and Signal Processing, University of Surrey, GU2 7XH, Surrey, United Kingdom, f.yan@surrey.ac.uk

Chair: *Ivan Reyer*, Dorodnicyn Computing Centre of RAS, ul. Pererva d. 58, kv. 153, 109451, Moscow, Russian Federation, reyer@forecsys.ru

1 - Anomaly detection in machine perception systems

Josef Kittler, Centre for Vision, Speech and Signal Processing, University of Surrey, GU2 7XH, Guildford, United Kingdom, J.Kittler@surrey.ac.uk

Anomaly detection in engineering systems is cast as a problem of detecting outliers to the distribution of observations representing a state of normality. We focus on anomaly detection in machine perception. We argue that in addition to outlier detection, anomaly detection in machine perception systems requires other detection mechanisms. They include incongruence detection, data quality assessment, decision confidence gauging, and model drift detection. These mechanisms are elaborated and their application illustrated on a problem of anomaly detection in a sports video interpretation system.

2 - Learning Optimal Semantically Relevant Visual Dictionary using Evolutionary Algorithms

Ashish Gupta, CVSSP, University of Surrey, University of Surrey, GU27XH, Guildford, Surrey, United Kingdom, a.gupta@surrey.ac.uk

We propose a novel optimally discriminative visual dictionary learning method using evolutionary algorithms. Due to large intra-category appearance variation, semantically equivalent descriptors are scattered over feature space. Current methods, using hard or soft assignment, are unable to cluster these equivalent descriptors, inter-leaved with other categories, together. We over partition feature space, generating a huge population of tiny syntactically cohesive partitions, which are optimally assigned, with locality constraints, so as to obtain a maximally discriminative visual dictionary.

3 - Transductive Transfer Learning for Action Recognition

Teofilo deCampos, Center for Vision Speech and Signal Processing, University of Surrey, GU2 7XH, Surrey, United Kingdom, t.decampos@surrey.ac.uk, *Nazli FarajiDavar*

In video processing, it is often the case that one video may contain several samples of actions that share a number of low level features (eg illumination, motion style, etc). Therefore, each video constitutes a domain. We show that, for action classification, a classifier that is trained with one video may lead to poor performance when applied to another video, but if the unlabelled samples of this other video are available, it is possible to apply a transductive transfer learning technique, leading to a significant improvement in performance.

■ TA-45

Tuesday, 8:30-10:00

BW-Water

Stochastic Logistical Networks

Stream: Stochastic Modelling in Logistical Networks
Invited session

Chair: *El-Houssaine Aghezzaf*, Industrial Management, Ghent University, Technologiepark 903 -, Campus Ardoyen, 9052, Zwijnaarde, Belgium, ElHoussaine.Aghezzaf@UGent.be

Chair: *Derek Verleye*, Industrial Management, Ghent University, Technologiepark 903, 9052, Zwijnaarde, Belgium, derek.verleye@ugent.be

1 - An Approximate Scenario-based Approach to Design Robust Supply Chain Networks under Uncertainty

Walid Klibi, Operations Management and Information Systems Department, BEM / CIRRELT, 680 cours de la Libération, 33405, Bordeaux, France, walid.klibi@bem.edu, *Alain Martel*

Supply Chain Networks (SCN) must be designed to last for several years and cope with any plausible future, and thus involve a value maximization problem under uncertainty. The original SCN design model is intractable. We propose some complexity reduction mechanisms to tackle the problem, and the design model is reduced to a bi-criterion, multi-period, two-stage stochastic program with recourse. This model considers future scenarios including high-impact disruptive events and recourse variables anticipating response policies in case of disruptions.

2 - On a strict solution algorithm for a stock replenishment policy with fill-rate constraints in the two-step supply chain

Takashi Hasuike, Graduate School of Information Science and Technology, Osaka University, 2-1 Yamadaoka, 565-0871, Suita, Osaka, Japan, thasuike@ist.osaka-u.ac.jp, *Koji Okuhara*, *Nobuyuki Ueno*

This presentation proposes a strict solution algorithm to obtain a stock replenishment policy with fill-rate constraints in the two-step supply chain. In previous researches, it is hard to solve this model strictly, because the model is formulated as a non-deterministic programming problem with several stochastic constraints. In order to overcome the disadvantage and develop a strict and efficient solution approach, the deterministic equivalent transformations in mathematical programming are performed. Then, the strict optimal stock replenishment policy is explicitly obtained.

3 - Stochastic and dynamic patient transportation

Jakob Puchinger, Mobility, AIT - Österreichisches Forschungs- und Prüfzentrum Arsenal Ges.m.b.H., Giefinggasse 3, 1210, Wien, Austria, jakob.puchinger@ait.ac.at, *Ulrike Ritzinger*, *Richard Hartl*

We consider a patient transportation problem for an emergency medical service in Vienna. The organization has to perform a large number of patient transports every day and, in addition, has to respond to arising emergency calls. In the considered application, about 60% of transportation requests are known in advance, whereas other requests are occurring throughout operations. Therefore, a stochastic and dynamic variant of the dial-a-ride problem is considered. The problem instances are big, consisting of a fleet of around 120 vehicles serving 800 to 1000 requests a day.

4 - Supply chain coordination with capacity reservation and emergency option

Guillaume Amand, HEC-Ulg, University of Liège, boulevard du rectorat, 7 - Bât. B31, 4000, Liège, Belgium, guillaume.amand@ulg.ac.be, *Yasemin Arda*

This study analyzes the contractual relation between a retailer and a supplier with the aim of determining possible deviations from the optimal system performance. In order to face a random demand, the retailer submits a contract to the supplier based on the number of units delivered and the capacity used to serve the retailer. Before the uncertainty is resolved, the supplier has to decide of the capacity that he reserves. Once the demand is known, the carrier may request additional

capacity from an emergency option at a higher cost. An asymmetric case is also discussed.

Tuesday, 10:30-12h00

■ TB-01

Tuesday, 10:30-12h00

RB-Alfa

Tutorial Lecture: Professor Guy Desaulniers

Stream: Keynote, Tutorial and Plenary Lectures

Tutorial session

Chair: *Marc Sevaux*, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - 20 years of column generation for the vehicle routing problem with time windows

Guy Desaulniers, École Polytechnique de Montréal and GERAD, H3C 3AT, Montréal, Canada, Guy.Desaulniers@gerad.ca

Column generation is a well-known mathematical programming technique for solving large-scale optimization linear problems. In the mid-1980s, it was shown that it can be successfully embedded in a branch-and-bound framework (yielding a branch-and-price method) for solving integer programs. Since then, it has become the most popular exact methodology for solving several classes of vehicle routing problems. As a fertile testbed, the vehicle routing problem with time windows (VRPTW) played an important role in this success. It consists of finding a set of least-cost vehicle routes to deliver goods to a set of customers. Each customer must be visited exactly once within a given time window and each route must respect vehicle capacity. In this talk, we survey the evolution of the column generation methods developed for the VRPTW, starting from the seminal work of Desrochers, Desrosiers, and Solomon (1992). In particular, we present various path relaxations proposed to avoid solving the NP-hard elementary shortest path subproblem, labeling algorithms used to generate their corresponding columns, and valid inequalities tightening the lower bounds, including those that are directly defined on the master problem variables. We discuss certain acceleration strategies, report computational results, and highlight current and future challenges.

■ TB-02

Tuesday, 10:30-12h00

RB-Beta

Scheduling and Logistics

Stream: Scheduling

Invited session

Chair: *Vitaly Strusevich*, School of Computing and Mathematical Sciences, University of Greenwich, Old Royal Naval College, Park Row, Greenwich, SE10 9LS, London, United Kingdom, sv02@gre.ac.uk

1 - Adding an Extra Machine to a Shop Parallel Identical Machines

Vitaly Strusevich, School of Computing and Mathematical Sciences, University of Greenwich, Old Royal Naval College, Park Row, Greenwich, SE10 9LS, London, United Kingdom, sv02@gre.ac.uk, *Kabir Rustogi*

We consider the problems of processing jobs on m parallel identical machines to minimize the makespan or the total flow time. We measure the machine impact for m machines to the one with $m+1$ machines. For the makespan, in the preemptive case the impact is $(m+1)/m$, while in the non-preemptive case the impact is 2. For minimizing the total flow time, we prove that the impact is $(m+1)/m$. We present polynomial-time algorithms that determine an optimal number of machines, provided that each machine incurs a cost and the objective function captures a trade-off.

2 - Approximation Schemes for Scheduling on a Single Machine Subject to Cumulative Deterioration and Maintenance

Kabir Rustogi, School of Computing and Mathematical ScienceMathema, University of Greenwich, Old Royal Naval College, Park Row, Greenwich, SE10 9LS, London, United Kingdom, rk41@gre.ac.uk, *Vitaly Strusevich*, *Hans Kellerer*

We consider a scheduling problem on a single machine to minimize the makespan. The processing conditions are subject to cumulative deterioration, but can be restored by a single maintenance period (MP). The decision-maker is free to choose when to start the MP. We link the problem to the Subset-sum problem (if the duration of MP is constant) and to the Half-product problem (if the duration of MP depends on its start time). For both versions of the problem, we adapt the existing fully polynomial-time approximation schemes to our problems by handling the additive constants, which are of the opposite sign with the variable part of the objective.

3 - Supply Chain Scheduling in a Competitive Environment

Miguel Zamarripa, Departamento de Ingeniería Química, Universitat Politècnica de Catalunya, Spain, miguel.angel.zamarripa@upc.edu, *Antonio Espuña*

Some of the published works address Supply chain under uncertainty in the available data, very few of them put the issue in a realistic operational environment, taking into account that the SC of interest will have to compete with other supply chains which, like to work as efficiently as possible to cover the same market demands. This work proposes to introduce into the model information about the expected performance of the competing supply chains (including the SC of interest) to improve the operational decision making in a competitive/cooperative environment using Game Theory optimization.

4 - Scheduling of coupled tasks with high multiplicity

Michaël Gabay, Laboratoire G-SCOP, 46 avenue Félix Viallet, 38031, Grenoble, France, michael.gabay@g-scop.grenoble-inp.fr, *Gerd Finke*, *Nadia Brauner*

The problem of scheduling tasks on a radar system can be modeled using coupled-tasks. We consider the case where all tasks are identical. This case raises original complexity questions and belongs to so-called high multiplicity scheduling problems. We present some complexity issues and results regarding the problem. We also describe a series of counter-examples showing that this problem is unlikely to be in NP.

■ TB-03

Tuesday, 10:30-12h00

RB-L1

Logistics, Transportation, Traffic - 3

Stream: Logistics, Transportation, Traffic

Contributed session

Chair: *Markus Bohlin*, Swedish Institute of Computer Science, Box 1263, SE-16429, Kista, Sweden, markus.bohlin@sics.se

1 - A heuristic solution approach for a real-size hierarchical hub location problem

Julia Sender, Institute of Transport Logistics, TU Dortmund University, Leonhard-Euler-Str. 2, 44227, Dortmund, NRW, Germany, julia.sender@tu-dortmund.de, *Uwe Clausen*

In wagonload traffic, flows of single wagons with different origins and destinations are consolidated on their routes through the railway network. The specific hierarchical hub-and-spoke-network is built up by several formations yards, which differ, for example, in their size and function. We present a specific hub location model for a strategic network design problem in wagonload traffic, which covers most characteristics of wagonload traffic in German railway logistics, and a new heuristic decomposition approach for solving the problem.

2 - Auto-Carrier Distribution Problem with Highly Variable Daily Demand at Dealers

Tsung-Sheng Chang, Graduate Institute of Logistics Management, National Dong Hwa University, 1, Sec.2, Da-Hsueh Rd., Shou-Feng, 974, Hualien, Taiwan, ts@mail.ndhu.edu.tw, *Hao-Ping Jiang*

Typically, auto-carriers must return to their original depots after completing their daily duties. However, such an operations strategy is quite ineffective in the presence of highly variable daily demand at dealers. Hence, this research intends to tackle the auto-carrier distribution problem that involves the main characteristics of multiple depots, multiple staging areas, multiple trips, time window constraints, and no fixed home depots. We first mathematically model the distribution problem, and then propose an optimization-based solution algorithm to solve the NP-hard distribution problem.

3 - Monte Carlo Simulation Techniques with Parallel Heuristics applied to solve the Capacitated Vehicle Routing Problem

Thiago Guimaraes, Centro Universitario Franciscano do Parana, Rua Mateus Leme, 1244 - Apartamento 201 - Centro Cívico, 80530000, Curitiba, Parana, Brazil, thiandgui@gmail.com, *Luis Gustavo Pereira*, *Wesley José Nogueira Medeiros*

It presents on this paper a new approach to solve the Capacitated Vehicle Routing Problem. The proposal is based on Cluster First-Route Second strategy, employing Monte Carlo Simulation Techniques to cluster the demand points and Classical Heuristics with permutation 2-opt to generation of the routes. Parallel computing techniques are used to reducing the processing time. An extensive computational experiment with classical instances showed an average deviation of 1,40% compared with its exact results on the other hand a greatly reduced processing time.

4 - Shunting with car mixing using column generation

Markus Bohlin, Swedish Institute of Computer Science, Box 1263, SE-16429, Kista, Sweden, markus.bohlin@sics.se, *Florian Dahms*, *Holger Flier*, *Matus Mihalak*

We consider a specific railway shunting problem that arose in the Hallsberg hump yard, specified formally by Bohlin et al. who showed it to be NP hard. A natural MIP formulation give a weak linear relaxation and consequently a large MIP gap. In our new work we use an extended formulation to model the problem's specifications while maintaining a tight relaxation. To solve the linear relaxation of our formulation we utilize column generation. The lower bounds provided by our relaxation are close (often exact) to the optimal objective and can be calculated in reasonable time for large instances.

■ TB-04

Tuesday, 10:30-12h00

RB-L2

Approaches for Integer Programming

Stream: Combinatorial Optimization

Invited session

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, Facultad de Matemáticas, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es

Chair: *Martine Labbé*, computer Science, Université Libre de Bruxelles, CP210/01, Boulevard du Triomphe, 1050, Bruxelles, Belgium, mlabbe@ulb.ac.be

1 - Optimal interval scheduling with a resource constraint

Carlo Filippi, Quantitative Methods, University of Brescia, Contrada S. Chiara 50, 25122, Brescia, BS, Italy, filippi@eco.unibs.it, *Enrico Angelelli*, *Nicola Bianchessi*

Consider a set of jobs and a set of parallel identical machines. Every job has: fixed start and finish times, a resource requirement, and a value. Every machine owns R units of a renewable resource and can process more than one job at a time, provided the resource consumption is at most R . Two questions arise: Which is a job subset of maximum total value that can be scheduled on a given number of machines? Which is the minimum number of machines required to schedule all jobs? For both problems we discuss complexity, heuristic and exact approaches, and preliminary computational experiments.

2 - Capacitated Network Design with Facility Location

Ivana Ljubic, Department of Statistics and Operations Research, University of Vienna, Bruennerstr. 72, 1210, Vienna, Austria, ivana.ljubic@univie.ac.at, *Bernard Gendron*, *Stefan Gollowitzer*

We consider a new network design problem that arises in the design of last mile telecommunication networks and combines the capacitated network design problem with the single-source capacitated facility location. We compare several MIP formulations with respect to the quality of their lower bounds and propose new sets of valid inequalities for the problem. We also develop a branch-and-cut approach and provide a computational study to assess its performance.

3 - A Branch-Cut-and-Price algorithm for the Piecewise Linear Network Flow Problem

Tue Christensen, Economics and Business, Aarhus University, Fuglesangs Allé 4, 8210, Aarhus V, Denmark, tuec@asb.dk, *Martine Labbé*

In this paper we present an exact solution method for the network flow problem with piecewise linear costs. This problem is fundamental within supply chain management and extends the fixed-charge transportation problem in a straight-forward way and has numerous applications. We propose a Dantzig-Wolfe reformulation of the problem and extend this to an exact method by branching and the addition of valid inequalities. On a number of randomly generated test instances the proposed method compares favorably to a standard mixed-integer programming solver with a significant reduction in runtime.

■ TB-05

Tuesday, 10:30-12h00

RB-L3

Problems on graphs I

Stream: Discrete Optimization, Geometry & Graphs (contributed)

Contributed session

Chair: *Nair Abreu*, Production Engineering, Federal University of Rio de Janeiro, Rua Joao Lira 106/401, Leblon, 22430 210, Rio de Janeiro, Rio, Brazil, nairan@veloxmail.com.br

1 - On rational approximation of geometric graph

Vladimir Benediktovich, Department of Combinatorial Models and Algorithms, Institute of Mathematics of NAS of Belarus, Surganova str., 11, 220072, Minsk, Belarus, vbened@im.bas-net.by

A geometric graph is rational if all its edges have rational lengths. Kleber (2008) asked for what graph its vertices can be slightly perturbed in their ϵ -neighborhoods so that the resulting graph becomes rational (ϵ -approximation) and in addition vertices have rational coordinates (rational ϵ -approximation). Any geometric cubic graph has a rational ϵ -approximation for any $\epsilon > 0$ (2008). In 2011 Dubickas assumed the existence of up to 4 vertices of degree above 3. We prove that any connected geometric graph with maximum degree 4 and vertex w of $\deg(w) < 4$ has a rational ϵ -approximation for any $\epsilon > 0$.

2 - New spectral upper bounds on the size of k -regular induced subgraphs

Domingos Cardoso, Departamento de Matematica, Universidade de Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, dcardoso@ua.pt, *Sofia Pinheiro*

In (Haemers' Ph.D. thesis, 1980) an upper bound (based on the least and largest adjacency eigenvalues) on the independence number of arbitrary graphs was introduced. Later, in (Lu et al, 2007), upper bounds (using the largest Laplacian eigenvalue) were deduced. For regular graphs, in (Bussemaker et al, 1976) a spectral upper bound on the order of induced subgraphs with average degree d was obtained. This upper bound is herein extended to arbitrary graphs, introducing three new upper bounds, based on adjacency, Laplacian and signless Laplacian eigenvalues, respectively.

3 - Graph spectra and combinatorial optimization

Nair Abreu, Production Engineering, Federal University of Rio de Janeiro, Rua Joao Lira 106/401, Leblon, 22430 210, Rio de Janeiro, Rio, Brazil, nairan@veloxmail.com.br,
Claudia Justel, *Domingos Cardoso*

Wilf(1967), followed by Hoffman(1970), presented the first results on graph spectra in combinatorial optimization by introducing graph eigenvalue bounds to the chromatic number. Later several articles appeared relating eigenvalues to classical invariants of graphs: stability and clique numbers, matching, connectivity and isoperimetric number. Furthermore, some hard combinatorial optimization problems have been approximated by using spectral techniques. We present a survey of significant results about graphs spectra applied to combinatorial optimization.

■ TB-06

Tuesday, 10:30-12h00

RB-Gamma

Performance evaluation and new metaheuristics

Stream: Metaheuristics

Invited session

Chair: *Cristina C. Vieira*, Department of Electronics and Informatics Engineering, University of Algarve, Faculty of Science and Technologies, Campus de Gambelas, Faro, Localidade, Portugal, cvieira@ualg.pt

1 - Using a multicriteria function to evaluate metaheuristics performance

Paulo Oswaldo Boaventura-Netto, Production Engineering, Federal University of Rio de Janeiro/COPPE, Rua Pinheiro Machado 99, ap. 1508, Laranjeiras, 22231-090, Rio de Janeiro, RJ, Brazil, pausa@globo.com, *Valdir Melo*

We propose a multicriteria evaluation scheme based on Condorcet ranking technique. It uses weights associated to the algorithms from a set being object of comparison. We used five criteria and a function on the set of natural numbers to create a ranking. The comparison involves three well-known problems of combinatorial optimization, taking instances from public libraries. Each algorithm was used with essentially the same structure, the same local search was used and the initial solutions were similarly built. The metaheuristics GRASP, Tabu Search, ILS and VNS, participate from the comparison.

2 - Performance Assessment of Electromagnetism-like Algorithm

Alkin Yurtkuran, Industrial Engineering Department, Uludag University, Uludag University, Industrial Engineering Department, 16059, Bursa, Turkey, alkin@uludag.edu.tr,
Erdal Emel

Meta-heuristic algorithms are robust and efficient techniques for solving complex real-world problems. Electromagnetism-like Algorithm (EMA) is one of the recently introduced population based meta-heuristic which simulate the behavior of charged particles on an electrical field. This work provides a comparison between EMA and popular foraging and evolutionary algorithms using well-known CEC05 benchmark functions based on the solution value and solution time. The results show that the performance of EMA is comparable to novel meta-heuristic algorithms in terms of solution quality and time.

3 - From constructive search to local search

Cristina C. Vieira, Department of Electronics and Informatics Engineering, University of Algarve, Faculty of Science and Technologies, Campus de Gambelas, Faro, Localidade, Portugal, cvieira@ualg.pt, *Carlos M. Fonseca*

Constructive search may be reinterpreted as local search by considering an appropriate solution space, defining a neighbourhood structure based on the original construction rules and specifying how to evaluate incomplete solutions. The resulting problem formulation is compatible with both local and constructive optimisation methods, and allows very different metaheuristics to be studied on exactly the same (local) formulation of a given (global) optimisation problem. The proposed approach is illustrated in the context of ACO and evolutionary algorithms on the TSP.

4 - Algorithm of inspired by virus and bacterium attack: A meta-heuristic approach as an optimization tool

Mahdi Bashiri, Shahed University, Iran, Islamic Republic Of, Bashiri@shahed.ac.ir, *Masoud Bagheri*, *Zeinab Rasoolinezhad*

In this paper, a new meta-heuristic algorithm has been proposed based on virus and bacterium attack (VBA). Actually presented solution approach is inspired by attack of virus and bacterium to human body. In the proposed algorithm, virus and bacteria attack to reach the body cells death. Some numerical examples have been selected from the literature to consider the proposed VBA's efficiency. Also the algorithm has been compared by the genetic algorithm (GA). The computational results verify its efficiency from computational time and solution quality aspects as well.

■ TB-07

Tuesday, 10:30-12h00

RB-Eta

Vehicle Routing and Logistics Optimization

Stream: Vehicle Routing and Logistics Optimization

Invited session

Chair: *Erdener Özçetin*, Industrial Engineering, Anadolu University, Iki Eylül Kamp., MMF END 107, 26000, Eskişehir, Turkey, eozcetin@gmail.com

1 - A Parallel Procedure for Dynamic Multi-objective TSP

Weiqi Li, School of Management, University of Michigan-Flint, 303 East Kearsley Street, 48502, Flint, Michigan, United States, weli@umflint.edu

We propose a new parallel search procedure for dynamic multi-objective traveling salesman problem. We design a multi-objective TSP in a stochastic dynamic environment. The proposed procedure first uses parallel processors to identify the extreme solutions of the search space for each of k objectives individually at the same time. These solutions are merged into a matrix E . The solutions in E are then searched by parallel processors and evaluated for dominance relationship. The proposed procedure was implemented in two different ways: a master-worker architecture and a pipeline architecture.

2 - Solving the vehicle routing problem with time windows by an interior point branch-price-and-cut framework

Pedro Munari, ICMC, University of Sao Paulo, Sao Carlos, Sao Paulo, Brazil, pedro.munari@gmail.com, *Jacek Gondzio*

In this talk, we present a branch-price-and-cut framework for the vehicle routing problem with time windows which is based on a primal-dual interior point method for efficiently solving the linear relaxations at each branch node. The interior point method is used to obtain well-centred, non-optimal solutions that are used to improve the generation of columns and valid inequalities. Computational results using the Solomon's instances show that the proposed approach has a better overall performance than the best branch-price-and-cut framework available in the literature.

3 - A Parallel Algorithm for Vehicle Routing Problem on GPUs

Erdener Özçetin, Industrial Engineering, Anadolu University, Iki Eylül Kamp., MMF END 107, 26000, Eskişehir, Turkey, ozcetin@gmail.com, *Gurkan Ozturk*

Vehicle Routing Problem (VRP) is a common and difficult logistics problem. To reach a solution with exact methods is mostly hard, several meta-heuristics have been developed. Graphics processing units (GPUs) on enhanced graphics cards are used to solve hard optimization problems with implementing meta-heuristic algorithms by parallelizing. In this paper, a parallel algorithm has been proposed for VRP. The performance of the algorithm, especially in execution time has been shown by solving literature test problems.

4 - Solving Vehicle Routing Problems with Equipment Allocation

Philip Kilby, NICTA and The Australian National University, Locked Bag 8001, 2601, Canberra, ACT, Australia, Philip.Kilby@nicta.com.au, *Fabien Tricoire*

We look at a routing problem where some tasks require particular equipment (and may require more than one type of equipment). The equipment allocated to a vehicle is a decision variable, and restricts the vehicles that can perform each task.

We look at two methods for solving the combined equipment allocation and vehicle routing problem. One method uses a standard vehicle routing solver, modified in a modular way to incorporate the additional functionality. We also describe a method based on column generation.

■ TB-08

Tuesday, 10:30-12h00

RB-Epsilon

VMI and Delivery

Stream: Supply Chain Planning

Invited session

Chair: *Marcel Turkensteen*, Business Studies, ASB, Fuglesangs Alle 4, 8210, Aarhus V, Denmark, matu@asb.dk

1 - Shipment consolidation by collaborative planning between industrial suppliers under VMI policy

Waldemar Kaczmarczyk, Department of Operations Research & Information Technology, AGH University of Science & Technology, al. Mickiewicza 30, 30-059, Krakow, Poland, waldek@agh.edu.pl

In industrial supply chains just-in-time policy forces frequent and small shipments. Transportation costs can be reduced by consolidation of shipments, but this is possible only if shipments can wait until the consolidated shipment is accumulated. The Vendor Managed Inventory system opens another possibility, suppliers may coordinate their shipments in advance. Proposed concept of horizontal collaborative planning enables more frequent consolidation without delivery delays. Presented results show potential benefits of such collaboration.

2 - An Improved Robust Particle Swarm Optimization Algorithm to the Uncertain Inventory Routing Problem

Isa Nakhai Kamalabadi, Department of Industrial Engineering, School of Engineering, Tarbiat Modares University, Jalal Ale Ahmad Highway, P.O.Box: 14115-143, 14115-143, Tehran, Tehran, Iran, Islamic Republic Of, nakhai@modares.ac.ir, *Ali Hossein Mirzaei*

We address a multi-period multi-product uncertain inventory routing problem where products are produced and delivered from one manufacturer to a set of retailers through a fleet of heterogeneous capacitated vehicles. Here, split delivery is permissible but each vehicle can travel just a tour per period. The uncertainty follows an unknown but bounded pattern. Due to the complexity of the problem, we develop an improved robust particle swarm optimization algorithm to solve the problem. The computational results show that the developed algorithm outperforms the benchmark algorithms.

3 - A vendor managed inventory model with transportation to geographically dispersed retailers

Marcel Turkensteen, Business Studies, ASB, Fuglesangs Alle 4, 8210, Aarhus V, Denmark, matu@asb.dk, *Christian Larsen*

This study considers a vendor that supplies a set of geographically dispersed retailers and wishes to use a coordinated inventory and distribution policy that minimizes the total costs incurred. Routing considerations, an infinite time horizon, and demand uncertainty make the problem hard to solve for existing approaches. Our solution is to estimate transportation distances with continuous approximation. Using Markov chain modeling, we then derive the delivery zones and vehicle utilization policies in combination with optimal inventory policies at the vendor and the retailers.

■ TB-09

Tuesday, 10:30-12h00

RB-Zeta

Cutting and Packing 6

Stream: Cutting and Packing

Invited session

Chair: *Andreas Bortfeldt*, Dept. of Information Systems, University of Hagen, Profilstrasse 8, 58084 Hagen, Germany, 58084, Hagen, FR Germany, Germany, andreas.bortfeldt@fernuni-hagen.de

1 - Optimal cutting of the raw materials

Jaroslav Hanzel, Institute of Control and Industrial Informatics, Slovak University of Technology, Ilkovicova 3, 812 19, Bratislava, Slovakia, jaroslav.hanzel@stuba.sk, *Ladislav Jurisica*, *Anton Vitko*, *Marian Klucik*, *Peter Paszto*

The contribution deals with optimal utilization of the materials in the industry. The problem is to find and cut out the rectangular part from the metal plate with no defects and a maximal surface. Simple algorithm applicable in the embedded systems with restricted computational resources is proposed. It is able to quickly find solutions close to optimal solution with low computational cost. On the other hand the problem was solved also by means of standard optimization method. The analysis and comparison of proposed and standard methodology on the basis of computed data is given.

2 - Different criteria to sort the list of pieces in 2D-Orthogonal Strip Packing Problem

Fernando Garcia_Perez, Matematicas Aplicadas, Universidad de Alcalá de Henares, Edificio de Ciencias. Campus Universitario, Carretera Madrid-Barcelona Km. 33,600, 28805, Alcalá de Henares, Madrid, Spain, fernando.garciap@uah.es, *Joaquin Aranda Almansa*, *Miguel Delgado Pineda*

In the two-dimensional strip packing problem, 2D-SPP, a set of n rectangular items and a strip of width W and unlimited height are given. Each item has an height and a width. This problem consists of allocating orthogonally all the items, without overlapping, by minimizing the overall height of the packing. It is usual to sort the small pieces in order to improve the result. We study the influence on the outcome of different criteria to sort the list of pieces and how to select the optimal criterion using around 1,000 instances from the literature.

3 - Generation of Two-dimensional Guillotine Cutting Patterns by Genetic Algorithms and Fit-Heuristics

Lilian Caroline Xavier Candido, Federal University of Parana, Avenida Candido de Abreu, numero 304, apartamento 905, 80530000, Curitiba, Parana, Brazil, liliancarolinex@gmail.com, *Thiago Guimaraes*

This paper proposes a new strategy for generation of two-dimensional guillotine cutting patterns, with non-stages and two stages with the possibility of rotation of the items in both cases. The methodology is divided into two phases: first, the items are selected and grouped into subsets by genetic algorithms. In the second phase, heuristics are employed to determine fitting geometric arrangement of the cutting pattern. Computational experiments performed with classical instances from the literature indicate excellent results for some instances with very low processing time for all of them.

4 - Algorithms Based on Particle Swarm Optimization for the Two-dimensional Knapsack Problem

David Álvarez, São Paulo State University, Brazil,
david.unesp@gmail.com, Ruben Romero

This study presents the (un)constrained (un)weighted k-staged fixed and rotated two-dimensional guillotineable single knapsack problem. An encoding based on slicing tree is presented. Four algorithms, based on the Particle Swarm Optimization (PSO) metaheuristic were used: basic PSO, PSO with the mutation operator, a hybrid of Variable Neighborhood Search (VNS) with PSO and a hybrid of VNS and PSO including the mutation operator as a turbulence factor. The computational results on large sets of test cases show that the methodology is very efficient for the two-dimensional knapsack problems.

■ TB-10

Tuesday, 10:30-12h00

RB-Theta

Inventory Management 3

Stream: Production Management & Supply Chain Management (contributed)

Contributed session

Chair: *Hicham Chehade*, ICD- LOSI, University of Technology of Troyes, 12 Rue Marie Curie, 10000, Troyes, France, chehadeh@utt.fr

Chair: *Harry Groenevelt*, Simon School of Business, University of Rochester, Wilson Blvd, 14627, Rochester, NY, United States, groenevelt@simon.rochester.edu

1 - An Inventory Model to Determine The Optimal Mix of Owned and Rented Items

Leonardo Epstein, School of Engineering, Universidad Adolfo Ibáñez, Av. Diagonal Las Torres 2640, (of 209 B), Peñalolén, Santiago, Chile, leonardo.epstein@uai.cl, *Eduardo González-Császár*

Inventory models for rental items may be used to plan operations that involve lending or renting tools, or providing service such as access to telephone lines. We address the situation where the service provider owns an inventory of items, which may not be sufficient to meet demand. Additional items may be obtained by renting them from another provider. Thus, emerges the problem of determining the optimal number of items the provider must own to maximize his expected profit within a time horizon. We consider the situation where the number of users is finite and future demand is uncertain.

2 - Analysis of Supply Contracts with Total Minimum Quantity Commitment and Fixed Order Costs

Frank Y Chen, Department of Management Science, City University of Hong Kong, Hong Kong, China, yhchen@se.cuhk.edu.hk

We study a supply contract that specifies a minimum total (cumulative) order quantity over the planning horizon (e.g., one year). Each replenishment order incurs both fixed and variable costs. We show the optimal policy to be of a modified (s, S) form.

3 - Heuristics for the (Q,R,S) inventory policy

Harry Groenevelt, Simon School of Business, University of Rochester, Wilson Blvd, 14627, Rochester, NY, United States, groenevelt@simon.rochester.edu

We will compare the performance of a number of heuristics for the (Q, R, S) inventory policy. This is a general policy that includes periodic and continuous review base stock and order point-order quantity policies as special cases. The heuristics trade off computational effort and accuracy, and provide estimates for a number of different performance metrics, such as inventory holding and backorder costs, unit fill rate, order fill rate, in-stock probability, etc..

■ TB-11

Tuesday, 10:30-12h00

RB-Iota

Transportation and Logistics

Stream: Transportation and Logistics

Invited session

Chair: *Sadegh Niroomand*, Industrial Engineering, Eastern Mediterranean University, Turkey, sadegh.niroomand@cc.emu.edu.tr

1 - Developing a sustainable model for city transportation networks

Narges Shahraki, industrial engineering, koc university, koc university, istanbul, Turkey, nshahraki@ku.edu.tr, *Metin Turkey*, *Ali Fattahi*

In this paper, we consider the design and upgrade of city transportation networks using robust and exact optimization methods. The transportation network is represented with a directed graph $G(N, A)$, where N is the set of nodes and A is the set of edges connecting these nodes. In the design and upgrade of the network, it is important to assign demand for different sectors (such as housing, industry, commerce and services) to certain locations in the metropolitan area while achieving a sustainable transportation system. We incorporate economical, social and environmental aspects of triple bottom line of sustainability.

2 - Inventory and Transport Planning of Raw Materials for Steel Enterprises

Hua-An Lu, Department of Shipping and Transportation Management, National Taiwan Ocean University, #2, Pei-Ning Road, 202, Keelung, Taiwan, halu@mail.ntou.edu.tw

Steel enterprises required different kinds of raw materials for smelting their products. For reducing transport costs, maritime carriers are used. The whole inventory and transport planning of raw material imports for a steel company is a complicate problem. This study proposes two models: one for inventory scheduling of raw materials and voyage allocation of different ship types; one for ship assignment in considering of deployment by own carriers or spot charter vessels. This planning procedure was applied to a real case study for China Steel Corporation in Taiwan.

3 - Experimenting a Metaheuristics for a Flexible Transport Service

Pasquale Carotenuto, Istituto per le Applicazioni del Calcolo "M. Picone", Consiglio Nazionale delle Ricerche, via dei Taurini 19, 00185, Roma, RM, Italy, carotenuto@iac.cnr.it, *Daniele Monacelli*, *Marco Turco*

A demand responsive transport system (DRTS) is a flexible system in which the stops are fixed and tours are variable. Client takes a reservation about a trip which could be in the same day or in the next. DRTS can be analyzed by two kind of dynamisms. The first is about the way in which requests arrives to the system. In this case DRTS could be static if the algorithm runs after received all the requests, or can be dynamic on line if the algorithm runs while the requests are arriving to the system. The second kind of dynamism is about when the requests are served: on reservation or on service.

4 - Optimal Supermarket Layout

Sadegh Niroomand, Industrial Engineering, Eastern Mediterranean University, Turkey, sadegh.niroomand@cc.emu.edu.tr, *Bela Vizvari*

The optimal layout of a supermarket is determined. It is well-known that the amount of sales is an increasing function of the length of the customer's path. To increase the sales, the objective is to increase the travelled path in the shop. Based on real life observations, customers are classified into 16 classes. It is supposed that each customer uses the optimal solution of the relevant TSP when visits departments. The mathematical model maximizes the total weighted length of the 16 TSPs' optimal solutions. The model uses the dual of DFF model. Numerical results are presented.

■ TB-12

Tuesday, 10:30-12h00

RB-Omicron

Robustness in Public Transportation

Stream: Optimization in Public Transport
Invited session

Chair: *Marie Schmidt*, Institut für Numerische und Angewandte Mathematik, Georg-August-Universität Göttingen, Lotzestraße 16-18, 37073, Göttingen, Germany, m.schmidt@math.uni-goettingen.de

1 - Robust Lockmaster's Problems

Christina Büsing, Operations Research, RWTH Aachen University, Kackertstraße 7, 52072, Aachen, Berlin, Germany, cbusing@math.tu-berlin.de, *Elisabeth Günther*

An efficient solution of the lockmaster's problem (LockP) reduces the transportation time of goods along waterways and thus makes this means of transport a competitive and environmental friendly alternative to trucks or railways. The LockP is to manage the lockage times such that ships arriving from different levels of a waterway get up or down lifted minimizing the total waiting time. Due to delays a pre-defined schedule may turn infeasible. To deal with these changes, we introduce robust models, obtain compact ILP-formulations and compare their performance on real data of the Kiel Canal.

2 - Robustness in Periodic and Aperiodic Timetabling

Marc Goerigk, Georg-August Universität Göttingen, 37083, Göttingen, Germany, m.goerigk@math.uni-goettingen.de, *Anita Schöbel*

In public transport timetabling, arrival and departure times need to be scheduled for a set of vehicles, minimizing travel times. This can be done with or without periodically reoccurring events, resulting in the periodic and aperiodic timetabling problem.

Finding timetables that also consider robustness against delays is a recently emerging field of research, with a wide variety of concepts how to define robustness.

In this talk an experimental evaluation of robust timetables on close-to-real-world data is given. Both the aperiodic as well as the harder periodic case are considered.

3 - On the improvement of robustness in railway station areas

Thijs Dewilde, Centre for Industrial Management/Traffic & Infrastructure, University of Leuven, Celestijnenlaan 300A, bus 2422, B-3001, Leuven, Belgium, Thijs.Dewilde@cib.kuleuven.be, *Peter Sels*, *Dirk Catrysse*, *Pieter Vansteenwegen*

To improve the robustness of a railway system in station areas, we introduce a repetitive procedure to successively optimize the train routing problem and to reinforce this solution by applying timetable changes in a tabu search environment. We introduce the spread of the trains in the objective function for the route choice and timetabling modules. The performance of our algorithms is evaluated based on the case study for Brussels' area, using a discrete event simulation. The computational results indicate an improvement in robustness and a reduction in knock-on delay.

4 - Robust bicriteria paths

Marie Schmidt, Institut für Numerische und Angewandte Mathematik, Georg-August-Universität Göttingen, Lotzestraße 16-18, 37073, Göttingen, Germany, m.schmidt@math.uni-goettingen.de, *Kenneth Kuhn*, *Andrea Raith*, *Anita Schöbel*

Finding robust solutions of optimization problems is important in practice and well researched for single-objective problems. However, in many applications one has to deal with several objective functions. Motivated by the application of routing airplanes through convective weather, where two conflicting objective functions are given by the length and the risk of the chosen route, we extend robustness concepts to the bicriteria case and develop new robustness concepts. The concepts are analyzed for different uncertainty sets and relations between the different concepts are identified.

■ TB-13

Tuesday, 10:30-12h00

RB-Tau

Geometric Clustering

Stream: Geometric Clustering
Invited session

Chair: *Andreas Brieden*, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85579, Neubiberg, Germany, andreas.brieden@unibw.de

Chair: *Peter Gritzmann*, Mathematics, TU München, Arcisstr. 21, D-80290, Munich, Germany, gritzman@ma.tum.de

1 - On the Diameter of Partition Polytopes

Steffen Borgwardt, Fakultät für Mathematik, Technische Universität München, Boltzmannstr. 3, 85748, Garching, Bayern, Germany, borgwardt@ma.tum.de

We study the combinatorial diameter of so-called 'partition polytopes', which are associated to partitioning a set of n items into clusters C_1, \dots, C_k of prescribed sizes t_1, \dots, t_k . We derive upper bounds on their diameter in the form of $t_1 + t_2, n - t_1$ and $n/2$, which is a generalization of the well-known diameter-2 result for the Birkhoff polytope. The constructive, graph-theoretical proof yields an effective algorithm to transfer such a partition into another one by applying a number of 'cyclical exchanges' in between the clusters that adheres to our provably low diameter bounds.

2 - A New Algorithmic Approach in Mitigating Supply Chain Risk

Michael Öllinger, Universität der Bundeswehr München, Germany, michael.oellinger@unibw.de, *Andreas Brieden*, *Peter Gritzmann*

In our world of distributed production supply chain safety is an important issue. A new algorithmic model for supply chain safety is introduced based on geometric clustering. Each cluster represents a different supply chain component in the supply network, responsible for a part of the overall production. Aiming for a minimum probability of a failure, the clustering constructs optimal supply chain components. The basic model is given in detail, complemented with simulations that indicate the excellent behavior in terms of mitigating supply chain risk and constructing a robust supply chain.

3 - Forecasting risk by means of geometric clustering

Andreas Brieden, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85579, Neubiberg, Germany, andreas.brieden@unibw.de, *Peter Gritzmann*

Applying the law of large numbers is a convenient way to predict risk for a large and at the same time homogenous data set. Unfortunately in practice you have either just small but homogenous or many, but at the same time inhomogenous, datasets. In the talk a new method is presented that can deal with this problem.

4 - On optimal weighted balanced clusterings and power diagrams

Peter Gritzmann, Mathematics, TU München, Arcisstr. 21, D-80290, Munich, Germany, gritzman@ma.tum.de, *Andreas Brieden*

We study weighted clustering problems under balancing constraints with a view towards separation properties. We introduce gravity polytopes and more general gravity bodies that encode all feasible clusterings. Then we show that their extreme points correspond to strongly feasible power diagrams, certain specific cell complexes, whose defining polyhedra contain the clusters, respectively. Further, we characterize strongly feasible centroidal power diagrams in terms of the local optima of some ellipsoidal function over the gravity polytope.

■ TB-14

Tuesday, 10:30-12h00

RB-Omega

New models in batch scheduling

Stream: Scheduling under Resource Constraints
Invited session

Chair: *Mikhail Y. Kovalyov*, United Institute of Informatics Problems, National Academy of Sciences of Belarus, Surganova 6, 220012, Minsk, Belarus, kovalyov_my@yahoo.co.uk
Chair: *Ammar Oulamara*, Lorraine University, LORIA UMR 7503, Parc de Saurupt, 54000, Nancy, France, oulamara@loria.fr

1 - Scheduling a hybrid flowshop with a serial batch machine: application to chemotherapy production

Ameur Soukhal, University of Tours, Computer Science Laboratory, 64, avenue Jean Portalis, 37200, Tours, France, ameur.soukhal@univ-tours.fr, *Jean-Charles Billaut*, *Yannick Kergosien*, *Christophe Lenté*, *Jean-François Tournamille*

The Unity of Biopharmacy and Clinical Oncology of CHRU of Tours produces cancer drugs and deliver them to nursing care services. Because these services are dispersed within a vast hospital complex, a person is dedicated to deliver the drugs. After being produced, the preparations are controlled by an automaton that is in charge to check the correct dosage of the various compounds of each preparation. The controller can be considered a serial batching machine. The objective of this study is to propose production methods to minimize the delays.

2 - Scheduling an unbounded batching machine with job processing time compatibilities

Adam Janiak, Institute of Computer Engineering, Control and Robotics, Wrocław University of Technology, Janiszewskiego 11/17, 50372, Wrocław, Poland, adam.janiak@pwr.wroc.pl, *Adrien Bellanger*, *Mikhail Y. Kovalyov*, *Ammar Oulamara*

The problem of scheduling jobs on an unbounded batching machine is considered. The machine can process any number of jobs simultaneously in a batch, subject to an additional constraint that, in the same batch, the job processing times are compatible. There are processing time intervals for the jobs. The job processing times are compatible if the corresponding processing time intervals intersect. The batch processing time is equal to the left endpoint of the intersection of the job processing time intervals in this batch. The objective is to minimize a regular function of job completion times.

3 - An optimal algorithm to schedule jobs on two identical parallel machines with an operator

Djamal Rebaine, Informatique et mathématique, Université du Québec à Chicoutimi, 555, boul. de l'Université, G7H 2B1, Chicoutimi, Québec, Canada, drebaine@uqac.ca, *Mohammed Zouba*, *Pierre Baptiste*

We consider the scheduling problem on two identical machines with an operator to minimize the makespan. The operator supervision is done through a subset of working modes to divide up his interventions over the machines. The processing times then become variable as they depend on the working mode being utilized. Therefore, the process of building a schedule includes the search of the subset of working modes to utilize along with the order and the duration of their utilization. A pseudo-polynomial time algorithm is exhibited to produce an optimal solution within a free changing mode.

■ TB-15

Tuesday, 10:30-12h00

RB-2101

Algorithms for Semi-Infinite Optimization

Stream: Semi-Infinite Optimization
Invited session

Chair: *Margarita Rodríguez Álvarez*, Dpto. Estadística e Investigación Operativa, Universidad de Alicante, Ctra. Alicante-San Vicente s/n, 03690, San Vicente del Raspeig, Alicante, Spain, marga.rodriguez@ua.es

1 - Numerical methods for solving semi-infinite programs with infinitely many conic constraints

Takayuki Okuno, Graduate School of Informatics, Kyoto University, Yoshida-Honmachi, Sakyo-Ku, 606-8501, Kyoto, Japan, t_okuno@amp.i.kyoto-u.ac.jp, *Shunsuke Hayashi*, *Masao Fukushima*

The semi-infinite program (SIP) is normally represented with infinitely many inequality constraints, and has been studied extensively so far. However, there have been few studies on the SIP involving conic constraints, even though it has important applications such as Chebyshev-like approximation, filter design, and so on. In this talking, we focus on the SIP with an infinite number of conic constraints. We provide some applications and algorithms for solving it.

2 - Zimmermann-cutting plane algorithm for solving non-symmetric fuzzy semi-infinite linear programming problems

Shmayeh Khosravi, Mathematics, Shiraz University of Technology, Shiraz, Iran, Islamic Republic Of, s.khosravi@sutech.ac.ir, *Alireza Fakharzadeh*

This paper introduces a solution method for fuzzy semi-infinite linear programming problems, in which contains the crisp objective function and the infinite number of fuzzy constraints. The solution method is the kind of cutting plane algorithm in which its sub-problem are solved by using the Zimmermann-method. The convergence of the algorithm is proved and some numerical examples are given.

3 - The alpha-BB based cutting plane method for semi-infinite program with multi-dimensional index set

Shunsuke Hayashi, Graduate School of Informatics, Kyoto University, Yoshida-Honmachi, Sakyo-Ku, 606-8501, Kyoto, Japan, shunhaya@amp.i.kyoto-u.ac.jp, *Kensuke Goumoto*

Recently, Shiu and Wu proposed the algorithm for semi-infinite program (SIP) combining the alpha-BB method with the cutting plane method. In this study, we extend their algorithm to the case where the index set in the SIP is multi-dimensional. When the index set is one-dimensional, the "refinement step" in the algorithm is just to divide a closed interval into the left and the right. However, such a division is not unique in the multi-dimensional case. We also apply the algorithm to the three-dimensional design-centering problem, which can be cast as an SIP with a two-dimensional index set.

4 - Weighted Voronoi cells via quadratic systems

Margarita Rodríguez Álvarez, Dpto. Estadística e Investigación Operativa, Universidad de Alicante, Ctra. Alicante-San Vicente s/n, 03690, San Vicente del Raspeig, Alicante, Spain, marga.rodriguez@ua.es, *Miguel Goberna*, *Virginia N. Vera de Serio*

Given a set T such that each point s has assigned a positive weight $w(s)$, the multiplicatively weighted (MW) Voronoi cell of s is the set of points closer to s than to any other point of T for the distance $d(.,t)/w(t)$. The MW-Voronoi diagram of T is the family of MW-Voronoi cells of all the elements of T . Recently, we applied the theory of linear semi-infinite systems to get information on the ordinary Voronoi cells and diagrams (with the same weight for all the points of T). In this talk, we apply results on quadratic systems to MW-Voronoi cells and diagrams.

■ TB-16

Tuesday, 10:30-12h00

RB-2103

Theory and Applications of Constrained Equilibria

Stream: Uncertainty and Perturbations in Optimization and in Environmental and Energy Modelling
Invited session

Chair: *Jacek Krawczyk*, School of Economics and Finance, Victoria University of Wellington, 6140, Wellington, New Zealand, J.Krawczyk@vuw.ac.nz

1 - Global emission ceiling versus international cap and trade: a comparison based on normalized Nash equilibria

Jacqueline Morgan, Department of Mathematics and Statistics & CSEF, University of Naples Federico II, Via Cinthia, 80126, Napoli, Italy, morgan@unina.it, *Fabien Prieur*

We model climate negotiations as a two-stage game. In the first stage, players agree on a global emission cap (GEC). In the second one, they non-cooperatively choose either their emission level or their emission quota, under the cap that potentially binds them together. When the emission cap is binding, among the coupled constraints Nash equilibria, we select a normalized equilibrium. With and without emission trading, there exists a range of values for which a binding cap improves all players' payoff. Moreover GEC outperforms the ITC system in terms of emission reduction and payoff gains.

2 - Robust Nash Equilibrium in a Class of Multi-Leader-Follower Games

Masao Fukushima, Kyoto University, Japan, fuku@i.kyoto-u.ac.jp

In this paper, we focus on a class of multi-leader-follower games under uncertainty with some special structure. By means of the robust optimization technique, we first formulate the game as the robust Nash equilibrium problem, and then the generalized variational inequality (GVI) problem. We then establish some results on the existence and uniqueness of a robust leader-follower Nash equilibrium. We also apply the forward-backward splitting method to solve the GVI formulation of the problem and present some numerical examples. [This is a joint work with Ming Hu.]

3 - Regulation of pollution in a Cournot equilibrium

Lars Mathiesen, Economics, Norwegian School of Economics, Helleveien 30, 5045, Bergen, Norway, Lars.mathiesen@nhh.no

This paper is concerned with modeling polluters that form an oligopoly in their product market. Adding emission-constraints converts the Cournot-Nash equilibrium into a generalized Nash equilibrium problem (GNEP). When coupling constraints are common and corresponding shadow prices are equal to all players the resulting equilibrium is a complementarity problem (CP). Conditions for convergence of a Newton process to a unique equilibrium of the CP are shown to be similar to those of the Cournot-Nash model. Computational results demonstrate its efficiency compared to other approaches.

4 - Economics of collective monitoring: a study of environmentally constrained electricity generators

Jacek Krawczyk, School of Economics and Finance, Victoria University of Wellington, 6140, Wellington, New Zealand, J.Krawczyk@vuw.ac.nz, *Javier Contreras*, *James Zuccollo*

We tackle welfare differences between individual and collective monitoring of pollution. Given a model of emissions propagation the regulator can calculate the optimal emissions quota for each generator and enforce it through individual monitoring. That will maximise welfare, but may be expensive because of implementation costs. An alternative is provided. We use a 3-node network, find that the welfare loss from collective monitoring can be small and that the imposition of transmission and environmental restrictions may benefit the "inefficient" generator and decrease consumer surplus.

■ TB-17

Tuesday, 10:30-12h00
RB-2105

Hub Location I

Stream: Hub Location
Invited session

Chair: *Ivan Contreras*, Concordia University, H3G 1M8, Montreal, Canada, icontrer@encs.concordia.ca

1 - P-HUB approach for the optimal park-and-ride facility location problem

Vladimir Marianov, Electrical Engineering, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, 7820436 Macul, 7820436, Santiago, Chile, marianov@ing.puc.cl, *Felipe Aros-Vera*

We optimally locate Park and Ride (P&R) facilities, modeled as capacitated hubs. P&R usage is maximized. Commuters can either use the service or choose to travel by car only, and their behavior follows a gravitational model. We consider users' generalized cost and attractiveness of P&R facilities as input for the gravity rule. For small instances of the problem, we propose a novel linearization of the gravity rule. A modification of the Heuristic Concentration Integer procedure is applied to solve larger instances. Numerical results are shown, including a case in Queens, NY.

2 - Hub location under uncertainty

Francisco Saldanha-da-Gama, CIO/DEIO, University of Lisbon, FCUL-DEIO, Bloco C6, Piso 4, 1749-016, Lisbon, Portugal, fsgama@fc.ul.pt, *Sibel A. Alumur*, *Stefan Nickel*

In this work, we address several aspects concerning hub location problems under uncertainty. Two sources of uncertainty are considered: the set-up costs for the hubs and the demands to be transported between the nodes. Generic models are presented for single and multiple allocation versions of the problems. Using a set of computational tests we analyze the changes in the solutions driven by the different sources of uncertainty considered isolated and combined.

3 - Hub and Spoke Network Design with Single-assignment, Capacity Decisions and Balancing Requirements

Stefan Nickel, Institute for Operations Research, Karlsruhe Institute of Technology (KIT), Geb 11.40, 76128, Karlsruhe, Baden-Wuerttemberg, Germany, Stefan.Nickel@kit.edu, *Isabel Correia*, *Francisco Saldanha-da-Gama*

An extension of the capacitated single-allocation hub location problem is considered in which not only the capacity of the hubs is part of the decision making process but also balancing requirements are imposed on the network. The decisions involve: the selection of the hubs, the allocation of the spoke nodes to the hubs, the flow distribution through the sub network defined by the hubs, and the capacity level at which each hub should operate. A set of computational experiments is performed and the results are reported.

4 - Supermodular Properties in Hub Location

Ivan Contreras, Concordia University, H3G 1M8, Montreal, Canada, icontrer@encs.concordia.ca, *Elena Fernandez*

In this work we show how a generalized hub location problem, that includes as particular cases well-known hub node and hub arc location problems, can be stated as the maximization of a supermodular function. As a consequence, we obtain worst-case bounds on the performance of a greedy heuristic. Moreover, we present two integer programming formulations for the generalized hub location problem. One of these formulations is derived from the properties of supermodular functions, and involves variables with at most two indices. Computational experiments confirm the efficiency of such formulation.

■ TB-18

Tuesday, 10:30-12h00
RB-2107

Location Analysis: Advanced Optimization Tools

Stream: Continuous Location
Invited session

Chair: *Víctor Blanco*, Quant. Methods for Economics & Business, Universidad de Granada, Facultad de Ciencias Economicas y Empresariales, Campus Cartuja, 18011, Granada, Spain, vblanco@ugr.es

1 - Expanding Search for a Hider on a Network

Steve Alpern, Mathematics Department, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, s.alpern@lse.ac.uk, *Thomas Lidbetter*

A Hider H is hidden somewhere on a network Q . A Searcher chooses continuously expanding sets, of total length. Starting at a given point A , he captures the Hider at the first time T with H in set. This new search paradigm models searching by a team of agents. We solve the Bayesian problem on a tree (where the distribution of H is known) and the game where the Hider chooses H and T is the payoff, for certain types of networks. This extends the article S. Alpern, 'Find-and-Fetch on a Tree', *Operations Research* 59 (2011).

2 - Solving the franchisor-franchisee bi-objective optimization problem

Pilar M. Ortigosa, Computer Architecture and Electronics, University of Almería, Ctra. Sacramento s/n, La Cañada de San Urbano, 04120, Almería, Spain, ortigosa@ual.es, *Juana López-Redondo*, *Jose Fernandez*, *Aranzazu Gila Arrondo*, *Carmen G. Escamilla*, *Victoria Plaza Leiva*

Though the problem of obtaining the Pareto-front for this problem has been previously tackled through exact general methods, they require high computational effort. In this work, we propose a new multi-objective optimization heuristic algorithm, which deals with the problem at hand in a fast and efficient way. It combines ideas from different multi-objective and single-objective optimization evolutionary algorithms, although it also incorporates new devices which help to reduce the computational requirements, and also to improve the quality of the provided solutions.

3 - Optimal Timings of Project Control Points using Facility Location Model and Simulation

Narjes Sabeghi, Applied Mathematics, Ferdowsi University of Mashhad, Faculty of Mathematical Sciences, No10, Jadan10, Vakilabad BLV, Mashhad, Iran, Mashhad, Iran, Islamic Republic Of, narjes_sabeghi@yahoo.com, *Hamed Reza Tareghian*, *Hassan Taheri*, *Mohammad Amini*

Approaches with static view to the project control suffer from the fact that the possibility of corrective actions is missing. In this paper, we consider a dynamic view to the project control and use an adapted version of the facility location model to find optimal timings of the control points. A simulation model is then used to predict the possible deviations from the base plan at each control point. Borrowing ideas from disturbance management, corrective actions are taken. This process continues until the timing of the last point of control is obtained.

4 - A hierarchy of SDP-relaxations for multifacility ordered median problems

Victor Blanco, Quant. Methods for Economics & Business, Universidad de Granada, Facultad de Ciencias Economicas y Empresariales, Campus Cartuja, 18011, Granada, Spain, vblanco@ugr.es, *Justo Puerto*, *Safae EL Haj Ben Ali*

We consider multifacility ordered median continuous location problems with any norm, and in any dimension. We show that there is a sequence of semi definite programming relaxations that converges to the optimal solution of the problem by using a Lasserre's moment approach. Furthermore, in order to solve larger problems, we prove that we can exploit the sparsity and the symmetry of the original problem to reduce, considerably, the size of the SDP problems in the sequence.

■ TB-19

Tuesday, 10:30-12h00

RB-2111

Quantitative Models for Risk Management in Insurance

Stream: Actuarial Sciences and Stochastic Calculus
Invited session

Chair: *Montserrat Guillen*, Econometrics-UB, University of Barcelona, Diagonal, 690, E-08034, Barcelona, Spain, mguillen@ub.edu

Chair: *Ana Maria Perez-Marin*, Econometrics and Statistics, University of Barcelona, Av. Diagonal 690, Faculty of Economics, 08034, Barcelona, Barcelona, Spain, amperez@ub.edu

1 - Selecting prospects for cross-selling financial products using multivariate credibility

Fredrik Thuring, Actuarial Science, Cass Business School, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, firt@codan.dk, *Jens Perch Nielsen*, *Catalina Bolance*

For many companies a possible way to expand its business is to sell more products to preferred customers in its portfolio. Data on the customers' past behaviour (e.g. past claiming history, for insurance products, or past information on defaulting, for banking products) is stored in the company's data base and can be used to assess whether or not more products should be offered to a specific customer. This study implements a method for using historical data of each individual customer, and the portfolio as a whole, to select a target group of customer to whom more products would be offered.

2 - A logistic regression approach to estimating customer profit loss due to lapses in insurance

Ana Maria Perez-Marin, Econometrics and Statistics, University of Barcelona, Av. Diagonal 690, Faculty of Economics, 08034, Barcelona, Barcelona, Spain, amperez@ub.edu, *Montserrat Guillen*, *Manuela Alcañiz*

This article focuses on business risk management in the insurance industry. A methodology for estimating the profit loss caused by each customer in the portfolio due to policy cancellation is proposed. Using data from a European insurance company, customer behaviour over time is analyzed in order to estimate the probability of policy cancellation and the resulting potential profit loss due to cancellation in two different lines of business contracts. Implications for understanding customer cancellation behaviour as the core of business risk management are outlined.

3 - Developing customer fidelity programs and strategies within customer relationship management activities

Aras Keropyan, Economics and Business Organization, University of Barcelona, 08034, Barcelona, Spain, arasaral@hotmail.com, *Ana Maria Gil-Lafuente*

Over the last decade, Customer Relationship Management (CRM) activities have become fundamental for companies. Every time it is being more costly to acquire new customers than retaining the existing business, therefore the big corporations are more disposed to invest more resources for existing customers in order to assure their satisfaction and fidelity with the company. In this study our objective is to implement a fuzzy based Hungarian Method that will allow us to develop efficient customer fidelity programs and strategies for different customer segments within CRM activities.

■ TB-20

Tuesday, 10:30-12h00

RB-2113

Financial Modeling and Optimization

Stream: Decision Making Modeling and Risk Assessment in the Financial Sector

Invited session

Chair: *Hüseyin Tatlıdil*, Statistics, Hacettepe University, Hacettepe Üniversitesi Beytepe Kampusu İstatistik Bölümü, Beytepe, 06532, Ankara, Turkey, tatlidil@hacettepe.edu.tr

1 - Portfolio optimization with a new quantile-based risk measure

Cristinca Fulga, Gheorghe Mihoc-Caius Iacob Institute of Mathematical Statistics and Applied Mathematics of Romanian Academy, Calea 13 Septembrie No.13, Sector 5, 050711, Bucharest, Romania, fulga@csie.ase.ro

We develop a portfolio selection method which takes into consideration the recent positive evolution of the risky assets that are not comprised in the portfolio available at the moment of the decision by using the Analytical Hierarchy Process. Our model relies on a new quantile based risk measure which is defined using the modified loss distribution according to the decision maker's loss aversion preferences.

We investigate the practical performance of the proposed Mean-Risk model on a portfolio composed of some of the most representative securities of the Bucharest Stock Exchange.

2 - Probability distribution models for european stock index returns

Chris Katris, Engineering Sciences, University of Patras, 26504, Patras, Greece, chriskatris@upatras.gr, *Sophia Daskalaki*

We study the marginal distributions of daily returns for eight European Stock Market Indices and attempt to fit the Generalized Hyperbolic and mixtures of Normal Distributions. We also create a model that combines the Generalized Pareto for the tails and other distributions for the rest of the data. The above marginal distributions are then considered as static models for parametric estimation of the Value at Risk Evaluation of the models concludes this work.

3 - A Query for Statistical Arbitrage in Fixed Income Markets for Developing Countries

Sait Satiroglu, Center For Computational Finance, Ozyegin University, Kusbakisi Cad No:2, Altunizade Uskudar, 34662, Istanbul, Turkey, sait.satiroglu@ozyegin.edu.tr, *Emrah Sener*, *Emrah Ah*

This paper studies the Nelson-Siegel framework driven fixed income arbitrage strategy in three developing countries. We consider the rich cheap analysis and butterfly trades which historically present abnormal yields to maturity, taking as reference a robust zero-coupon yield curve fitted with bond prices. The main contribution of the paper is the construction-optimization, back-testing and comparison of our fitted yield curves and Z-score based strategies. We show that "intellectual capital" required yield curve arbitrage strategies produce positively skewed returns also in emerging markets.

4 - The Performance of Value at Risk and Expected Shortfall Under Subfamilies of Generalized Hyperbolic Distributions: Evidence from ISE-30

Ali Sabri Taylan, Market Oversight, Turkish Derivatives Exchange, Vadeli Islem ve Opsiyon Borsasi A.S., Akdeniz Cd. Birsal Is Mrk. No:14 Kat:6, 35210, Izmir, Turkey, staylan@turkdex.org.tr, *Hüseyin Tatlidil*

The approach based on normal distribution was used in the studies of guessing the VaR as a standard risk measuring criterion. However, in many researches it is understood that the distribution of return series of financial variables has heavy tails and it is skewed and straight. In this study, we fit subfamilies of generalized hyperbolic distributions and evaluate the performance of quantile-based risk measures such as VaR and Expected Shortfall with a dataset of daily prices of ISE-30 Index and stocks. We also examine the differences between the success rates of the calculated risk measures.

■ TB-21

Tuesday, 10:30-12h00

RB-2115

Financial Mathematics and OR 6

Stream: Financial Mathematics and OR
Invited session

Chair: *Tatiana Zolotova*, Chair of Applied mathematics, State University of the Ministry of Finance of the Russian Federation, 127006, Moscow, Nastasinski lane, house 3, case 2, Research financial institutions, 127006, Moscow, Russian Federation, tgold11@mail.ru

Chair: *Tansel Avkar*, Department of Mathematics, Middle East Technical University, 06531, Ankara, Turkey, tanselavkar@gmail.com

1 - The general approach to the modeling of the risk management procedures and its specification for investment problems

Tatiana Zolotova, Chair of Applied mathematics, State University of the Ministry of Finance of the Russian Federation, 127006, Moscow, Nastasinski lane, house 3, case 2, Research financial institutions, 127006, Moscow, Russian Federation, tgold11@mail.ru

The work is devoted to the description of the general model of the risk management, including two submodels: the model of an estimation of system effectiveness and the model of an estimation of the risk of its functioning. The general model can be applied to decision-making in conditions of risk for various complex systems and processes. Problems of management are considered for stochastic processes at the strategic and share investment, using various estimations of risk. Methods of these problems decision in view of criteria of efficiency and risk are offered.

2 - Stochastic Hybrid Dynamical Financial Systems and Their Optimization

Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr, *Büsra Temocin*, *Azar Karimov*, *Erdem Kilic*, *Yeliz Yolcu Okur*

We represent dynamics in finance under uncertainty and covariance. An emerging representation tool for this is Stochastic Differential Equations. It has become acknowledged that additionally an impulsive part is needed, together amounting for Levy processes. Even these are often composed piecewise with changes happening at thresholds. We present several classes of these Hybrid Systems, discuss problems of identification, keeping them between barriers and optimizing portfolios with regard to them, discussing approaches of Hamilton-Jacobi-Bellman and Maximum Principle.

3 - Parameter Estimation for Stochastic Differential Equations

Tansel Avkar, Department of Mathematics, Middle East Technical University, 06531, Ankara, Turkey, tanselavkar@gmail.com, *Gerhard-Wilhelm Weber*

Stochastic differential equations play a fundamental role in modeling dynamic phenomena in nature, technology and economy. Models defined via SDEs usually depend on finite or possibly infinite dimensional parameters. To obtain a useful model, it is critical to estimate them. But these equations are hard to represent by a computer and to resolve. We express them in the manner of approximation by a discretization and additive models with splines. Our estimation refers to the linearly involved spline coefficients and the partially nonlinearly involved probabilistic parameters.

4 - A Surrogate Constraint Approach for a Scenario-based Capital Budgeting Model

José Paixão, Dept. Statistics and Operations Research, Faculty of Sciences - University of Lisbon, Bloco C6 - Campo Grande, 1749-016, LISBOA, Portugal, jpaixao@fc.ul.pt, *Anabela Costa*

Contingent claims analysis can be used for project evaluation when the project develops stochastically over time and the decision to invest can be postponed. In that perspective, a model has been presented in the literature. However, the corresponding linear integer program turns out to be quite intractable even for small size instances. In this talk, we present a surrogate constraint relaxation for the original problem yielding the determination of lower and upper bounds for the optimal value of the problem. Computational experience, allowing the comparison with other approaches, is reported.

■ TB-22

Tuesday, 10:30-12h00

RB-2117

Mathematical Models in Macro- and Microeconomics 1

Stream: Mathematical Models in Macro- and Microeconomics
Invited session

Chair: *Marta Kostrzewska*, Institute of Mathematics, University of Silesia, ul. Bankowa 14, Katowice, 40-007, Katowice, Poland, marta.kostrzewska83@gmail.com

1 - Efficiency-Indices for revealed preference tests: Complexity results and algorithms

Bart Smeulders, Faculty of Business and Economics, KU Leuven, Naamsestraat 69, 3000, Leuven, Belgium, bart.smeulders@econ.kuleuven.be, *Frits Spieksma*

In this paper, we prove a number of complexity results regarding efficiency-indices for revealed preference tests. These indices are often used in micro-economics as a measure of consumer rationality. While a number of observations regarding the difficulty of calculating these indices are made in the economics literature, few formal results exist. For one popular efficiency-index we provide exact polynomial time algorithms, whilst for two other common efficiency-indices we prove NP-Hardness for four different axioms of revealed preference.

2 - Who's Number One? Asymmetric Production Costs as a Determinant of Quality Rankings

Mihkel Tombak, Management, University of Toronto, 3359 Mississauga Rd North, L5L 1C6, Mississauga, Ontario, Canada, mihkel.tombak@rotman.utoronto.ca, *Sergio Meza*

We examine how production cost asymmetries affect the way firms compete in prices and quality in a vertical differentiation model and obtain an endogenously determined quality ranking. When cost differences grow, quality differentials decrease, and when they grow large enough, we have a unique duopoly equilibrium where the low-cost firm offers high quality. We illustrate the robustness of these results to different costs of quality formulations and find our results are strengthened when adding costs of quality. We conduct a welfare analysis and discuss implications.

3 - Time-varying regression model of gross domestic product

Damir Atygayev, Control/Management and Applied Mathematics, Moscow Institute of Physics and Tehnology, Russian Federation, atygaevdr@gmail.com, *Vadim Mottl*

In this paper, we review time-varying linear regression, which is the essence of recovering some hidden dependences (GDP's components), which are time-varying in the general case. Feature of this model is the assumption of zero presence of noise in the observations and hidden components. This assumption imposes additional constraints on the observations and the functional dependence of the hidden components. The method being proposed is simple in tuning and has linear computational complexity with respect to the signal length.

4 - Games in the network flows

Marta Kostrzewska, Institute of Mathematics, University of Silesia, ul. Bankowa 14, Katowice, 40-007, Katowice, Poland, marta.kostrzewska83@gmail.com, *Leslaw Socha*

The aim of this presentation is to study the cooperative games related to the network cost flow problem. We consider the network in which the set of arcs is shared between K players. Every coalition is interested in maximizing the value of the preference function together with minimizing the linear function representing the total cost of a flow. The coalition is winning if both criteria do not exceed defined extreme values. The properties and the costs of stability of defined games are studied.

■ TB-23

Tuesday, 10:30-12h00

RB-Delta

Mathematical Programming and Regulatory - Ecological Systems

Stream: Mathematical Programming
Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Joanna M. Makulska*, Department of Cattle Breeding, University of Agriculture in Krakow, al. Mickiewicza 24/28, 30-059, Kraków, Poland, rzmakuls@cyf-kr.edu.pl

1 - Robust Optimization in Spline Regression Models for Target-Environment Networks

Ayse Özmen, Scientific Computing, Institute of Applied Mathematics, Middle East Technical University, Kazimkarabekir Mah. 2048. Sok No:5/5, Etimesgut, 06790, Ankara, Turkey, ayseozmen19@gmail.com, *Erik Kropat*, *Gerhard-Wilhelm Weber*

Solutions to optimization problems can represent significant sensitivity to perturbations in the parameters of the problem. So, optimization affected by parameter uncertainty is a focus of the mathematical programming and a need to tackle uncertain data when optimization results are combined within real-life applications. Since the regression models of target-environment networks can be affected by noise, we introduce spline regression models using MARS, Conic MARS (CMARS) and, their robust versions under polyhedral uncertainty by using robust optimization that deal with data uncertainty.

2 - Optimal parameters region for Pulse Width - Pulse Frequency and Pseudo-Rate modulators

M. Navabi, SMARTLAB, Shahid Beheshti University, GC, 1234, NY, Iran, Islamic Republic Of, astronautics.facult@gmail.com, *Hamed Rangraz*

Pulse Width - Pulse Frequency, the device that translates the continuous commanded torque signal to an on/off signal, is analyzed, the optimal range of its parameters is determined and compared with pseudo-rate modulator. Thrusters used as attitude control actuator operate in on-off mode, but controller create a continuous signal, therefore a unit is needed to translate continuous signal while providing lowest fuel consumption and thruster firing for attitude control of spacecraft. Two modulators are selected and optimized through system analysis.

3 - Economically optimal days open and days dry in high milking cows

Joanna M. Makulska, Department of Cattle Breeding, University of Agriculture in Krakow, al. Mickiewicza 24/28, 30-059, Kraków, Poland, rzmakuls@cyf-kr.edu.pl, *Andrzej Węglarz*, *Anna Stygar*

Numerous investigations indicate a necessity to change standard recommendations on the optimal length of days open and days dry in high yielding dairy herds. This study presents the solutions obtained from the multi-level hierarchic Markov model developed to support the economically optimal decisions on insemination, drying-off and replacement of high milking cows. The biological, technical and economic parameters of the model were derived based on the empirical data representing the conditions of dairy cattle production in Poland and on the results of a literature review.

■ TB-24

Tuesday, 10:30-12h00

CC-A11

Financial Forecasting and Risk Analysis

Stream: Forecasting

Invited session

Chair: *Patricia Xufre*, CIO-FCUL and NovaSBE, Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal, pxufre@novasbe.pt

1 - Are the tails different from the body?

Jose Faias, UCP, Catolica Lisbon School of Business and Economics, Palma de Cima, VAT 501082522, 1649-023, Lisbon, Portugal, jfaias@clsbe.lisboa.ucp.pt

In recent years there has been an increasing interest in modeling dependence in heavy tail phenomena such as the latest turbulence episodes in financial markets. We measure extremal correlation in international equity markets. Our analysis offers a new perspective into the dynamics governing asset return comovements during periods of stress at the cross-country and cross-sectoral levels.

2 - Investment models with a VaR constraint

Patricia Xufre, CIO-FCUL and NovaSBE, Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal, pxufre@novasbe.pt, *Antonio Rodrigues*

We analyse how VaR (Value-at-Risk) can be used directly to design an investment strategy. We propose 2 methods to build an investment model based on the profit maximization with VaR constrained: (i) the distribution of the returns is stationary, (ii) a recursive way to estimate VaR allowing adaptation to new information. The estimation of the quantile is made through a new neurocomputational procedure. Both methods were tested for several price time series, as well as with artificial data generated according to different stochastic models.

3 - Recursive quantile estimation vs. quantiles from recursive density estimation

Jose Luis Carmo, CIO and University of Algarve, Portugal, jlcarmo@ualg.pt, *Antonio Rodrigues*

Many decision problems, namely in the areas of financial investing, inventory management or quality control, are approachable by the recursive estimation of quantiles, from (possibly) nonstationary time series. In this work, we compare different recursive quantile estimation methods, and end up concluding, on the basis of empirical evidence, in favour of an alternative approach: the computation of quantiles from recursively estimated probability densities, the latter being accomplished through an original adaptive exponential smoothing method.

4 - How the stochastic problem drives the Brazilian electric sector

Reinaldo Souza, Departamento de Engenharia Elétrica, Pontifícia Universidade Católica do Rio de Janeiro, Rua Marquês de São Vicente, 22453-900, Rio de Janeiro, RJ, Brazil, reinaldo@ele.puc-rio.br, *Pedro Ferreira*, *Fernando Luiz Cyrino Oliveira*

This article aims, first of all, at presenting the reader a broad perspective of the Brazilian Electric sector, identifying the process of transformation through which it underwent during the last decades, arriving at the Brazilian Electric Sector's (BES) New Model. With this New Model, it is shown how a good modeling of the stochastic variable is determinant to the good functioning of the BES' three fundamental pillars, that is, planning, operation, and accounting and settlement process of the energy transactions in the short term market.

■ TB-25

Tuesday, 10:30-12h00

CC-A23

Sustainable Supply Chains

Stream: Environmental Issues in Operations Management

Invited session

Chair: *Mehmet Soysal*, Operations Research and Logistics, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, mehmet.soysal@wur.nl

1 - Carbon-Optimal and Carbon-Neutral Supply Chains

Charles Corbett, UCLA Anderson School of Management, 110 westwood plaza, box 951481, 90095-1481, Los Angeles, CA, United States, charles.corbett@anderson.ucla.edu, *Felipe Caro*, *Tarkan Tan*, *Rob Zuidwijk*

We introduce a model of joint production of GHG emissions in general supply chains, decomposing total footprint into processes, each of which can be influenced by any combination of firms. We examine when the supply chain can be carbon-optimal, ie. when all firms exert first-best emissions reduction effort levels. We find that, to induce carbon-optimal effort levels, emissions need to be over-allocated. This means that the focus in the LCA and carbon footprinting literature on avoiding double-counting is, in the context of setting incentives, misguided.

2 - An application of Revenue Management in remanufacturing: the case of a third party remanufacturer

Joao Quariguasi, MACE, University of Manchester, Manchester, United Kingdom, joao.quariguasifrotaneto@manchester.ac.uk, *Andy Reade*, *Azadeh Dindarian*

Optimally deciding as to whether recycle, refurbish, remanufacture or retrieve parts from a returned product is no trivial task, and is dictated by a number of factors: the WTP for the remanufactured product, scrap prices, remanufacturer's idle capacity. Moreover, in the case of large third party remanufacturers, these decisions have to be made hundreds of thousands of times a year. In this paper, using real data obtained from a large remanufacturer in the UK, and drawing on revenue management techniques, we develop an automated system to support such decisions.

3 - Robust design of production networks for second generation synthetic bio-fuel

Grit Walther, Schumpeter School of Business and Economics, Chair of Production and Logistics, Bergische Universität Wuppertal, Rainer-Gruenter-Str. 21, 42119, Wuppertal, Germany, walther@wiwi.uni-wuppertal.de, *Thomas Spengler*, *Anne Schatka*, *Laura Hombach*

Second generation synthetic bio-fuels can make an important contribution to sustainable mobility. However, there are currently high uncertainties with regard to development of production technology, future political requirements, and future demand. We develop a multi-period MIP-model for integrated location, capacity and technology planning for the design of production networks for second generation synthetic bio-fuels. Principle network configurations are developed, and the uncertainties are regarded using a scenario based approach.

4 - An integrated model for sustainable food logistics management

Mehmet Soysal, Operations Research and Logistics, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, mehmet.soysal@wur.nl, *Jacqueline Bloemhof*, *Jack van der Vorst*

Food supply chains (FSCs) require different quantitative models for aiding management decisions, mainly because of the perishability of the product. Addition of sustainability concerns makes models for the FSCs more challenging. In this study, we develop a generic MILP model for the logistics management of FSCs while considering the perishability of the products and the sustainability (GHG emissions) of the transportation modes. The model minimizes various costs, while fulfilling demand requirements and can be used as a decision support tool for improving the sustainability of FSCs.

■ TB-27

Tuesday, 10:30-12h00

CC-A25

Decision Analysis in Practice

Stream: Decision Processes

Invited session

Chair: *Mara Airoidi*, Dept of Management, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, m.airoidi@lse.ac.uk

1 - Assessing the value for money of UK public services

Tom McBride, National Audit Office, SW1W 9SP, London, United Kingdom, Tom.McBride@nao.gsi.gov.uk

The National Audit Office provides the UK Parliament with independent assurance on the use of public resources. One way we do this is by publishing around 60 Value for Money (VfM) reports per year. These reports are on topics as diverse as dementia services and banking support. OR plays an important role in our work. For example they can be used to construct a counterfactual to assess if VfM has been achieved; or to examine the integrity of Government forecasts. This presentation will give an overview of our role, and present 3 case studies of how we have used OR to analyse UK public services.

2 - Disinvestments in practice

Mara Airoidi, Dept of Management, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, m.airoidi@lse.ac.uk

A challenge faced by many public sector organisations is how to reduce costs. Disinvesting is more challenging than allocating additional spend, because the staff who know the service best do not see honest presentation of the options as being in their interest. We show how a decision conferencing approach was used to help a health authority make critical decisions about the reconfiguration of an eating disorders service in order to secure cost savings, and discuss lessons learned.

3 - Tackling uncertainties in multi-criteria decision support for sustainable water infrastructure planning

Lisa Scholten, System Analysis, Integrated Assessment and Modelling, EAWAG:Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstr 133, P.O.Box 611, 8600, Dubendorf, Zurich, Switzerland, Lisa.Scholten@eawag.ch, *Judit Lienert*

To support water infrastructure choices under uncertain scenarios, MAUT is applied to a case study in Switzerland. Different sources of uncertainty from internal and external factors of MCDA will be considered during evaluation. Due to the complexity of elicitation and uncertainty modeling, usually much simplified preference models are used (e.g. risk neutrality, additive aggregation). Knowing (from global sensitivity analysis), such uncertainty really matters, will help to focus on more adapted elicitation design. The overall decision analytic framework and first results will be presented.

■ TB-28

Tuesday, 10:30-12h00

CC-A27

Optimization Modeling

Stream: Structured Optimization and Applications
Invited session

Chair: *Marcel Sinske*, Institute of Operations Research, Karlsruhe Institute of Technology, Kaiserstraße 12, 76131, Karlsruhe, Germany, sinske@kit.edu

1 - Taxonomy of concepts and terms in administration, OR and management

Erwin Reizes, O.R., Fac.Ing./UdelaR, Uruguay, Luis A.de Herrera 1042,ap.1701 (home), ap.1701, 11300, Montevideo, Uruguay, bereizes@adinet.com.uy

A Taxonomy of concepts and terms seems necessary to scope with the "Babel" of synonyms and homonyms in administration, OR and management theory and practice. Based on ideas of Logic, System Theory, Linguistics, Biology, OR and Informatics, a uniform correspondance of concepts and terms is given.

2 - Measuring the Performance of TV Campaigns based on DEA: an Empirical Study

Katsuaki Tanaka, Faculty of Business Administration, Setsunan University, 17-8 Ikedanakamachi, 572-8508, Neyagawa, Osaka, Japan, k-tanaka@kjo.setsunan.ac.jp, *Yoshinori Matano*

Though much efforts have been done to have a understanding of the TV advertising effects, there is no definite standard. The frontier analysis is useful clarifying whether the campaign is efficient or not. DEA is a frontier analysis based on the empirical data. By observing the distance from the frontier, it provides the improvement of the inefficient DMU. In this paper, DEA is employed to measure the performance of TV advertising campaigns. Each campaign is considered as a DMU - the inputs are the advertising expenditures whereas the outputs are the awareness and knowledge of the campaigns.

3 - Double and One Sided Moral Hazard in the Three-tier hierarchical Organization of the Venture Capital Finance

Ayi Gavirel Ayayi, Science de la gestion, Université du Québec, 3351 Boulevard des Forges, G9A 5H7, Trois Rivières, Québec, Canada, ayi.ayayi@uqtr.ca

The paper studies double-sided moral hazard problem (MHP) between venture capitalists (VCs) and entrepreneurs and one-sided MHP between the investors in the venture capital funds and VCs because of the direct impact of the moral hazard on the performance of the funds as well as on the growth and the success of the investees. I show that an optimal compensation contract can reconcile the different needs and concerns of the three contracting parties; given the information distribution and the behavioral assumptions. Global optimization program is used to solve goal congruence optimal contract.

■ TB-29

Tuesday, 10:30-12h00

CC-A29

MINLP and Nonlinear Network Flows in Gas Transport I

Stream: Mixed-Integer Non-Linear Programming
Invited session

Chair: *Benjamin Hiller*, Optimization, Zuse Institute Berlin, Takustr. 7, 14195, Berlin, hiller@zib.de

1 - Checking Feasibility in Stationary Models of Gas Transportation

Claudia Stangl, Mathematics, University of Duisburg-Essen, Butlerstrasse 10, 47058, duisburg, Germany, claudia.stangl@uni-due.de, *Rüdiger Schultz*

Checking the feasibility of transportation requests belongs to the key tasks in gas pipeline operation. In its most basic form, the problem is to decide whether a certain quantity of gas can be sent through the network from prescribed entries to prescribed exit points. In the stationary case, the physics of gas flow together with technological and commercial side conditions lead to a pretty big (nonlinear, mixed-integer, finite dimensional) inequality system. We present elimination and approximation techniques so that the remaining system gets within the reach of standard NLP-solvers.

2 - The Gas Network Nomination Validation Problem - An MIP Approach

Bjoern Geissler, Mathematics, FAU Erlangen-Nürnberg, Discrete Optimization, Cauerstraße 11, 91058, Erlangen, Germany, bjoern.geissler@math.uni-erlangen.de, *Alexander Martin*, *Antonio Morsi*, *Lars Schewe*

Nomination validation constitutes kind of a core problem for many optimization tasks in gas economy. It is about to decide whether a gas network can be operated such that given demands are satisfied subject to legal, physical and technical constraints. The nomination validation problem is most naturally modeled as nonconvex MINLP. However, for large networks these models are intractable by state-of-the-art MINLP-solvers. We present an alternative approach based on a new kind of MIP-relaxations and provide computational evidence for its suitability even for large real-life instances.

3 - Gas Network Topology Optimization

Jesco Humpola, Optimization, Zuse Institute Berlin, Takustrasse 7, 14159, Berlin, Berlin, Germany, humpola@zib.de, *Thorsten Koch*, *Thomas Lehmann*, *Jonas Schweiger*

We aim for topology optimization of large-scale, real-world gas transmission networks. Given a nomination, i.e. a balanced allocation of source and sink flows, we look for a suitable setting of all network components and a cost optimal selection of new network elements, such that the requested amount of gas can be transmitted through the network without violating physical or operational constraints. The problem can be stated as a non-convex MINLP, which we solve by a special tailored combination of the solvers SCIP and IPOPT and a heuristic that makes use of the dual values of the IPOPT calls.

4 - Modeling flow in gas transmission networks using shape-constrained expectile regression

Fabian Sobotka, Economics, Universität Goettingen, Platz der Göttinger Sieben 5, 37073, Göttingen, Niedersachsen, Germany, fabian.sobotka@wiwi.uni-goettingen.de, *Radoslava Mirkov*, *Werner Römisch*, *Thomas Kneib*

The gas flow within a gas transmission network is studied with the aim to optimise such networks. A geoaddivitive model for describing the dependence between the maximum daily gas flow and the temperature on network exits is proposed. Semiparametric expectile regression provides the possibility to model the upper tail of the response distribution while accounting for the spatial correlation between different exits. The effect of the temperature is modeled with shape constraints to include knowledge about gas load profiles and to allow for a realistic prediction.

■ TB-30

Tuesday, 10:30-12h00
CC-A31

Applications and Decision Support Systems

Stream: Emerging Aspects of Production Planning in Continuous Process Industries: Theory, Optimization, and Practice
Invited session

Chair: *Jim Everett*, Centre for Exploration Targeting, University of Western Australia, 49 Goldsmith Rd, 6009, Nedlands, WA, Australia, jim.everett@uwa.edu.au

1 - A decision-support tool for designing cost-effective biopharmaceutical manufacturing processes

Sofia Simaria, Biochemical Engineering, University College London, Torrington Place, WC1E 7JE, London, United Kingdom, a.simaria@ucl.ac.uk, *Richard Allmendinger*, *Suzanne Farid*

A decision-support tool using genetic algorithms to aid the design of flexible and cost-effective multi-product facilities that can cope with diverse biopharmaceutical drug candidates is presented. Results from an industrially relevant case study show that the most cost-effective purification sequences and equipment sizing strategies that meet demand and purity targets for each product in the facility are identified. Emphasis is also placed on the use of graphical methods to allow the visualisation of trade-offs in the set of optimal solutions so as to enhance the decision-making process.

2 - Optimal Supply Chain Planning: Service Levels and Profitability Scores

Ana Amaro, Applied Mathematics and Informatics, ISCAC, Accounting and Administration College of Coimbra, Quinta Agrícola, Bencanta, 3040-316, Coimbra, Portugal, aamaro@iscac.pt, *Ana Paula Barbósa-Póvoa*

Globalization has led businesses to focus on the worldwide markets. To maintain competitive advantage, process industries and associated supply chains (SCs) have to address new challenges. The present contribution develops a Mixed Integer Linear Programming formulation to model different SC performance and planning criteria such as service levels and profitability. These represent efficiency goals and SCs' ability to manage customers' expectations. The impact of each planning strategy on the optimal plan is analysed and the applicability is illustrated through an industrial pharmaceutical SC.

3 - Joint lot sizing and routing problem of perishable goods

Márcio Antônio Ferreira Belo Filho, Instituto de Ciências Matemáticas e de Computação, Universidade de São Paulo, Avenida Trabalhador são-carlense, 400 - Centro, São Carlos, São Paulo, Brazil, marciobelof@gmail.com, *Pedro Amorim*, *Franklina Toledo*, *Christian Almeder*, *Bernardo Almada-Lobo*

The joint production and distribution planning problem usually addresses batching of orders disregarding lot sizing. We investigate the value of considering lot sizing versus batching for a multi-customer delivery problem with routing and perishable products. Results show that lot sizing is able to deliver better solutions than batching. Moreover, the flexibility due to lot sizing decisions can reduce production and distribution costs. Finally, these savings are leveraged by customers with tight time windows and production systems with non-triangular setups.

■ TB-31

Tuesday, 10:30-12h00
CC-A33

Data Analysis and Its Applications

Stream: Data Mining, Knowledge Discovery and Artificial Intelligence

Contributed session

Chair: *Irina Yatskiv*, Computer Science, Transport and Telecommunication institute, Lomonosova 1, LV-1019, Riga, Latvia, ivl@tsi.lv

1 - Extending Learning Vector Quantization for mixed-type data classification

Chung-Chian Hsu, Dept. of Information Management, National Yunlin University of Science and Technology, 123 University Rd. Sec. 3, 640, Douliou, Yunlin, Taiwan, hsucc@yuntech.edu.tw, *Jiang-Shan Wang*, *Hung-Yi Tsai*, *JongChen Chen*

Real-world data usually consist of categorical and numeric values. Learning Vector Quantization (LVQ), a useful classification technique, however handles only numeric data. Categorical values need to be converted to numeric ones prior to training. Nevertheless, careless conversion schemes can lose semantics inherent in categorical values and may result in reduced classification accuracy of LVQ. In this study, we propose an extended LVQ which incorporates a distance scheme: distance hierarchy for taking into account the semantics. Experimental results demonstrated effectiveness of ELVQ.

2 - Continuous predictor modality multinomial correlated interpretation

Andrew Yatsko, ITMS Dept., University of Ballarat, Mt. Helen campus, 3350, Mount Helen, VIC, Australia, andrewyatsko@students.ballarat.edu.au, *Andrew Stranieri*, *Adil Bagirov*, *Herbert Jelinek*

Compactness of data leads to improved performance of classification algorithms. Discretization of continuous features is also a way to uniform representation of problems with nominal features. Certain reliable, yet simple techniques exist. At the same time, interval optimization of multiple attributes poses a significant challenge. This article explores a suboptimal approach based on cluster analysis. The method is being compared to others and appears to be competitive, although limits exist to what can be achieved, imposed by noise, data specifics, and the bias of classification methods.

3 - Assessing Bayesian Network classifiers for software defect prediction

Karel Dejaeger, Faculty of Business and economics, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, karel.dejaeger@econ.kuleuven.be, *Thomas Verbraken*, *Bart Baesens*

Software testing is a crucial activity during software development and defect prediction models assist practitioners herein by providing an upfront identification of faulty software. While Naive Bayes (NB) is often applied in this regard, citing predictive performance and comprehensibility as its major strengths, alternative Bayesian algorithms boosting the promise of simpler networks remain underexposed. We explored 15 such classifiers, in combination with a Markov blanket feature selection procedure, and found that simpler models can be constructed using Bayesian classifiers other than NB.

4 - A decision support system for ERP implementation in small and medium sized enterprise

Ying Xie, Dept of System Management and Strategy,
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ERP implementation is challenging for small and medium sized enterprises (SMEs) as it is time consuming and risky. An integrated decision support system for ERP implementation (DSS_ERP) is developed integrating analytical regression models, a simulation model and nonlinear programming models. The DSS_ERP offers an analytical model to accurately monitor the progress each critical success factor (CSF) makes along the time horizon and monitor the cost consumed; it determines the priorities of CSFs and facilitates decision makings on resource allocations.

■ TB-32

Tuesday, 10:30-12h00
CC-A34

Developing Methodology in Soft OR

Stream: Soft OR and Problem Structuring Methods
Invited session

Chair: *Amanda Gregory*, Business School, University of Hull,
HU6 7RX, Hull, United Kingdom, a.j.gregory@hull.ac.uk

1 - Evaluating interventions using a lean systems methodology

Gavin Betts, Hull University Business School, University of
Hull, Cottingham Road, HU6 7RX, Hull, East Yorkshire,
United Kingdom, g.betts@hull.ac.uk

This research seeks to evaluate the Vanguard Methodology. This methodology has been developed by Vanguard Consulting over thirty years and has been labelled a lean systems methodology in the literature. It has been designed for the service sector and claims improved service at reduced costs. An evaluation framework developed to assess cases using this methodology will be presented.

2 - The use of the CAQDAS (Computer Aided Qualitative Data Analysis Software) to structuring problems in Operations Research

William Vianna, Information Science, Federal University at
Santa Catarina- Brazil, Rua Cônego Bernardo, 100. ap. 202,
Trindade, 88036570, Florianópolis, Santa Catarina, Brazil,
wpwilliam@hotmail.com, *Eduardo Hoji*, *Edilson Giffhorn*

The aim of this study is to propose the use of CAQDAS (Computer Aided Qualitative Data Analysis Software) to support the analysis of qualitative data in structuring problems in Operations Research. The application is given in terms of data integration between postgraduate evaluation system and the Basic Education system evaluation in Brazil. The qualitative data repository favors recursivity and structured return to data at any stage of development of the multicriteria model.

3 - Exploring the use of Collaboration Engineering approaches within the practice of Soft Systems Methodology

Aida Azadegan, Business School, Nottingham University
Business School, Apt. 1/3, 1 Rice Street, M3 4JL, Manchester,
United Kingdom, aida.azadegan@gmail.com, *Giles Hindle*

Soft OR contains a family of approaches that support groups in a range of tasks including tackling complex problem situations and making strategy. There has been increased interest in supporting the facilitation of Soft OR approaches in practice. This paper explores the use of Collaboration Engineering ideas within the practice of Soft Systems Methodology. In particular, we examine the use of ThinkLets to script the tools and steps of Soft Systems Methodology.

4 - It looks like a PSM and it does what a PSM does but is it a PSM?

Amanda Gregory, Business School, University of Hull, HU6
7RX, Hull, United Kingdom, a.j.gregory@hull.ac.uk,
Jonathan Atkins

The defining characteristics of a PSM and the set of approaches to which the label can be applied are generally agreed. This paper focuses on extending the label PSM to approaches that have the characteristics of a PSM but which have been developed outside of the OR/systems field and the potential (dis)advantages of this. The discussion will be illustrated by reference to such an approach, the DP-SIR (Drivers — Pressures — State Changes — Impacts — Responses) framework, which is widely used within the particularly 'wicked' context of ecosystem management.

■ TB-33

Tuesday, 10:30-12h00
CC-A37

Logistic and Development

Stream: OR for Development and Developing Countries
Invited session

Invited session

Chair: *Youssef Masmoudi*, University of Sfax, Hight School of
Commerce of Sfax, BP 954, 3018, Sfax, Tunisia,
youssef.masmoudi@gmail.com

Chair: *Habib Chabchoub*, LOGIQ, Institut Supérieur de Gestion
Industrielle, 3018, Sfax, Sfax, Tunisia,
Habib.chabchoub@fsegs.rnu.tn

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics,
Middle East Technical University, ODTÜ, 06531, Ankara, Turkey,
gweber@metu.edu.tr

1 - Time Dependant Intermodal Transportation in the Region of Marmara

Giray Resat, Industrial Engineering, Koc University, Turkey,
gresat@ku.edu.tr, *Metin Turkey*

This talk presents a multi-objective optimization model for combining different transportation modes (such as Road, Rail and Sea) in the design and operation of an intermodal transportation network in a region. The problem is formulated as a mixed-integer optimization problem that accounts for time and congestion dependent vehicle speeds. We represent the modeling approach, data analysis and outline the important characteristics of the mathematical programming problem for minimization of the transportation cost and time simultaneously for the Marmara Region of Turkey.

2 - 3D Container Ship Loading Planning Problem with multiple scenarios

Luiz Salles Neto, Federal São Paulo State University,
12231-280, São José dos Campos, São Paulo, Brazil,
luiz.leduino@unifesp.br, *Anibal Azevedo*, *Antônio Moretti*,
Antônio Chaves

The proposed paper presents a new 3D Container Ship Loading Planning Problem with multiple scenarios. This problem is modeled as a bi-objective framework that minimizes two criteria: the number of movements and also the instability measure computed as the distance between gravity and geometric center for every different scenario. To deal with this multiobjective and stochastic problem a new representation that allows a compact and efficient encoding which enables the solution of large-scale problems proper related with real-life scenarios.

3 - Graph Theoretic Properties and Algorithms with Application in Disaster Response

Reza Zanjirani Farahani, Kingston Business School, Kingston
University London, Room 330, Kingston Hill, KT2 7QH,
Kingston Upon Thames, London, United Kingdom,
rezazanjirani@yahoo.com, *Hannaneh Rashidi Bajgan*

This paper considers directing paths in transportation networks so that all points could be reached. These problems are hard to solve optimally while sometimes even sub-optimal solutions are acceptable provided we find them quickly; this application is evident in disasters. This paper presents two algorithms based on graph theoretic properties to solve such problems; the first utilizes concept of faces in planar graphs and the second uses perfect matching rules. Such quick algorithms we do not look for optimal solutions but these methods can also help speed up current optimal algorithms.

■ TB-34

Tuesday, 10:30-12h00

CC-A39

Optimization for Sustainable Development 1

Stream: Optimization for Sustainable Development
Invited session

Chair: *Herman Mawengkang*, Mathematics, The University of Sumatera Utara, FMIPA USU, KAMPUS USU, 20155, Medan, Indonesia, mawengkang@usu.ac.id

1 - A Chance-constrained Optimization Model for a Water Distribution Network Problem

Asrin Lubis, Mathematics, Unimed/Graduate School of Mathematics, University of Sumatera Utara, FMIPA USU, 20155, Medan, Sumatera Utara, Indonesia, lubis.asrin@yahoo.com, *Herman Mawengkang*

The optimal design of a Water Distribution Network (WDN) consists of the choice of a diameter for each pipe, the pipe line network design, and the pipe length. In this paper we propose a nonlinear stochastic optimization model for tackling a WDN under the consideration of reliability in water flows. The nonlinearities arise through pressure drop equation. We transform the stochastic programming model into a deterministic multi-objective model using sampling average approach. Then we solve the result model using an interactive method.

2 - Land use management problems under uncertainty

Siti Rusdiana, Mathematics, University of Syiah Kuala, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, srusdiana10@yahoo.com

This paper is to find an optimal land portfolio composition through time under market uncertainty. We assume that an optimal land use management program will involve a gradual sequence of conversion decisions through time, evolving as each land allocation value becomes known more accurately. In this paper we formulate stochastic programming model, which takes into account the uncertainty related to the market value of revenues accruing from the land in different states.

3 - How to Determine Optimum Promotions through CLV Maximization?: A Case Study in a Turkish Bank

Fusun Ulengin, Industrial Engineering, Dogus University, Dogus Universitesi, Muhendislik Fak. Endustri Muh. Bol, Acibadem, Kadikoy, 34722, Istanbul, Turkey, fulengin@dogus.edu.tr, *Yeliz Ekinci*, *Nimet Uray*

The purpose of this study is to develop a methodology to guide managers in determining the optimal promotion campaigns for different market segments in order to maximize the Customers' Lifetime Value. It aims to find an optimal promotion plan for a service company through stochastic dynamic programming. It also determines the 'value' states for the customers using classification and regression tree analysis. An experiment is designed to observe the impacts of different promotion campaigns on customers. It is applied in a private Turkish bank and the improvement of profit is tested.

4 - A stochastic optimization model for multi-product fish production planning problem under uncertainty in raw resources and demand

Intan Syahrini, Mathematics, University of Syiah Kuala, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, isyahrini89@yahoo.com, *Herman Mawengkang*

A multi-product fish production planning produces simultaneously multi fish products from several classes of raw resources. The quality of raw resources and market demand are uncertain during the planning period. This paper proposes a multi-stage stochastic integer programming to model the production planning problem. A direct search method is used to solve the model.

■ TB-35

Tuesday, 10:30-12h00

CC-A41

Electric Mobility

Stream: Energy, Environment and Climate 2
Invited session

Chair: *Patrick Jochem*, Chair of Energy Economics (IIP), Karlsruhe Institute of Technology (KIT), Hertzstr. 16, 76187, Karlsruhe, Germany, jochem@kit.edu

1 - A framework for modelling the electricity demand by plug-in electric vehicles

Rashid Waraich, Institute for Transport Planning and Systems, ETH Zürich, Wolfgang-Pauli-Str. 15, 8903, Zürich, Zürich, Switzerland, waraich@ivt.baug.ethz.ch

Plug-in electric vehicles (PEVs) are envisioned by many as the cure to several current problems, especially environmental ones. What is often neglected in this context is that a large scale penetration of such vehicles may also pose new challenges, as charging these vehicles will result in changes of current electricity demand patterns. The presented work introduces a framework, which models electricity demand by PEVs by extending a transport simulation called MATSim. The framework allows the evaluation of new charging policies and helps pinpoint possible bottlenecks in the electric grid.

2 - Technical and Economical Aspects of Integrating Plug-in Electric Vehicles in Large Scale Power Systems

Miguel Carrión, Electrical Engineering, University of Castilla - La Mancha, Avda Carlos III, s/n, Campus Fábrica de Armas, 45071, Toledo, Spain, miguel.carrion@uclm.es, *Luis Sanchez-rodriguez*

Plug in - Electric Vehicles (PEVs) are becoming an actual option to replace traditional combustion-engine cars. In this situation, it is a priority to analyze the impact of an extensive usage of electric vehicles in actual power systems. In this work, we study the technical and economical aspects of the integration of PEVs in the Iberian Peninsula power system (MIBEL). Three different approaches modelling the coordination between the system operator and PEVs users are considered. Finally, a realistic case study is solved and sensitivity studies are performed.

3 - Integrating Electric Vehicles into the Germany Electricity Grid — an Interdisciplinary Analysis

Patrick Jochem, Chair of Energy Economics (IIP), Karlsruhe Institute of Technology (KIT), Hertzstr. 16, 76187, Karlsruhe, Germany, jochem@kit.edu, *Thomas Kaschub*, *Alexandra-Gwyn Paetz*, *Wolf Fichtner*

This study analyses the integration of electric vehicles (EV) into the German power grid including different demand respond (DR) approaches from a technical, economical and user perspective. For this an overview of the future German electricity market with the focus on EV integration is given. It is shown that the shortage in the regional and local electricity grid is increased. DR can help to tackle this issue by controlled unidirectional or bidirectional (V2G) charging of EV. From the current perspective especially the first alternative seems to be attractive in all considered disciplines.

■ TB-36

Tuesday, 10:30-12h00
CC-A43

DEA and Performance Measurement: Applications 4

Stream: DEA and Performance Measurement
Invited session

Chair: *Zilla Sinuany-Stern*, Industrial Engineering and Management, Ben Gurion University, Beer-Sheva, 84105, Beer-Sheva, Israel, zilla@bgu.ac.il

1 - Analysing the Research and Teaching Quality Achievement Frontier

David Mayston, Economics and Related Studies, University of York, University of York, YO10 5DD, York, United Kingdom, dm3@york.ac.uk

The paper analyses the achievement possibility frontier between research and teaching quality in higher education. It finds several important reasons why the associated feasible set is likely to be non-convex, making use of the standard performance analysis technique of Data Envelopment Analysis less valid. The paper therefore investigates the alternative Free Disposal Hull technique, and compares the results of deploying these techniques to the performance evaluation of UK Departments of Economics. See: <http://york.ac.uk/media/economics/documents/discussionpapers/2011/1125.pdf>

2 - Benchmarking the implementation path to efficiency: The case of small regional airports

Ekaterina Yazhemsky, Business School, Hebrew University of Jerusalem, Mount Scopus, 91905, Jerusalem, Israel, katy1@mscc.huji.ac.il, *Nicole Adler*, *Tolga Ülkü*

Small and regional airports suffer from limited traffic, large fixed facilities and insufficient revenues to cover their costs. The question is how these airports should be structured, managed and financially supported in order to survive. Efficient operations contribute to decreasing the financial dependency of airports on subsidies. According to a DEA-based, bound adjusted measure, the efficiency levels of 89 European airports are determined. Due to heterogeneity across the sample, multiple ideal points are applied to identify implementation paths and to highlight managerial best practices.

3 - Performance assessment of wind farms

Clara Vaz, School of Technology and Management, Polytechnic Institute of Bragança, Campus de Santa Apolónia, Apartado 134, 5301 - 857, Bragança, Portugal, clvaz@ipb.pt

This study develops a methodology to provide insights regarding the performance of wind farms from a European player in energy sector. Firstly, the DEA is used to measure the performance of wind farms in generating electricity from the resources available and non-discretionary variables such as wind (speed and availability). This analysis enables to identify the benchmarks whose best practices can be emulated by inefficient units and provides useful information for regulators in the sector. Secondly, bootstrap procedures are applied to obtain statistical inference on the efficiency estimates.

4 - Hospitals efficiency in Israel: 1999-2009

Zilla Sinuany-Stern, Industrial Engineering and Management, Ben Gurion University, Beer-Sheva, 84105, Beer-Sheva, Israel, zilla@bgu.ac.il, *Dov Chernichovsky*, *Lea Friedman*

Data Envelopment Analysis (DEA) is used to measure the efficiency of major general hospitals in Israel, during 1999-2009. The inputs are number of standard beds; the outputs are number of hospitalization days and number of discharges. In the second phase, we used regression analysis, to examine the effect of size, and type of ownership on hospitals efficiency. We found that independent hospitals are the most efficient and have decreasing returns to scale, followed by the governmental and public hospitals which have increasing returns to scale. Also Malmquist analysis was used over time.

■ TB-37

Tuesday, 10:30-12h00
CC-Act

OR in Health & Life Sciences 2

Stream: OR in Health & Life Sciences (contributed)
Contributed session

Chair: *Leanne Smith*, School of Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, United Kingdom, SmithL13@cf.ac.uk

Chair: *Paul Harper*, School of Mathematics, Cardiff University, CF24 4AG, Cardiff, United Kingdom, harper@cardiff.ac.uk

1 - A Takt time based resource optimization technique to minimize patient wait time in hospitals

Jyoti R. Munavalli, Computer Science & Engineering, PESIT, India, Ph.D Research Scholar with Maastricht University, Netherlands, Ring Road,, BSK III stage, 580083, bangalore, karnataka, India, jyothimunavalli@gmail.com, *Frits van Merode*, *Srinivas A*

We propose a technique to address the resource optimization, patient flow balancing and wait time minimization in a hospital set-up. We present a mathematical model for resource optimization which is based on Takt time concept (average time a patient spends in a hospital for treatment) for each department in all the timeslots and considers the dependency constraints. The Linear programming solution provides the resource allocation pattern for each department during every time slot within the resource availability to balance the patient flow and achieve higher patient satisfaction levels.

2 - Optimizing the emergency distribution network in the case of epidemic outbreaks response

Tom Dasaklis, Department of Industrial Management, University of Piraeus, 80 Karaoli & Dimitriou str., 18534, Piraeus, Attica, Greece, dasaklis@unipi.gr, *Nikolaos Rachaniotis*, *Costas Pappis*

Effective control of an epidemic's outbreak calls not only for a rapid response but also for the establishment and management of an emergency supply chain. During the control effort huge amounts of medical supplies should be distributed from central warehouses to local areas. In this paper an epidemic diffusion model based on differential equations is coupled with an emergency logistics distribution model. An integrated solution approach is proposed combining epidemics control rules and logistics network design. A numerical example is finally presented illustrating the methodology proposed.

3 - Modelling ambulance location and deployment in Wales

Leanne Smith, School of Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, United Kingdom, SmithL13@cf.ac.uk, *Paul Harper*, *Vincent Knight*, *Israel Vieira*, *Janet Williams*

Response time targets for the Welsh Ambulance Service Trust (WAST) are not currently being met, particularly for high priority emergencies in rural areas. A discrete event simulation makes use of initial vehicle allocations given by a developed location model, in order to identify the affect demand, number of available vehicles and handover times have on regional response. The aim of these mathematical models is to help WAST make better decisions on locations, capacities and deployments, so that they may provide a more efficient and effective service and achieve the Government set targets.

4 - MetSim: a simulation support tool using meteorological information to improve the planning and management of hospital services

Paul Harper, School of Mathematics, Cardiff University, CF24 4AG, Cardiff, United Kingdom, harper@cardiff.ac.uk, *R John Minty*

Improved short-term predictions of hospital admissions and bed occupancy offer the potential to plan resource needs more accurately and effectively. The MetSim project explores the relationship between weather and health, building novel Bayesian models that are more sensitive to the weather. Short-term forecasts of the numbers of admissions categorised. In turn, MetSim uses hazard ratios embedded within

a simulation framework to provide forecasts of short-term bed needs. The web-based tool has been piloted in UK hospitals and is supported by the Met Office.

■ TB-38

Tuesday, 10:30-12h00

HH-Colombus

Hybrid Evolutionary Multiobjective Optimization Algorithms

Stream: Multiobjective Optimization
Invited session

Chair: *Karthik Sindhya*, of Mathematical Information Technology, University of Jyväskylä, Finland, karthik.sindhya@jyu.fi

1 - A Preference-based Evolutionary Algorithm for Multi-objective Optimization: The Weighting Achievement Scalarizing Function Genetic Algorithm

Ana Belen Ruiz, Applied Economics (Mathematics), University of Malaga, C/ Ejido, 6, 29071, Malaga, Spain, aruiz@uma.es, *Rubén Saborido Infantes*, *Mariano Luque*

We suggest a preference-based EMO algorithm which asks the DM for a reference point (RP) and which is based on the EMO algorithm NSGA-II and on achievement scalarizing functions (ASFs). In practice, an ASF finds the closest efficient solution to the RP, and this solution also depends on a weight vector used in the ASF. The proposed approach modifies the dominance criterion of NSGA-II in order to highlight solutions closer to the RP. The classification of the points into the nondominated fronts is done according to the values that each solution takes on an ASF, using different weight vectors.

2 - Preference-based Evolutionary Algorithm for Multi-objective Bilevel Optimization

Pekka Malo, Information and Service Economy, Aalto University School of Economics, Runeberginkatu 22-24, 00100, Helsinki, Finland, pekka.malo@aalto.fi

We present an evolutionary framework for solving multiobjective bilevel problems, where the upper-level has multiple objectives and lower-level has a single objective. The implementation of the algorithm is based on a new technique for approximating the optimal lower-level solution mapping by a class of smooth and continuous single-valued functions. The algorithm is well-motivated by the recent results obtained for general parametric optimization problems and set-valued analysis. The performance of the algorithm is demonstrated with respect to a collection of scalable test-problems.

3 - A Hybrid Evolutionary Multi-objective Optimization Algorithm for Enhanced Convergence and Diversity

Karthik Sindhya, of Mathematical Information Technology, University of Jyväskylä, Finland, karthik.sindhya@jyu.fi, *Kaisa Miettinen*, *Kalyanmoy Deb*

Evolutionary multi-objective optimization (EMO) algorithms are used to find approximate Pareto optimal solutions, though they have slow convergence speed. We present a modular hybrid EMO algorithm including a local search module (involving an achievement scalarizing function) to increase the convergence speed, a diversity enhancement module, etc. It can be connected with various EMO methods like MOEA/D. Numerical tests on test problems indicate the efficacy of our hybrid EMO algorithm, which can also be used to handle dynamic process simulation based multi-objective optimization problems.

■ TB-39

Tuesday, 10:30-12h00

HH-Cousteau

MCDA: New Approaches and Applications 1

Stream: MCDA: New Approaches and Applications
Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Yves De Smet*, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be

1 - Monotonicity and minimax biproportional apportionments

Paolo Serafini, Dept. of Mathematics and Computer Science, University of Udine, Via delle Scienze 206, 33100, Udine, Italy, paolo.serafini@uniud.it

We deal with biproportional apportionment problems (BAP). On one hand we may approach BAP via the axiomatic approach where some axioms are stated and the assigned seats must satisfy the axioms. Another approach requires the definition of quotas and the seats must minimize an error measure wrt the quotas. It is therefore important to understand to what extent error minimization methods satisfy the most common axioms. In this talk we investigate the axiom of monotonicity and show that minimization of the maximum absolute error with respect to regional quotas satisfies monotonicity.

2 - Multi attribute regional market location problem based on the clustering approach

Mohsen Yahyayi, Shahed University, Iran, Islamic Republic Of, mohsen.yahyayi@gmail.com, *Mahdi Bashiri*

Regional market location is considered in this paper; a hybrid approach is presented including 3 phases of clustering, elimination and decision making. In the first phase cities are clustered with maximum homogeneity. Then low potential points are eliminated. Finally cities are ranked to be a regional market according to (1) Distance from the cluster median point optimized by SFLP to have less transportation cost, (2) City population, (3) Distance from major transportation corridors, (4) Tourism attractions. Our approach was applied in Iran regional market using 10-means clustering.

3 - A Careful Look at Criterion Importance and Weights

Pekka Korhonen, Aalto University School of Economics, 00100, Helsinki, Finland, pekka.korhonen@aalto.fi, *Jyrki Wallenius*, *Anssi Oorni*

We investigate the connection between announced importance of criteria and weights. Our considerations are based on a simple experimental setting, where the subjects were asked to pairwise compare alternatives with two criteria. We used the subjects' responses to choices to estimate the weights and compared them to "direct" (given) weights. The comparison was based on prediction power of a linear function. Our results point out that there is a reason to question the common belief that the values of the weights have the same rank order as criteria importance.

4 - Rank reversal in the PROMETHEE I and II rankings: a summary of recent investigations

Yves De Smet, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be, *Céline Verly*, *Julien Roland*

The multicriteria methods based on pairwise comparisons suffer from possible rank reversal occurrences when the set of alternatives is modified. We study this distinctive feature in the scope of the PROMETHEE I and II methods. First, empirical tests are conducted on the basis of artificial data sets in order to quantify the likelihood of rank reversal instances. Then conditions to avoid this phenomenon are provided. Finally, we investigate manipulation risks on a simplified version of PROMETHEE II.

■ TB-40

Tuesday, 10:30-12h00

HH-Livingstone

Preference Learning 1

Stream: Preference Learning
Invited session

Chair: *Krzysztof Dembczynski*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, kdembczynski@cs.put.poznan.pl

Chair: *Willem Waegeman*, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure links 653, 9000, Ghent, Belgium, willem.waegeman@ugent.be

1 - Active learning for preference learning

Nir Ailon, Computer Science, Technion Israel Institute of Technology, Taub Building, Technion City, 32000, Haifa, Israel, nailon@cs.technion.ac.il

Analyzing preferences lies in the intersection of many fields, most notably econometrics (discrete choice theory), combinatorial optimization and machine learning theory and practice. In a typical setting, the ultimate goal is to be able to predict the order of a given set of alternatives given a set of observed, noisy pairwise comparisons. In this work I will discuss the adversarial noise case, and present a new active learning ERM (Empirical Risk Minimization) algorithm with an almost optimal preference query complexity and provable guarantees.

2 - Optimal recommendation sets

Paolo Viappiani, Computer Science Dept, Aalborg University, selma lagerfos vej 300, 9000, Aalborg, Denmark, paolo.viappiani@gmail.com

Utility elicitation is an important component of many applications, such as decision support systems. Such systems query users about their preferences and offer recommendations based on the system's belief about the user's utility function. We analyze the connection between the problem of generating optimal recommendation sets and the problem of generating optimal choice queries, considering both Bayesian and regret-based elicitation. Our results show that, somewhat surprisingly, under very general circumstances, the optimal recommendation set coincides with the optimal query.

3 - Large-scale training of linear ranking support vector machines

Antti Airola, University of Turku, Finland, ajairo@utu.fi

We introduce a large-scale training algorithm for the linear ranking support vector machine, which is one of the most widely applied methods for inferring ranking models using machine learning. The method generalizes the most efficient previously known method, which is applicable to ordinal regression problems with a small constant number of classes, to tasks with an arbitrary number of different levels of utility. This is achieved by combining a cutting plane optimization technique with the use of self-balancing binary search trees. The method easily scales to millions of data points.

■ TB-41

Tuesday, 10:30-12h00

HH-Heyerdahl

AHP/ANP 5

Stream: Analytic Hierarchy Process, Analytic Network Process
Invited session

Chair: *Eizo Kinoshita*, Urban Science Department, Meijo University, 4-3-3 Nijigaoka, 509-0261, Kani, Gifu, Japan, kinoshit@urban.meijo-u.ac.jp

1 - Super Pairwise Comparison Matrix in MDAHP

Takao Ohya, School of Science and Engineering, Kokushikan University, 4-28-1 Setagaya, 154-8515, Setagaya-ku, Tokyo, Japan, takaohya@kokushikan.ac.jp, *Eizo Kinoshita*

We have proposed a Super Pairwise Comparison Matrix (SPCM) to express all pairwise comparisons in the evaluation process of the dominant analytic hierarchy process or MDAHP as a single pairwise comparison matrix. This paper shows, by means of a numerical counterexample, that in MDAHP an evaluation value resulting from the application of LLSM to a SPCM does not necessarily coincide with that of the evaluation value resulting from the application of the GMMDAHP to the evaluation value obtained from each pairwise comparison matrix by using the geometric mean method.

2 - Research on the comparison of electronic monetary value in the information society

Shunei Norikumo, General Management Department, Osaka University of Commerce, 4-1-10, Mikuriyasakae-machi, 577-8505, Higashiosaka, Osaka, Japan, shunei.norikumo@gmail.com

This study considers the social influence that computerization of the money to advance rapidly gives to an existing value of money and compares the value of money using dominant AHP. In late years the money changed from a form printed on paper to electronic money and virtual money. Outwardly the money that the property was totally different from the conventional substantial money and currency in even the same money came to flow on information system.

3 - An Application of Energy Alternative Selection: A Fuzzy AHP-ELECTRE Methodology

Abit Balin, Industrial Engineering, Yildiz Technical University, Yildiz Technical University, Department of Industrial Engineering, Besiktas, 34000, Istanbul, Turkey, abitbalin@hotmail.com, *Özge Nalan Alp Bilişik*, *Hayri Baraçlı*

Energy planning problem is a very complex issue and has a lot of criteria that must be taken into account to solve this problem. The assessment criteria that will be used in this study are technical, economic, environmental and social. All of the criteria must be determined and evaluated carefully because these criteria are so critical for governments, human beings and environment. In this study, to make a decision about energy planning problems we use fuzzy AHP to determine the criteria weights and ELECTRE to determine the best energy resource.

4 - Dominant AHP as Measuring Method of Service Value

Eizo Kinoshita, Urban Science Department, Meijo University, 4-3-3 Nijigaoka, 509-0261, Kani, Gifu, Japan, kinoshit@urban.meijo-u.ac.jp

The author believes is surpassed by AHP, a measuring method of value of goods in a service economy. This is because a utility function which represents value is expressed based on an absolute scale (best suited for an industrialized society) in utility theory, whereas in AHP, it is expressed based on a relative scale (best suited for a service economy). However, the author mathematically identifies a fundamental flaw of Saaty's AHP in this paper, and proves that Dominant AHP, proposed by Kinoshita and Nakanishi, is superior to Saaty's AHP as a measuring method of value of services.

■ TB-42

Tuesday, 10:30-12h00

BW-Amber

Networks under Uncertainty

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science
Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: *Sandra Rauscher*, Management Science, Lancaster University, United Kingdom, s.rauscher@lancaster.ac.uk

Chair: *Selis Onel*, Chemical Engineering, Hacettepe University, Department of Chemical Engineering, Beytepe Campus, 06800, Beytepe, Ankara, Turkey, selisonel@gmail.com

1 - Research of the methods of stochastic approximation and genetic algorithms for the transport system microscopic simulation models calibration

Elena Yurshevich, Mathematical Methods and Modeling Department, Transport and Telecommunication Institute, Lomonosova str. 1, 1019, Riga, Latvia, elena_y@tsi.lv

It is considered the calibration procedure of traffic flow's microscopic models as an optimization problem of the vector of the model numerical parameters. The problem is complicated by the absence of the analytical model, capable to describe the relationship between the vector of numerical parameters and objective function. It was considered the capability of the stochastic approximation and heuristic methods application for calibration. The investigation was implemented using the transport system simulation model constructed in VISSIM package and an aggregated data of traffic flow.

2 - Simulation Metamodeling using Bayesian Networks

Kai Virtanen, Mathematics and Systems Analysis, Aalto University, School of Science, Finland, kai.virtanen@aalto.fi

We introduce a novel approach towards simulation metamodeling using Bayesian networks (BNs). A BN represents the joint probability distribution of a set of random variables and enables the efficient calculation of their marginal and conditional distributions. A BN metamodel gives a non-parametric description for the joint probability distribution of simulation inputs and outputs as well as provides various what-if analyses by combining simulation data with expert knowledge. The construction and utilization of BN metamodels are illustrated with a simulation example involving a queueing model.

3 - On the Peter Principle: An Agent Based Investigation into the Consequential Effects of Social Networks and Behavioural Factors

Angelico Fetta, Maths, Cardiff University, United Kingdom, angelico_fetta@hotmail.com, *Paul Harper*, *Vincent Knight*, *Israel Vieira*, *Janet Williams*

The Peter Principle (PP) is a theory used to describe job incompetence in a hierarchical organisation. It argues that should staff be competent at a given level, their competence may not be implicit at a higher level. Through the use of Agent Based Simulation coupled with social networks and organisational thought, the PP is assessed under previously unexplored conditions. Results show that the PP may not be as detrimental to organisational efficiency as previously thought, while promotion on merit offered the best efficiency trade off in the absence of clear evidence of the PP paradigm.

4 - Hybrid lateral transshipments in multi-item inventory networks

Sandra Rauscher, Management Science, Lancaster University, United Kingdom, s.rauscher@lancaster.ac.uk, *Kevin Glazebrook*, *Colin Paterson*, *Thomas Archibald*

We present a new approach for addressing shortages in multi-location inventory systems facing multivariate, non-homogeneous Poisson demand. A hybrid lateral transshipment policy allows rebalancing of inventory levels along with reacting to stock-outs. We derive this by applying a dynamic programming policy improvement step to a no-transshipment policy. Shipment costs are modelled with a knapsack-like structure to accommodate different item types. We carry out an extensive simulation study showing the benefit of modelling multi-item transshipments against using single item models in parallel.

■ TB-43

Tuesday, 10:30-12h00

BW-Granite

Recent Applications of Probabilistic Programming

Stream: Stochastic Programming
Invited session

Chair: *Milos Kopa*, Department of Probability and Mathematical Statistics, Charles University in Prague, Faculty of Mathematics and Physics, Sokolovská 83, CZ 186 75, Prague, Czech Republic, kopa@karlin.mff.cuni.cz

1 - Robustness in stochastic programs with the first order stochastic dominance and/or probabilistic constraints

Milos Kopa, Department of Probability and Mathematical Statistics, Charles University in Prague, Faculty of Mathematics and Physics, Sokolovská 83, CZ 186 75, Prague, Czech Republic, kopa@karlin.mff.cuni.cz, *Jitka Dupacova*

The paper presents robustness results for stochastic programs with the first order stochastic dominance and probabilistic constraints. Due to their frequently observed lack of convexity and/or smoothness, these programs are rather demanding both from the computational and robustness point of view. Under suitable conditions on the structure of the problem and for discrete distributions we suggest a new robust portfolio efficiency test with respect to the first order stochastic dominance. We exploit the contamination technique to analyze the resistance with respect to additional scenarios.

2 - Chance constrained problems: reformulation using penalty functions and sample approximation technique

Martin Branda, Department of probability and mathematical statistics, Charles University in Prague, Ke Karlovu 3, 12116, Prague 2, Czech Republic, martin.branda@seznam.cz

We compare basic formulations of stochastic programming problems with chance constraints, generalized integrated chance constraints and penalties in the objective function. It is shown that the problems are asymptotically equivalent. We discuss solving the problems using sample approximation technique. Rates of convergence and estimates on the sample size are derived for problems with mixed-integer bounded sets and/or several constraints. We present applications to an investment problem with real features and to a vehicle routing problem with time windows, random travel times and demand.

3 - Robust Pricing of Monopolistic Cloud Computing Services with Service Level Agreements

Vladimir Roitch, Department of Computing, Imperial College London, 180 Queen's Gate, SW7 2AZ, London, United Kingdom, vr06@doc.ic.ac.uk, *Daniel Kuhn*, *Yike Guo*

We address the optimal pricing of cloud computing services from the perspective of a monopolistic service provider that needs to manage demand responsiveness and uncertainty. We formulate the pricing problem for on-demand based services as a multi-stage stochastic program and model service level agreements via chance constraints. Under weak assumptions about the demand uncertainty we show that the resulting model can be reduced to an equivalent two-stage stochastic program. We state various new results. Finally, we investigate the possibility of selling unused capacity on a spot market.

4 - Tractable Dynamic Model of Price and Volume Given Uninformed Market Maker

Martin Smid, Econometrics, UTIA, Czech Academy of Sciences, Pod Vodarenskou vezi 4, CZ 182 08, Praha 8, Czech Republic, smid@utia.cas.cz

We construct a simple yet realistic model of a market with a market maker, maximizing the expected consumption while keeping the probability of bankruptcy small. The market maker estimates the fair price by means of a proxy. The order sizes are random. We show our model to conform several stylized facts. Further, we describe a dynamics of the price and the traded volume and we show that the price volatility can be decomposed into the part caused by the movements of the fair price, the part due to the order arrivals and the part due to the uncertainty.

■ TB-44

Tuesday, 10:30-12h00

BW-Marble

Computer Vision (2) and Machine Learning

Stream: Machine Learning and its Applications
Invited session

Chair: *Teofilo deCampos*, Center for Vision Speech and Signal Processing, University of Surrey, GU2 7XH, Surrey, United Kingdom, t.decampos@surrey.ac.uk

Chair: *Fei Yan*, Center for Vision Speech and Signal Processing, University of Surrey, GU2 7XH, Surrey, United Kingdom, f.yan@surrey.ac.uk

Chair: *Ivan Reyer*, Dorodnicyn Computing Centre of RAS, ul. Pererva d. 58, kv. 153, 109451, Moscow, Russian Federation, reyer@forecsys.ru

1 - Efficient Large Scale Scene Understanding

Ramin Zabih, Cornell, Computer Science, 4130 Upson Hall, 14853, Ithaca, New York, United States, rdz@cs.cornell.edu, *Philip Torr*

Image understanding can be thought of as a discrete labelling problem in which the goal is to decide a per pixel label. Labels might be such things as depth or object labels. This problem is very large scale discrete optimization, with millions of labels needing to be determined in the course of a video. In this talk I will discuss some tricks for making this process efficient.

2 - Skeleton Base and Scalable Boundary-Skeletal Shape Model

Ivan Reyer, Dorodnicyn Computing Centre of RAS, ul. Pererva d. 58, kv. 153, 109451, Moscow, Russian Federation, reyer@forecsys.ru, *Ksenia Zhukova*

A scalable shape model of an image is presented. It uses a polygonal figure approximating a raster object and its skeleton base. The skeleton base is a subset of the figure's skeleton. It defines a closed planar domain (skeleton core) describing possible position of a skeleton's essential part for any region with Hausdorff deviation from the figure not exceeding the given value. The skeleton base changes steadily and continuously as the admissible deviation increases. The family of skeleton bases defines a scalable boundary-skeletal model reflecting shape features at various levels of detail.

3 - Structured Output Learning for Automatic Analysis of Court Games

Fei Yan, Center for Vision Speech and Signal Processing, University of Surrey, GU2 7XH, Surrey, United Kingdom, f.yan@surrey.ac.uk, *Josef Kittler*

We investigate the application of structured output learning (SOL) in automatic analysis of court games. We formulate the problem as one of learning a mapping from observations to structured labels, where the labels are event sequences, and employ max-margin Markov networks to achieve a max-margin solution in the joint feature space. We compare closely the more popular generative approach based on a hidden Markov model (HMM) with our discriminative approach, and demonstrate that our approach leads to an improved performance in real world tennis video analysis.

■ TB-45

Tuesday, 10:30-12h00

BW-Water

Logistics and stochastics 1

Stream: Stochastic Modelling in Logistical Networks
Invited session

Chair: *Birger Raa*, Mgt Information Science & Operations Mgt, Ghent University, Tweakerkenstraat 2, 9000, Gent, Belgium, Birger.Raa@UGent.be

Chair: *Wout Dullaert*, Faculty of Economics and Business Administration, VU University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, Netherlands, wout.dullaert@vu.nl

1 - The effect of capacitated replenishments on periodic review inventory systems

Wout Dullaert, Faculty of Economics and Business Administration, VU University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, Netherlands, wout.dullaert@vu.nl, *Birger Raa*

We study periodic review inventory systems with lost sales and capacitated replenishments. This capacity restriction implies that the inventory position may not reach the order-up-to level when placing an order, such that additional safety stock is needed to reach the same service level. To determine the required level of safety stock, a generic iterative procedure based on Markov chain analysis is proposed. Computational experiments illustrate the impact of a limited replenishment capacity on the required safety stock level, and the effectiveness of the proposed iterative calculation method.

2 - A stochastic model for controlling the deterioration of a two machines production system: Extensions to remanufacturing

Pierre Dejax, IRCCyN, Ecole des Mines de Nantes, La Chantrerie, 4, rue Alfred Kastler, BP 20722, 44307, Nantes cedex 3, France, pierre.dejax@mines-nantes.fr, *Annie Francie Kouedeu*, *Jean-Pierre Kenne*, *Victor Songmene*

A deteriorating production system consisting of two parallel machines is investigated. The goal is to find the production rates of machines so as to minimize a long term average expected cost. The failure rate of one machine depends on its production rate. The paper proposes a stochastic programming formulation of the problem and derives the optimal production policies numerically. Control policy parameters are obtained by simulation. Sensitivity analyses of system parameters are conducted to validate the proposed methodology. We finally present an extension to reverse logistics.

3 - A stochastic formulation of the disassembly line balancing problem

Mohand Lounes Bentaha, Industrial Engineering and Informatics, Ecole des Mines de Saint-Etienne, 158 Cours Fauriel, 42023, Saint-Etienne, France, bentaha@emse.fr, *Olga Battaia*, *Alexandre Dolgui*, *Frédéric Grimaud*

The disassembly line balancing problem is studied under uncertainty. Disassembly task times are assumed random variables with known probability distributions. An AND/OR graph is used to model the precedence relations among tasks. The goal is to assign the disassembly tasks to workstations while respecting precedence and cycle time constraints. The objective is to minimize the total line cost including the incompleteness cost arising from tasks not completed within the cycle time. A stochastic linear mixed integer programming formulation is developed.

4 - Quantification of value of flexibility in a hybrid MTO and MTS system

Beyazit Ocaktan, Industrial Engineering, Sakarya University, Balikesir University, Engineering Faculty, Industrial Engineering Department M 5211, 10100, Balikesir, Turkey, bocaktan@gmail.com, *Ufuk Kula*

We consider a production system which produces products for make-to-order and for make-to-stock. Our objective is to quantify the value of flexible in this system. To achieve this, a production environment consisting of 2 parallel machines is considered. Machine 1 produces product 1 only. The other machine produces product 1 and product 2. Product 2 is produced to order. We formulate this problem as an MDP and use approx. D.P. to determine approximately optimal control policy of such system and quantify the value of flexibility, and provide insight on when such flexibility is most beneficial.

Tuesday, 12:30-14:00

■ TC-01

Tuesday, 12:30-14:00

RB-Alfa

Keynote Lecture: Professor Bjorn Jorgensen

Stream: Keynote, Tutorial and Plenary Lectures
Keynote session

Chair: *Peter Letmathe*, Faculty of Business and Economics, RWTH Aachen University, Chair of Management Accounting, Templergraben 64, 52062, Aachen, Germany, Peter.Letmathe@rwth-aachen.de

1 - Accounting

Bjorn Jorgensen, Accounting and Business Law, University of Colorado at Boulder, UCB 419, 995 Regent Drive, 80309, Boulder, CO, United States, bjorn.jorgensen@colorado.edu

This presentation uses optimization and stochastic processes to provide a formal introduction to disclosure, financial accounting, and valuation. Financial accounting produces balance sheets, income statements, and cash flow statements relying on two basic principles: Double entry bookkeeping and the accrual basis of accounting. Disclosure of financial accounting statements is today mandatory for publicly traded firms. A single-period benchmark setting is initially used to establish what disclosures would maximize firm value in the absence of mandatory disclosure. Second, in a multi-period setting, the so-called clean surplus relation ties together consecutive balance sheets through comprehensive income from the income statement. Third, under the accrual basis of accounting, income decomposes into cash flows and accruals. Since accruals arise from the non-cash component of income such as depreciation, accruals must reverse over time in the sense that they add up to zero over the complete life cycle of the firm. I propose to model accruals as a moving average time-series process with a unit root. This modeling approach has implications for how market values relate to earnings, cash flows, and balance sheet book values.

■ TC-02

Tuesday, 12:30-14:00

RB-Beta

Scheduling in Robotics and Manufacturing

Stream: Scheduling
Invited session

Chair: *Seda Hezer*, Industrial Engineering, Selcuk University, Department of Industrial Engineering, 420031, Konya, Turkey, sedahezer@gmail.com

1 - The Job Shop with Blocking and a Rail-Bound Transfer System

Reinhard Bürgy, Dept of Informatics, University of Fribourg, Bd de Pérolles 90, 1700, Fribourg, Switzerland, reinhard.buergy@unifr.ch, *Heinz Gröflin*

Considered is the following Job Shop with no buffers. Jobs are processed on machines and transferred from one machine to the next by robots (or cranes) moving on a single rail. The robots do not pass each other, but can "move out of the way". The objective is to find the starting times for all operations, the assigned robots for all transfer operations and the trajectory of each robot, in order to minimize makespan. We give a disjunctive graph formulation and use the job insertion (sub-) problem as a mechanism for local search. Computational results support the value of the approach.

2 - A special case of the minimization of tool switches problem

Horacio Yanasse, LAC, INPE, Av. dos Astronautas 1758, CP 515 - INPE/CTE, 12227-010, São José dos Campos, SP, Brazil, horacio@lac.inpe.br

Consider the case where the MOSP graph corresponding to a minimization of tool switches problem (MTSP) has some cutting vertex. If we remove this vertex and all edges incident to it, an optimal solution for the original problem can be built from optimal solutions of the connected components of the resulting graph. We can use this result to develop polynomial algorithms for special cases of the MTSP when the corresponding MOSP graph has particular topologies.

3 - Two sided disassembly line balancing problem

Seda Hezer, Industrial Engineering, Selcuk University, Department of Industrial Engineering, 420031, Konya, Turkey, sedahezer@gmail.com, *Yakup Kara*

The disassembly line balancing problem (DLBP) can be stated as the assignment of disassembly tasks to workstations such that all the precedence relations are satisfied and some measure of effectiveness is optimized. In this study a mathematical model is proposed for two sided disassembly line balancing problem (TSDLBP) in which product flows along a production line with workstations on both sides of the line. To the best of our knowledge, the TSDLBP has not been applied to the DLBP and so this is the first study about TSDLBP. The model's performance is evaluated using test problems.

4 - Scheduling activities in a research centre to minimize the total energy consumption

Maciej Lichtenstein, Institute of Computer Engineering, Control and Robotics, Wrocław University of Technology, Janiszewskiego 11/17, 50-372, Wrocław, Poland, maciej.lichtenstein@pwr.wroc.pl, *Adam Janiak*, *Tomasz Krysiak*, *Mateusz Gorczyca*

We study the problem of scheduling activities in a research center with the objective of the total electrical power consumption minimization. The considered research center is powered by some number of "green energy" power plants and the activities conducted in that center deals with the research on those power plants. There are given a time characteristics of the power plants efficiency, and the energy demands of all activities. We present the precise model of the considered research center in terms of scheduling activities, which minimizes the total energy consumption over time.

■ TC-03

Tuesday, 12:30-14:00

RB-L1

Sustainable Network Design and Railway/Sea Transport

Stream: Sustainable Transport Planning
Invited session

Chair: *Joachim R. Daduna*, Hochschule für Wirtschaft und Recht Berlin Berlin, Badensche Str. 52, 10825, Berlin, Germany, daduna@hwr-berlin.de

1 - Road-Rail-Sea hub location-allocation with sustainability considerations

Ali Fattahi, Industrial Engineering, Koc University, Rumelifeneri, Sariyer, 34450, Istanbul, Istanbul, Turkey, afattahi@ku.edu.tr, *Metin Turkay*

Integration of different transportation modes in geographical regions offers a number of advantages with respect to cost, environmental impact and some social considerations. Important decisions in this integration include hub location and flow allocation. Although this problem is very important, it has not been examined with sustainability considerations previously. In this paper, the design of intermodal transportation is expressed as a MILP problem including sustainability considerations. The accuracy and efficiency of the model is tested on a number of instances derived from real data.

2 - Green supplier network design based on customer segmentation

Leyla Ozgur, Industry Engineering, Pamukkale University, Pamukkale Üniversitesi Kampüsü Rektörlük Binası Bilgi İşlem Daire Başkanlığı, 20070, Denizli, Turkey, Turkey, lozgur@pau.edu.tr, *Semih Coskun, Askiner Gungor, Olcay Polat*

Customer awareness on environmental issues has increased significantly for the last couple of decades. Despite good intentions, there is a huge variation of demand for green products among customers in the market. For this reason, there is a segmentation requirement for customers' green purchasing trends. Green companies therefore need to redesign their green supplier networks (GSN) according to customer segments. In this study, a mathematical model is proposed to design a GSN based on customer segmentation by including the important criteria of production and marketing in green supply chain.

3 - Designing efficient transportation processes for sustainable city logistics

Joachim R. Daduna, Hochschule für Wirtschaft und Recht Berlin Berlin, Badensche Str. 52, 10825, Berlin, Germany, daduna@hwr-berlin.de

Discussions about City Logistics are mostly concerned with freight transport in urban areas. However, passenger traffic is not taken into account, even though it is essential that customers are able to reach retail locations to make purchases. The objective is therefore to present a concept of a Passenger Traffic and Logistics Service Center that stresses the accessibility of inner-city shopping areas by customers. Here the underlying structures include the reduction of traffic in urban areas by reducing motorized individual traffic as well as delivery processes in the commercial sector.

■ TC-04

Tuesday, 12:30-14:00

RB-L2

Optimization problems on graphs and networks

Stream: Combinatorial Optimization

Invited session

Chair: *Ivana Ljubic*, Department of Statistics and Operations Research, University of Vienna, Bruennerstr. 72, 1210, Vienna, Austria, ivana.ljubic@univie.ac.at

1 - Minimum Spanning Trees with Generalized Degree Constraints

Pedro Moura, DEIO, Faculty of Sciences University of Lisbon, Cidade Universitária, Campo Grande, 1749-016, Lisbon, Lisbon, Portugal, pmmoura@fc.ul.pt, *Luis Gouveia, Amaro de Sousa*

We describe a MST problem which arises in the design of wireless networks. In a wireless link, the signal strength on the receiver side decreases with the distance to the transmitter side. To guarantee that the interference on the receiver side is under a given threshold, we impose a maximum amount of interference caused by the frequency channels used by the other links on both end nodes of the link. Different types of links may be installed between two nodes depending on the distance between them and their degrees. We introduce three models and compare the corresponding LP relaxations.

2 - Layered Graph Approaches for the Hop Constrained Steiner Tree Problem with multiple Root Nodes

Markus Leitner, Institute of Computer Graphics and Algorithms, Vienna University of Technology, Favoritenstraße 9-11, 1040, Vienna, Austria, leitner@ads.tuwien.ac.at, *Luis Gouveia, Ivana Ljubic*

We consider the following generalization of the hop constrained Steiner tree problem: Given an edge-weighted undirected graph whose nodes are partitioned into root nodes, terminals and Steiner nodes, find a minimum-weight subtree that spans all the roots and terminals so that

the number of hops between each terminal and an arbitrary root does not exceed a given hop limit H . In this work, we show how to model the problem over layered graphs and introduce a branch-and-cut approach for solving this model. Furthermore, comparisons to previously proposed flow- and path-based models are given.

3 - On a time-dependent formulation for the travelling salesman problem

Luis Gouveia, DEIO, University of Lisbon, Campo Grande, Bloco C6, 1749-016, Lisbon, Portugal, legouveia@fc.ul.pt, *Maria Teresa Godinho, Pierre Pesneau*

We present an updated classification of formulations for the asymmetric travelling salesman problem (ATSP) where we contextualize a new time-dependent formulation presented in Godinho et al (2010). The new formulation is an improved version of the Picard and Queyranne (PQ) formulation. The PQ formulation uses, as a subproblem, an exact description of the n -circuit problem. The new formulation uses more variables and is based on using, for each node, a stronger subproblem, namely a n -circuit subproblem with the additional constraint that the corresponding node is not repeated in the circuit.

4 - The Recoverable Robust Two-Level Network Design Problem

Eduardo Álvarez-Miranda, Dipartimento di Elettronica, Informatica e Sistemistica, Università di Bologna, Viale del Risorgimento 2, 40136, Bologna, BO, Italy, e.alvarez@unibo.it, *Ivana Ljubic, S. Raghavan, Paolo Toth*

We consider a problem modeled as the two level network design problem under uncertainty. One of two technologies can be installed on each edge and all nodes of the network need to be served by at least the secondary one. There is uncertainty regarding the set of primary customers; only a discrete set of realizations of them is available. The network is built in two stages. We model this problem using recoverable robustness, we provide mixed integer programming models and use a branch & cut algorithm to solve it.

■ TC-05

Tuesday, 12:30-14:00

RB-L3

Problems on graphs II

Stream: Discrete Optimization, Geometry & Graphs (contributed)

Contributed session

Chair: *Victor Lepin*, Institute of Mathematics, National Academy of Sciences of Belarus, 11 Surganova str, 220072, Minsk, Belarus, lepin@im.bas-net.by

1 - Extremal graphs for the randic index when minimum, maximum degree and order of graphs are odd

Ljiljana Pavlovic, Department of Mathematics, Faculty of Natural Sciences and Mathematics, Radoja Domanovica 12, 34000, Kragujevac, Serbia, pavlovic@kg.ac.rs, *Tomica Divnic*

Let $G(k,m,n)$ be the set of connected simple n vertex graphs with minimum vertex degree k and maximum vertex degree m . The Randic index of G is the sum of $d(u)d(v)$ raised to the power of $-1/2$, where $d(u)$ is the degree of vertex u and the summation extends over all edges uv of G . We find for k greater or equal to $n/2$, and k, m, n are odd, extremal graphs for which this index attains its minimum value. We show that the extremal graphs have only vertices of degree k, m and $m-1$, the number of vertices of degree $m-1$ is one and the number of vertices of degree k is as close to $n/2$ as possible.

2 - Disjoint Path Problem in Mixed Acyclic Graphs

Cong Zhang, Graduate School of Informatics, Kyoto University, sakyoku, higashitakeyamachi, 606-8393, kyoto, kyoto, Japan, tyou@amp.i.kyoto-u.ac.jp, *Hiroshi Nagamochi*

The disjoint path problem asks to find a set of vertex-disjoint paths between k pairs of source and sink vertices. It is known that the problem is NP-hard in a general undirected/directed graph, and the problem with a fixed k admits a polynomial time algorithm for an undirected graph or a DAG (directed acyclic graph). In this talk, we show a common generalization of these two results; i.e., the problem with a fixed k can be solved in polynomial time when a mixed graph becomes a DAG by contracting each component consisting of undirected edges into a single vertex.

3 - Full cycle extendability of $K(1,4)$ -restricted locally connected graphs

Pavel Irzhavski, Department of Discrete Mathematics and Algorithmics, Faculty of Applied Mathematics and Computer Science, Belarusian State University, Nezalezhnasti ave., 4, 220030, Minsk, Belarus, irzhavski@bsu.by, *Yury Orlovich*

A graph G is $K(1,p)$ -restricted if, for any subgraph H of G which is isomorphic to the complete bipartite graph $K(1,p)$, the number of edges of the subgraph induced in G by all the vertices of H is at least $p+(p-2)$. We prove that a connected locally connected $K(1,4)$ -restricted graph on at least three vertices is either fully cycle extendable or isomorphic to one of five exceptional (non-Hamiltonian) graphs. This result generalizes several previous results on the existence of Hamilton cycles in graphs.

4 - Biclique partition for graphs with special blocks

Victor Lepin, Institute of Mathematics, National Academy of Sciences of Belarus, 11 Surganova str, 220072, Minsk, Belarus, lepin@im.bas-net.by, *Oleg Duginov*

The biclique partition problem is to find a minimum number of edge-disjoint bicliques (complete bipartite subgraphs) that cover all edges of a given graph. We present a linear-time algorithm for the biclique partition problem in graphs whose blocks are complete graphs, cycles, complete bipartite graphs, special bipartite graphs or wheels.

■ TC-06

Tuesday, 12:30-14:00

RB-Gamma

Rich vehicle routing problems

Stream: Metaheuristics

Invited session

Chair: *Jose Brandao*, Management, University of Minho, Largo do Paço, 4704 -553, Braga, Portugal, sbrandao@eeg.uminho.pt

1 - The Pickup and Delivery Problem with Cross-Docking Opportunities

Hanne Petersen, Department of Transport, Technical University of Denmark, Denmark, hlp@transport.dtu.dk, *Stefan Ropke*

We present a pickup and delivery problem, where a number of requests with time windows must be served. Each request consists of a pickup and/or a delivery, and the aim is to construct a set of feasible vehicle routes at the lowest possible cost. Several cross-docks are available to help carry out the transportation operations, allowing for transfer of goods between vehicles and intermediate storage, and thus one request can be served by one or multiple vehicles. The problem is solved using a Parallel Adaptive Large Neighbourhood Search, on real-life and generated data.

2 - Metaheuristics for the vehicle routing problem with backhauls and soft time windows

Jose Brandao, Management, University of Minho, Largo do Paço, 4704 -553, Braga, Portugal, sbrandao@eeg.uminho.pt

The vehicle routing problem with backhauls and soft time windows (VRPBSTW) contains two distinct sets of customers: those that receive goods from the depot and those that send goods to the depot. To each customer is associated an interval of time (time window), during which each one should be served. This time window is called soft because it can be violated, but this represents an additional cost. We solve the VRPBSTW using iterated local search and iterated tabu search. The performance of these metaheuristics is tested using a large set of benchmark problems from the literature.

3 - A Multi-Objective Algorithm for Open Vehicle Routing Problems. A Real Case Study for a Spanish Company with time constraints

Ana Dolores López Sánchez, Economía, Métodos Cuantitativos e Historia Económica, Universidad Pablo de Olavide, Carretera de Utrera, km 1, 41013, Sevilla, Spain, adlopsan@upo.es, *Alfredo G. Hernandez-Diaz*, *Julian Molina*, *Rafael Caballero*, *Macarena Tejada*

Vehicle Routing Problems (VRP) arise in transportation problems optimizing one or several objectives in conflict. We will focus on Open Vehicle Routing Problems with a homogeneous fleet and three objectives (total distance, maximum travel time and number of routes). We propose a multiobjective local search based algorithm capable of obtaining efficient solutions in reasonable times. A real case study for a Spanish Company concerning the collection of workers at their homes is also considered. Results demonstrate the validity of the proposed algorithm compared to current routes.

4 - Tabu Search and Genetic Algorithms for the solution of the Capacitated Vehicle Routing Problem with Time Windows

Arthur Gomez, University of Vale do Rio dos Sinos, AV unisinos 950, São Leopoldo, Brazil, Av. Joao Satt 25 apt 802A, 91390364, porto alegre, rs, Brazil, atgomezbr@gmail.com, *Cristiano Galafassi*, *Leonardo Chiwiacowsky*

This paper addresses the Vehicle Routing Problem with constraints related to the vehicle capacity and time windows for customer service. The problem is solved by a Hybrid Algorithm based on Tabu Search and Genetic Algorithms metaheuristics. The algorithm performance is evaluated assuming different values for the metaheuristics parameters. Finally, the results are compared with the best heuristic and exact methods results found in the literature. The Hybrid Algorithm here proposed shows efficiency and robustness, with several optimal solutions achieved.

■ TC-07

Tuesday, 12:30-14:00

RB-Eta

Warehouse Operations Optimization

Stream: Vehicle Routing and Logistics Optimization

Invited session

Chair: *Hasan Akyer*, Industrial Engineering, Pamukkale University, Pamukkale University Engineering Faculty, Industrial Engineering Department, 20070, Denizli, Turkey, hakyer@pau.edu.tr

1 - Development of a systematic method to evaluate packaging areas

Judith Weiblen, Institute for Material Handling and Logistics, KIT, 76131, Karlsruhe, Germany, weiblen@kit.edu, *Dominik Berbig*, *Kai Furmans*

Consolidation & packaging areas cause 26% of total costs in a distribution center. Due to a big rate of manual jobs, it is the most important process after storage & picking. But there is hardly any literature concerning packaging areas. Thus we present both a systematic method to structure and evaluate packaging areas including a KPI-System and best-practices to design such areas. Above all, a market study of technical realization is shown. These results help to make tendering simpler, tenders can be compared better and monitoring and evaluation of packing areas gets possible.

2 - Optimal number of vehicles and paths of movement in GridFlow systems with AGVs

Melanie Schwab, Material Handling and Logistics, KIT, Karlsruhe, Germany, melanie.schwab@kit.edu

The new concept GridFlow is an automatic materialflow system to buffer, sort and store pallets. The pallets are arranged in a grid with at least one empty location and each can be moved in four directions, if no other pallet is blocking it. Pallets are moved by AGVs which drive underneath the pallets. Sequential movement of pallets allows to retrieve pallets that can not be accessed directly. As investment for vehicles is the main cost factor in the system, the optimal number of vehicles and path of movement is derived from a mixed integer optimization model which shall be presented.

3 - Optimization of the order-picking processes in the warehouse

Michał Jakubiak, Logistics, Wrocław University of Economics, Komandorska 118/120, 50-345, Wrocław, Poland, michal.jakubiak@ue.wroc.pl

The order picking problems in a warehouse are an important aspect in improving the productivity of modern logistic hubs. According to various estimates, the costs associated with order picking in the warehouse are from 55 - 65% of the total material handling costs. The author, using simulation tools, examines what factors influence the selection of moving methods during the process of order picking in the warehouse.

4 - A novel heuristic approach for the joint order batching and picker routing problems in warehouses

Hasan Akyer, Industrial Engineering, Pamukkale University, Pamukkale University Engineering Faculty, Industrial Engineering Department, 20070, Denizli, Turkey, haker@pau.edu.tr, Osman Kulak, Mustafa Egemen Taner

A novel heuristic approach is proposed to solve order batching and picker routing problems jointly for multiple cross aisles warehouse systems. The clustering algorithm integrated with GAs is developed to provide fast and effective solutions for the order batching problem. We adjust the routing problem of pickers as a TSP and propose efficient TSP heuristics. Numerical experiments are carried out to evaluate the performances of the proposed methods. GANN comes out to be the most attractive method in terms of solution quality and computational efficiency.

■ TC-08

Tuesday, 12:30-14:00

RB-Epsilon

Applications

Stream: Supply Chain Planning

Invited session

Chair: Mikael Rönnqvist, Département de génie mécanique, Université Laval, G1V 0A6, Québec, Canada, mikael.ronnqvist@nhh.no

1 - Mathematical programming models for master planning in ceramic tile supply chains. Evaluation and comparison of distributed and centralised scenarios.

David Pérez Perales, Organización de Empresas, (CIGIP), Universidad Politécnica de Valencia, Camino de Vera, 46022, Valencia, Spain, dapepe@omp.upv.es, Mareva Alemany

This paper deals with the replenishment, production, and distribution problem in a ceramic tile supply chain. A distributed decision-making approach made up of two decisions centers is initially considered in a multi-item, multi-facility and multi-level context. For each one, a deterministic MIP model for the multi-period master planning aiming to maximize their own local profits is proposed. Then, an ideal centralized approach is also evaluated as a benchmark. An example based on modifications of real-world industrial problems is presented to evaluate and compare both scenarios.

2 - A Mixed Integer Programming Model for Shelf Life Integrated Planning, Scheduling and Distribution in Yoghurt Production

Çağrı Sel, Department of Industrial Engineering, Dokuz Eylül University, Dokuz Eylül University, Department of Industrial Engineering, Buca, 35160 Izmir, Turkey, 35160, Izmir, Turkey, cagri.sel@deu.edu.tr, Bilge Bilgen

In this study, we deal with a supply chain problem on yoghurt production to make production and distribution decisions in an integrated way and focus not only on the packaging stage, but also the fermentation/incubation stage. We introduce a new multi-echelon, multi-period and multi-objective mixed integer linear programming model. Sequence-dependent times and costs, perishability constraints, shelf life, labor and working time restrictions are explicitly taken into account. As a result of the study, optimal solutions are obtained within a reasonable computational time.

3 - A production-inventory problem in pharmaceutical supply chain — mixed integer approach

Paweł Hanczar, Department of Logistics, University of Economics, ul. Komandorska 118/122, 54-608, Wrocław, Poland, pawel.hanczar@ue.wroc.pl

The paper considers the production inventory problem in pharmaceutical supply chains. First the structure of the supply chain being analyzed is presented and the production process is briefly described. Three optimization models were taken into account in the main part of the research. The first two models were used to ensure (only if possible) the feasibility of production and to minimize setup times for one period. The third model takes into account all periods on the planning horizon. The paper finishes with the presentation of results from a real life application of the presented models.

4 - Use of Lagrangian decomposition in coordination of refinery production and sales planning

Jiehong Kong, Department of Finance and Management Science, NHH Norwegian School of Economics, Helleveien 30, 5045, Bergen, Norway, jiehong.kong@nhh.no, Mikael Rönnqvist

The integrated planning model in refinery operation is a highly nonlinear problem. The standard decoupled approach is to divide the problem into two subproblems representing refinery production and sales planning. Information such as approximate component and product prices are used to coordinate the solutions. To converge to a solution, restrictions on the volumes are also needed. In this paper we propose a decomposition scheme based on LaGrange decomposition. It generates solutions that are more stable than the existing approaches without requiring additional volume constraints.

■ TC-09

Tuesday, 12:30-14:00

RB-Zeta

Colourings, Independence and Assignment

Stream: Graphs and Networks

Invited session

Chair: Reinhardt Euler, Informatique, Université de Brest, 20 av. Le Gorgeu, B P 817, 29285, Brest, France, reinhardt.euler@univ-brest.fr

1 - Lessons for finding Mutually Orthogonal Latin Squares (MOLS) for $n=10$ from new and old proofs for infeasibility of $n=6$

Gautam Appa, Operational Research, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, g.appa@lse.ac.uk, Reinhardt Euler, Anastasia Kouvela, Dimitris Magos, Yiannis Mourtos

A Latin Square of size n is an $n \times n$ matrix with numbers 1 to n appearing once in each row & column. Two Latin Squares are mutually orthogonal if each of the n square pairs of numbers (s,t) where s,t range in $1,\dots,n$, occur exactly once in the n square cells. It is known that there does not exist an orthogonal pair for $n=6$. We review the proofs of this by Tarry(1901), Fisher& Yates (1934), Yamamoto (1954), Stinson (1984), Dougherty (1994), Appa&Magos&Mourtos (2004) and extend the work of Mann (1944). The purpose is to see what can be useful in deciding whether there exist 3 MOLS of size $n=10$.

2 - On the recognition of 2-row orthogonal Latin rectangle circuits

Anastasia Kouvela, Management Science Group, London School of Economics and Political Science, 29 Abercorn Pl, Flat 171, NW89DU, London, United Kingdom, a.kouvela@lse.ac.uk, Gautam Appa, Reinhardt Euler, Dimitris Magos, Yiannis Mourtos

This study focuses on the completability of incomplete pairs of orthogonal Latin squares to identify all reasons that forbid it. We present this problem as a 3-index assignment problem and as a first step give the complete clutter of 2-row orthogonal Latin rectangle circuits. These are minimal structures that forbid completability. To identify them in any incomplete pair of orthogonal Latin squares we present a polynomial time recognition algorithm.

3 - Polyhedral aspects of cardinality constraints

Yiannis Mourtos, Management Science & Technology, Athens University of Economics & Business, Greece, mourtos@aueb.gr

A cardinality constraint states that every value of a discrete set must be received by a minimum and a maximum number of variables involved in that constraint. Adopting an IP perspective, we study the polytope defined as the convex hull of vectors satisfying multiple cardinality constraints. We provide families of facets and efficient separation algorithms and establish a convex hull relaxation for the case of 2 constraints. We discuss the relationship of multiple cardinality constraints to some generalizations of graph colouring.

4 - Approximating the multi-level bottleneck assignment problem

Frits Spieksma, Operations Research and Business Statistics, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, frits.spieksma@econ.kuleuven.be, Trivikram Dokka, Anastasia Kouvela

We consider the multi-level bottleneck assignment problem (MBA). This problem is described in the recent book "Assignment Problems" by Burkard et al. (2009) on pages 188 - 189. One of the applications described there concerns bus driver scheduling. We view the problem as a special case of a bottleneck m -dimensional assignment problem. We give approximation algorithms and inapproximability results, depending upon the completeness of the underlying graph.

An intermediary firm has to buy some quantity of an output directly from the producer. But the producer has two possible ends to allocate its production between them, one end being certain and the other one being uncertain. The problem of the intermediary firm is a pricing problem: that of determining the price in the certain end in order to get exactly the desired amount of output from the producer. In this paper, we model a situation of this kind, and study some aspects of the behavior both of the producer and of the intermediary firm.

2 - Integrated Pricing and Scheduling for Order Outsourcing in a Supply Network

Woldemar Wedel, Business Information Systems and Operations Research, University of Kaiserslautern, 8050, Zurich, Switzerland, woldemar@w-edel.de, Yike Hu, Oliver Wendt

Our work analyzes various pricing strategies and multiattribute dynamic pricing mechanisms for the outsourcing of manufacturing and logistics service orders in a supply network. Via multi-agent system simulation we investigate how prices should depend on resource availability, the negotiable contract execution time, the cost structure and willingness to pay of the network participants and their market structure. We compare the performance of cost-, competition-, and market/demand-oriented pricing strategies for determining an adequate lower price bound as a basis for interactive pricing.

3 - On Coordination under Random Yield and Random Demand

M. Güray Güler, Industrial Engineering, Bogazici University, Turkey, guler@boun.edu.tr, Taner Bilgic

The aim of this study is to analyze coordination in a supply chain with random yield and random demand. We study five well known contracts from the literature and show that all but the wholesale price contract are able to coordinate the chain under voluntary compliance. We also provide a sensitivity analysis on the optimal policy parameters.

4 - Layout Planning and Shelf Space Allocation in Retail Store: A Case Study for Chain Markets in Turkey

Yelda Cansu Adali, Industrial Engineering, Istanbul Kultur University, Istanbul Kultur University, Atakoy Kampus, Istanbul, Turkey, yeldacansuadali@gmail.com, Rifat Gürkan Özdemir, Kayhan Karaman

The study addresses layout planning and shelf space allocation problems simultaneously in a retail store. In the layout planning, placement of category areas is determined on the store floor such that areas do not overlap. In the shelf space allocation problem, space area and location of each unit on the shelf need to be determined. A two stage mathematical model will be developed for solving the above mentioned problem for maximizing total sales revenue in the period. The developed model will be implemented in a real life retailer's store layout and shelf space allocation problem.

■ TC-10

Tuesday, 12:30-14:00

RB-Theta

Pricing and Applications

Stream: Production Management & Supply Chain Management (contributed)

Contributed session

Chair: M. Güray Güler, Industrial Engineering, Bogazici University, Turkey, guler@boun.edu.tr

1 - A pricing problem in a two-ends model under uncertainty

Alberto A. Álvarez-López, Quantitative Applied Economics II, UNED (Spanish National University of Distance Education), Paseo Senda del Rey, 11, 28040, Madrid, Spain, aalvarez@cee.uned.es, Inmaculada Rodríguez-Puerta

■ TC-11

Tuesday, 12:30-14:00

RB-Iota

Exact Methods for Arc Routing Problems

Stream: Arc Routing

Invited session

Chair: Claudia Bode, Chair of Logistics Management, Gutenberg School of Management and Economics, Johannes Gutenberg University Mainz, 55099, Mainz, Germany, claudia.bode@uni-mainz.de

1 - Mixed Capacitated General Routing Problem: Exact and Heuristic Methods

Francesca Vocaturo, Dipartimento di Economia e Statistica, Università della Calabria, Via Pietro Bucci - Cubo 0C, 87036, Arcavacata di Rende (CS), Italy, vocaturo@unical.it, Adamo Bosco, Demetrio Laganà, Roberto Musmanno

The general routing problem (GRP) arises in contexts where it is needed not only to service some arcs or edges of a graph, but also some isolated vertices. It is common in many real-life applications of waste collection and mail delivery. Despite the importance, relatively few studies have been published on this problem. Moreover, most works deal with the uncapacitated case. We present exact and heuristic approaches for the capacitated GRP defined on a mixed graph. Computational results are also reported.

2 - Modeling the Rural Postman Problem with Time Windows

Ingrid Marcela Monroy Licht, Mathematics and Industrial Engineering, École Polytechnique de Montréal, 2900, boul. Édouard-Montpetit. Chemin de Polytechnique., H3T 1J4, Montréal, Québec, Canada, marcela.monroy@polymtl.ca, *Ciro Alberto Amaya, André Langevin*

During the winter season it is necessary to monitor the formation of ice on roads. This is the case in Quebec, Canada, where a patrol vehicle must check the status of roads during certain time intervals, depending on weather conditions. To design efficient monitoring, we have modeled this problem as a Rural Postman Problem with Time Windows. We explored three models to formulate the problem: a mixed integer model in arcs, an equivalent problem in nodes and a constraint programming problem. Some results are presented comparing the models on directed and non-directed graphs.

3 - Analysis of Pricing Problem Relaxations for the Capacitated Arc Routing Problem

Claudia Bode, Chair of Logistics Management, Gutenberg School of Management and Economics, Johannes Gutenberg University Mainz, 55099, Mainz, Germany, claudia.bode@uni-mainz.de, *Stefan Irnich*

We present an in-depth analysis of the pricing problem and possible relaxations in the branch-and-price context for the CARP. Any pricing problem relaxation must be able to handle two sets of tasks for modeling elementary routes and for branching. This complicates the pricing relaxations. We expose the following relaxations of CARP pricing problem: partially elementary tours, NG-route relaxation (including a dynamic version), and k-loop-free pricing. The requirement to construct task-2-loop free tours is rather intricate for k-loop elimination. Finally, acceleration techniques are addressed.

In a public transport setting without seat reservations, the typical way peak demand can be balanced against operational and inventory costs by balancing price strategy against rolling stock allocation. Since passengers have to share capacity, the satisfaction of a passenger is influenced by the allocation of other passengers. We will discuss a model where we take individual tolerance levels for crowdedness into account. We aim to optimize a social optimum for this model and then compare the results to a simulation where the passengers try to maximize their own individual satisfaction.

3 - Improving railway infrastructure utilization through pricing mechanisms - Modelling train flows

Michal Kaut, SINTEF Technology and Society, PO Box 4760 Sluppen, 7465, Trondheim, Norway, michal.kaut@sintef.no, *Adrian Werner, Arnt-Gunnar Lium, Truls Flatberg, Teodor Gabriel Crainic, Teodor Gabriel Crainic*

The goal of the project is to improve the utilization of the Norwegian railway network by creating incentives for train operators to move some of their load to off-peak times, by assigning penalties to the usage of specific sections at given times. This leads to a bilevel problem: in the upper level, we set the prices and in the lower level, the train operators create their routes.

We focus on the lower-level optimization problem, in which we have to approximate the way the train operators react to the usage prices, while ensuring that the proposed schedule is feasible in the network.

4 - Computing capacity consumption of railway lines and networks

Rob Goverde, Transport and Planning, Delft University of Technology, Stevinweg 1, 2628 CN, Delft, Netherlands, r.m.p.goverde@tudelft.nl

This paper describes a mathematical model to compute the capacity consumption of a railway line and extends this concept to railway networks. Capacity consumption is measured as the occupation time plus buffer time relative to the scheduled time interval. The occupation time is obtained by compressing the timetable while maintaining feasibility. This is modelled as a critical path problem over precedence graphs. The line capacity problem is based on a microscopic model which gives input to the macroscopic model of the network capacity problem that also includes connections at stations.

■ TC-12

Tuesday, 12:30-14:00

RB-Omicron

Capacity and Infrastructure

Stream: Optimization in Public Transport
Invited session

Chair: *Rob Goverde*, Transport and Planning, Delft University of Technology, Stevinweg 1, 2628 CN, Delft, Netherlands, r.m.p.goverde@tudelft.nl

1 - OR in shunt planning

Joel van 't Wout, Netherlands Railways, Netherlands, joel.vantwout@ns.nl

The final planning phase for a railway operator is the shunt planning. This involves the processes within the local station area, mainly choosing parking tracks and finding routes between the station and the shunting yard. OR models for shunt planning can be of great help to the planners of Netherlands Railways, because of limited parking and routing capacity in the Dutch railway network. Moreover, NS would like to make the shunt plans as late as possible, generating time pressure for the planners. We will present a model that solves the problem of matching, parking and routing rolling stock.

2 - A model for balancing price, capacity and crowdedness in public transport

Paul Bouman, Decision and Information Sciences, Rotterdam School of management, Erasmus University, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, PBouman@rsm.nl

■ TC-13

Tuesday, 12:30-14:00

RB-Tau

Assembly systems and automotive production

Stream: Manufacturing and Warehousing
Invited session

Chair: *Rüdiger Berndt*, Computer Science 7, Uni Erlangen-Nürnberg, 91058, Erlangen, Germany, ruediger.berndt@informatik.uni-erlangen.de

1 - Job rotation in assembly lines with disabled workers

Alysson M. Costa, University of São Paulo, Brazil, alysson@icmc.usp.br, *Mayron César Oliveira Moreira*

We study the problem of planning job rotation schedules in assembly lines with heterogeneous workers. Practical motivation for this study comes from the context of balancing assembly lines in sheltered work centers for the disabled. We propose a new problem in which the tasks are kept fixed in the stations for the whole planning period while each worker rotates within a subset of the stations. A mathematical model and some preliminary results are discussed.

2 - Improving ergonomics by OR methods applied in the planning process: The example of the automobile industry

Alena Otto, Management Science, Friedrich-Schiller University Jena, Carl-Zeiß-Straße 3, 07743, Jena, Germany, elena.otto@gmx.de

Poor workplace ergonomics results in occupational diseases and in high costs for firms, e.g., from absenteeism and errors. It is possible to improve ergonomics at low costs, especially at the earlier steps of planning. Then, mitigation of ergonomic risk factors also goes with raises in productivity and a higher quality. Currently, firms have difficulties to incorporate ergonomic aspects into the planning process. We show examples of how to integrate ergonomic aspects into the planning decisions. We discuss important planning steps, formulate problem settings and point out OR models.

3 - Precompiled Configuration Spaces for the Verification of Consistency in Production Planning Processes

Rüdiger Berndt, Computer Science 7, Uni Erlangen-Nürnberg, 91058, Erlangen, Germany, ruediger.berndt@informatik.uni-erlangen.de, *Peter Bazan*, *Kai-Steffen Hielscher*

Highly customizable products and mass customization - as increasing trends of the last years - are mainly responsible for an immense growth of complexity within the digital representations of knowledge. This also applies to the scope of car manufacturing and to the production planning processes and the involved data. We develop a method to detect and analyze inconsistencies by employing a Multi-Valued Decision Diagram (MDD) which encodes the set of all valid product configurations. On this basis, we state a number of rules of consistency that are checked by a set-based verification scheme.

4 - Queue Optimization in Deterministic Linear Manufacturing Systems

Zuzana Němcová, Department of Information Technologies, Faculty of Informatics and Management, University of Hradec Králové, Rokitsanského 62, 500 02, Hradec Králové, Czech Republic, Czech Republic, zuzana.nemcova@uhk.cz, *Martin Gavalec*

The contribution describes cost optimization in deterministic linear queuing systems. A manufacturing system is linear if it consists of a series of servers. Knowledge of the development of the queue lengths during the run of the system is useful for controlling the total costs. The method of finding the optimal setup of service capacities of the servers in each time period in which the service times stay unchanged is suggested. It helps the manager of the system in deciding when and how the service times of the servers should be changed. This results in significant cost savings.

Traditional approaches to solving the nurse rostering problem have mainly focused on the minimisation of the number of constraint violations across all the nurses. However, these rosters generally fail to ensure that individual nurses are treated fairly and the workload is shared evenly amongst nurses. In this paper, we introduce new fairness measures and propose an agent-based framework for cooperative search that combines the strength of several heuristic and meta-heuristic agents to optimise these measures in order to generate fair nurse rosters.

2 - Multi-level Decision Support in Rostering and Staffing

Patrick De Causmaecker, Computer Science/CODES, Katholieke Universiteit Leuven, Campus Kortrijk, Etienne Sabbelaan 53, BE-8500, Kortrijk, Flanders, Belgium, Patrick.DeCausmaecker@kuleuven-kortrijk.be, *Stefaan Haspeslagh*

The connection between rostering software and inter-ward decision making is studied. The assignment of nurses to shifts in a ward is subject to a large numbers of constraints and must allow flexibility in meeting unforeseen circumstances. Often software is available to support the assignment task. We model the impact of the rostering strategy and the ward configuration on its operational platform in terms of demand and occupation. By studying the impact of algorithm behavior on the operational efficiency, a better informed management of load and resource distribution becomes possible.

3 - The Nurse Scheduling Problem: Modelling the Nurses' Preferences in a Hospital in Turkey

Alejandra Duenas, Management, IESEG School of Management, Socle de la Grande Arche, 1 Parvis de la Défense, 92044, Paris, France, a.duenas@ieseg.fr, *G.yazgi TütÜncÜ*

The nurse scheduling problem consists of generating a work schedule that considers working days and days off for nursing staff in a Turkish hospital. Schedules meet all hard constraints and consider nurses' preferences modelled by fuzzy sets and aggregated to determine an overall preference cost function. The schedules are generated by a hybrid approach based on an interactive method which is combined with a multi-objective genetic algorithm(GA). The GA's fitness function is based on goal and aspiration levels. The results reveal that the proposed approach generates good quality solutions.

4 - From Simplified to Detailed Solutions To The Nurse Rostering Problem

Geetha Baskaran, Computer Science, The University of Nottingham Malaysia Campus, Faculty of Science, Jalan Broga, 43500, Semenyih, Kajang, Malaysia, Geetha.Baskaran@nottingham.edu.my, *Andrzej Bargiela*, *Rong Qu*

This paper presents a novel approach to solving the nurse rostering through information granulation. Compared to the established scheduling methods, our approach involves judicious grouping (granulation) of shift types that lead to a reformulation of the original problem in a significantly reduced solution space. The schedules are then translated back into the original problem space by considering the constraints that could not be represented in the reduced space. The proposed method has been evaluated on the standard benchmark problems and has shown to be capable of finding high quality schedules.

■ TC-14

Tuesday, 12:30-14:00

RB-Omega

Nurses Scheduling

Stream: Timetabling and Rostering
Invited session

Chair: *Geetha Baskaran*, Computer Science, The University of Nottingham Malaysia Campus, Faculty of Science, Jalan Broga, 43500, Semenyih, Kajang, Malaysia, Geetha.Baskaran@nottingham.edu.my

1 - Agent-based Cooperative Meta-heuristic search for Fairness in Nurse Rostering

Simon Martin, Mathematics, University of Portsmouth, Lion Building, Lion Gate, PO1 3HE, Portsmouth, Hampshire, United Kingdom, simon.martin@port.ac.uk, *Pieter Smet*, *Djamila Ouelhadj*, *Ender Özcan*, *Greet Vanden Berghe*

■ TC-15

Tuesday, 12:30-14:00

RB-2101

Vector and Set-Valued Optimization I

Stream: Vector and Set-Valued Optimization
Invited session

Chair: *Vicente Novo*, Matematica Aplicada, Universidad Nacional de Educacion a Distancia, Juan del Rosal no. 12, 28040, Madrid, Spain, vnovo@ind.uned.es

Chair: *Beatriz Hernández-Jiménez*, Economics, University Pablo de Olavide, Edificio N° 3, José Moñino - 2ª planta-despacho26, Ctra. de Utrera, Km. 1- 41013 Sevilla, 41013, SEVILLA, Spain, mbherjim@upo.es

1 - Variational-like inequality problems and vectorial optimization problems in Banach spaces

Gabriel Ruiz-Garzón, Estadística e I.O., University of Cadiz, Campus de Jerez de la Frontera, Avda. de la Universidad s/n, 11405, Jerez de la Frontera, Cádiz, Spain, gabriel.ruiz@uca.es, *Lucelina Batista dos Santos*, *Antonio Rufián-Lizana*, *Rafaela Osuna-Gómez*

This work is devoted to the study of relationships between solutions of Stampacchia and Minty vector variational-like inequalities and Pareto and weak Pareto solutions of vector optimization problems in Banach spaces under pseudo invexity and pseudo monotonicity hypotheses. We have extended the results given by various authors to Banach spaces and the relationships obtained to weak efficient points in Santos et al. are completed and enabled to relate Pareto points and solutions of the weak and strong Minty, Stampacchia and perturbed vector variational-like inequalities.

2 - Efficiency in multiobjective variational problem under generalized convexity

Manuel Arana-Jiménez, Estadística e Investigación Operativa, University of Cadiz, Facultad CCSS y de la comunicación, Av. Universidad s/n, 11405, Jerez de la Frontera, Cadiz, Spain, manuel.arana@uca.es, *Antonio Rufián-Lizana*, *Rafaela Osuna-Gómez*, *Gracia M. Nieto-Gallardo*

We study efficiency in multiobjective variational problems. For this purpose, we introduce new classes of functions, called V-KT(FJ)-pseudoconvex. These functions are characterized in order that all critical points (Kuhn-Tucker/Fritz John) are efficient solutions. That is, we propose the weakest properties on the functions involved in the multiobjective variational problem, such that we can ensure that a critical point is an efficient solution. These new classes of functions and results are a generalization of others recently appeared in multiobjective mathematical programming problems.

3 - The exact l1 penalty function method for vector optimization problems

Tadeusz Antczak, Faculty of Mathematics and Computer Science, University of Lodz, Banacha 22, 90-238, Lodz, lodzkie, Poland, antczak@math.uni.lodz.pl

In our considerations, we use the vector exact l1 penalty function method for solving convex and nonconvex vector optimization problems. The most important property of this method, that is, exactness of the penalization, is examined. We show that, there exists a lower bound of the penalty parameter, above which this value, the equivalence between the set of (weak) Pareto optimal solutions in multiobjective programming problem and the set unconstrained (weak) Pareto optimal solutions in its associated vector penalized optimization problem with the vector exact l1 penalty function holds.

4 - Characterization of weakly efficient solutions for non-regular vector optimization problems with conic constraints

Beatriz Hernández-Jiménez, Economics, University Pablo de Olavide, Edificio N° 3, José Moñino - 2ª planta-despacho26, Ctra. de Utrera, Km. 1- 41013 Sevilla, 41013, SEVILLA, Spain, mbherjim@upo.es, *Rafaela Osuna-Gómez*, *Marko A. Rojas-Medar*

In non-regular problems the classical optimality conditions are totally inapplicable. Meaningful results were obtained for scalar problems with conic constraints by Izmailov and Solodov. In this paper we give a necessary optimality condition for a non-regular vector optimization problems with conic constraints defined using abstract spaces, and appropriate generalized convexity notions to show that the optimality condition given is both necessary and sufficient to characterize the weakly efficient solutions set. The results that exist in the literature up to now, even for the regular case, are particular instances of the ones presented here.

TC-16

Tuesday, 12:30-14:00
RB-2103

Perturbation and sensitivity in Markov control problems and games

Stream: Uncertainty and Perturbations in Optimization and in Environmental and Energy Modelling
Invited session

Chair: *Konstantin Avrachenkov*, MAESTRO team, INRIA Sophia Antipolis, 2004 Route des Lucioles B.P. 93, 06902, Sophia Antipolis, France, K.Avrachenkov@sophia.inria.fr
Chair: *Yi Zhang*, Mathematical Sciences, University of Liverpool, Department of Mathematical Sciences, University of Liverpool, L69 7ZL, Liverpool, Merseyside, United Kingdom, zy1985@liv.ac.uk

1 - Markov decision processes with unknown transition matrices

Masayuki Horiguchi, Department of Mathematics and Physics, Faculty of Science, Kanagawa University, 2946 Tsuchiya., 259-1293, Hiratsuka, Kanagawa, Japan, horiguchi@kanagawa-u.ac.jp

We are concerned with Markov decision processes (MDPs) with unknown transition matrices. We introduce a Bayesian approach of intervals of prior measures to this uncertainty model, by which we can estimate unknown transition matrices to be posterior interval of closed convex set in each component and formulate interval estimated MDPs. We characterize this model as a controlled Markov set-chain model with intervals of transition matrices. Some convergence properties for uncertain MDPs of Bayesian approach are discussed and also numerical experiments are shown.

2 - Detecting non-Hamiltonicity in cubic graphs using linear feasibility problems

Jerzy Filar, School of Computer Science, Engineering and Mathematics, Flinders University, Sturt Road, 5042, Bedford Park, SA, Australia, jerzy.filar@flinders.edu.au, *Michael Haythorpe*, *Serguei Rossomakhine*

We present a series of linear feasibility problems containing a polynomially-bounded number of constraints and variables. We show that the feasibility problems are guaranteed to be feasible when generated for Hamiltonian cubic graphs, but may not be feasible otherwise. We prove that cubic graph graphs always generate an infeasible set of constraints. We provide strong empirical evidence that almost all non-Hamiltonian cubic graphs can be identified as such using this approach.

3 - Transformation method for discounted continuous-time Markov decision processes with unbounded rates

Yi Zhang, Mathematical Sciences, University of Liverpool, Department of Mathematical Sciences, University of Liverpool, L69 7ZL, Liverpool, Merseyside, United Kingdom, zy1985@liv.ac.uk, *Alexei Piunovskiy*

The standard uniformization technique for reducing a continuous-time Markov decision process (CTMDP) to a discrete-time Markov decision process has been well known for long. This technique requires the boundedness on the transition rates. In this talk, for a discounted CTMDP in Borel spaces, we present a transformation method that generalizes the standard uniformization technique to the case of arbitrarily unbounded transition rates. We also obtain a necessary and sufficient condition for the finiteness of the underlying value function, which leads to a non-explosion condition for a CTMDP.

4 - The expected total cost criterion for Markov decision processes under constraints: a convex analytic approach

Francois Dufour, Institut de Mathématiques de Bordeaux, Université Bordeaux, 351 Cours de la Liberation, 33400, Talence, France, dufour@math.u-bordeaux1.fr, *Masayuki Horiguchi*, *Alexei Piunovskiy*

This paper deals with discrete-time Markov Decision Processes under constraints where all the objectives have the same form of an expected total cost over the infinite time horizon. The existence of an optimal control policy is discussed by using the convex analytic approach. We work under the assumptions that the state and action spaces are general Borel spaces and the model is non-negative, semi-continuous and there exists an admissible solution with finite cost for the associated linear program. Our result ensures the existence of an optimal solution to the linear program given by an occupation measure of the process generated by a randomized stationary policy.

■ TC-17

Tuesday, 12:30-14:00

RB-2105

Hub Location II

Stream: Hub Location

Invited session

Chair: *Barbaros Tansel*, Industrial Engineering, Bilkent University, Bilkent, 6800, Ankara, Turkey, barbaros@bilkent.edu.tr

1 - A new approach to economies of scales in hub location problems

Martin Baumung, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Kackertrasse 7, 52072, Aachen, Germany, baumung@or.rwth-aachen.de

Despite economies of scales being one of the main reasons for hub & spoke networks, little attention has been paid to their adequate consideration in hub location models. In most of nowadays models unit transportation costs are assumed to be independent of the actual flow and are discounted by a constant factor on interhub links to take account of economies of scale. We present a new approach where transportation costs are not incurred by flows but by vehicle tours. This way consolidation can be achieved on any link of the network and the number of hubs no longer needs to be constrained.

2 - The ring star hub location problem: A Benders decomposition approach

Ricardo Camargo, Engenharia de Produção, Universidade Federal de Minas Gerais, 30161-010, Belo Horizonte, Minas Gerais, Brazil, camargo.rico@gmail.com, *Gilberto Miranda*, *Henrique Luna*, *Elisangela Martins de Sá*

The ring star hub location problem is the design of a two level hierarchical network: At the top, a ring network linking hubs, which are selected from a node candidates set, while observing scale economies on the links; and, at the bottom, a star network, single allocating exchanging flow customers to a hub. The problem is an extension of hub location problems to rapid transit and telecommunication applications. A new formulation is proposed and tackled by a Benders decomposition algorithm, which efficiently solves large scale instances to optimality, due to a new cut selection scheme.

3 - The p-Hub Median Problem on Incomplete Transportation Networks

Barbaros Tansel, Industrial Engineering, Bilkent University, Bilkent, 6800, Ankara, Turkey, barbaros@bilkent.edu.tr, *İbrahim Akgün*

The p-hub median problem has been studied so far under the assumption of a fully connected (complete) network where there is an undirected arc present for each pair of nodes. Transportation networks in the physical world are generally incomplete. That is, many of the arcs may be missing. While an incomplete network problem can always be handled by converting it first to a complete network problem, we strongly deviate from this tradition and give a new formulation that represents the problem directly on the given incomplete network. We present the new formulation and certain modeling advantages related to it.

■ TC-18

Tuesday, 12:30-14:00

RB-2107

Competitive Location.

Stream: Continuous Location

Invited session

Chair: *Blas Pelegrin*, Statistics and Operations Research, University of Murcia, Spain, pelegrin@um.es

1 - Solving a Huff-type location model on networks

Rafael Blanquero, Estadística e Investigación Operativa, Universidad de Sevilla, Faculty of Mathematics, Tarfia S.N. 41012-Seville (Spain), 41012, Seville, Spain, rblanquero@us.es, *Emilio Carrizosa*, *Amaya Nogales*, *Frank Plastria*

In this talk we address the problem of locating a single facility on a network according to the Huff competitive location model, where the nodes of the network represent users asking for a certain service. The objective function of this problem is shown to be multimodal and can be written as the difference of two convex functions. This fact is exploited in a branch and bound procedure which allows us to solve this problem on networks of reasonable size. Computational results are presented.

2 - Location models and GIS tools for franchise distribution

Rafael Suarez-Vega, Metodos Cuantitativos en Economia y Gestion, Universidad de Las Palmas de Gran Canaria, Edificio Departamental de Ciencias Economicas y Empresariales, Campus Universitario de Tafira, 35017, Las Palmas de Gran Canaria, Las Palmas, Spain, rsuarez@dmc.ulpgc.es, *Dolores R. Santos-Peñate*, *Pablo Dorta-González*

We consider a competitive location model and GIS tools to make decisions in a franchise distribution system when a single facility has to be located in a planar space. Two normally in conflict objectives are involved, the maximization of the market share of the firm and the minimization of the cannibalization. Maps representing the market share, the cannibalization effect, or a combination of them, are obtained. GIS tools allow the incorporation of forbidden regions and other restrictions, and the visualization of the effects produced by the opening of a new facility into the market.

3 - On a biobjective location model for firm expansion with binary customer behaviour

Algirdas Lančinskis, Institute of Mathematics and Informatics, Vilnius University, Akademijos st. 4, LT-08663, Vilnius, Lithuania, algirdas.lanciskas@mii.vu.lt, *Julius Zilinskas*, *Blas Pelegrin*, *Pascual Fernandez*

We study a bi-objective location model on a network for firm expansion in competition with other firms. The aim of the expanding firm is to maximize its market share and to minimize the cannibalism effect caused by new facilities. Demand in each market is fixed and customers select the most attractive facility while attraction depends on facility quality and distance to the customers. Under general condition, efficient locations are proved to be in the set of nodes. A heuristic algorithm is proposed to find efficient solutions for a large set of markets. Computational results are discussed.

■ TC-19

Tuesday, 12:30-14:00

RB-2111

Risk Modeling and Risk Measures

Stream: Actuarial Sciences and Stochastic Calculus

Invited session

Chair: *David Wozabal*, TUM School of Management, Technische Universität München, Arcisstraße 21, DE-80333, München, Germany, david.wozabal@univie.ac.at

1 - Modeling the ATM Cash Delivery Problem as a Vehicle Dispatch Problem and Solving It via a New Hybrid Heuristic Algorithm

Kübra Fenerci, Industrial engineering, Boğaziçi University, Mareşal Çakmak Cd. İnce Su Sk. Abacı Apt 8/1 Şirinevler/İST., İstanbul, Turkey, kubrafenerci@windowslive.com, *Ilhan Or, Ekrem Duman*

The Savings' and Sweep algorithms are two classical, but widely used approaches to find good near optimal solutions for vehicle routing problems. A variant heuristic integrating the basic philosophies of these algorithms is developed and applied to the vehicle routing problem arising in the route optimization of ATM cash delivery vehicles. An "angle criterion" (reflecting the spatial tendencies of the sweep approach) is embedded into the "savings criterion" to generate a hybrid algorithm. Relative weights of the "sweep" and "savings" criteria are experimentally determined.

2 - "Jumping Assets", "Timing Effect" and "Systemic Risk" in Portfolio Selection Problems

Sergio Ortobelli, MSIA, University of Bergamo, Via dei Caniana, 2, 24127, Bergamo, Italy, sol@unibg.it, *Enrico Angelelli*

In this paper we propose a comparison among the ex-post sample paths of the wealth obtained optimizing some large scale dynamic portfolio strategies. We use the stock of the main US market of the last 20 years. This empirical portfolio selection analysis has permitted: 1) To identify some assets, called "jumping assets", that present returns with big oscillations in a very short time. 2) To use portfolio strategies that maximize the time the portfolio reaches a loss and minimize the time the portfolio reaches an earn (Timing effect). 3) To forecast the periods of systemic risk.

3 - Robustifying Convex Risk Measures: A Non-Parametric Approach

David Wozabal, TUM School of Management, Technische Universität München, Arcisstraße 21, DE-80333, München, Germany, david.wozabal@univie.ac.at

We are robustifying convex, version independent risk measures. The robustified risk measures are defined as the worst case portfolio risk over a Kantorovich neighborhood of a reference distribution. We demonstrate that the optimization problem of finding the worst case risk can be solved analytically and consequently closed form expressions for the robust risk measures are obtained. We use these results to derive robustified versions for several examples of risk measures and demonstrate the favorable properties of the resulting robust measures in rolling-window out-of-sample evaluations.

2 - On distributional robust probability functions and their computations

Man Hong Wong, Systems Engineering and Engineering Management, The Chinese University of Hong Kong, Room 609, William M. W. Mong Engineering Building, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong, edmhong@gmail.com, *Shuzhong Zhang*

Consider a random vector, and assume that a set of its moments information is known. Among all possible distributions obeying the given moments constraints, the envelope of the probability distribution functions is introduced in this paper as distributional robust probability function. We show that such a function is computable in the bi-variate case under some conditions. Connections to the existing results in the literature, as well as the applications in risk management, will be discussed.

3 - Recent Features of UK Income Protection Claim Durations

Isabel Cordeiro, Escola de Economia e Gestão, Universidade do Minho/CEMAPRE, ISEG, Escola de Economia e Gestão, Universidade do Minho, Campus de Gualtar, 2710-057, Braga, Portugal, icordeiro@eeg.uminho.pt

In this paper we calculate average claim durations conditioned on recovery, on death and not conditioned on any particular mode of claim termination, using the most recent graduations of the transition intensities defined for a multiple state model for Income Protection (IP). These average claim durations are compared with similar durations presented in Cordeiro (2002, 2007), calculated with graduations for an earlier period. We also analyse other features of the distribution of the duration of an IP claim. All this information can be very useful for insurance companies selling IP policies.

4 - Valuation of employee Stock Option with stochastic exercise price for a Brazilian Firm

Tara Keshar Nanda Baidya, Industrial Engineering, PUC-Rio, Rua Marquês de São Vicente 225 — Gávea, 22451-041, Rio de Janeiro, RJ, Brazil, baidya@puc-rio.br, *Fernando Visser*

Employee Stock Option is being used more and more in Brazil recently. The objective of our research is to propose a model to price this option in the Brazilian context. For this purpose, we have chosen a Brazilian Airline firm called TAM S.A. The exercise price of this option is stochastic, it depends on the General Price Index of Brazil called IGPM. It has another particularity, the stock option can be exercised only after a certain period of time. In our case, there are options issued with a waiting period of 2, 3 and 4 years.

■ TC-20

Tuesday, 12:30-14:00

RB-2113

Risk Assessment in the Financial Sector

Stream: Decision Making Modeling and Risk Assessment in the Financial Sector

Invited session

Chair: *Tara Keshar Nanda Baidya*, Industrial Engineering, PUC-Rio, Rua Marquês de São Vicente 225 — Gávea, 22451-041, Rio de Janeiro, RJ, Brazil, baidya@puc-rio.br

1 - A Study on Quantitative Evaluation of the Model for the Piano Fingering

Keisuke Hotta, Faculty of Information and Communication, Bunkyo University, 1100 Namegaya, 253-8550, Chigasaki, Kanagawa, Japan, khotta@shonan.bunkyo.ac.jp

The fingering problem is to decide the natural fingering for the music score. In the previous research, I studied the fingering of the musical passage with single-note, 3rd or 6th-chord and the chord for both right and left hand respectively, by optimizing them as IP. The passage with single-note is the most difficult because of the flexibility. Then, unnatural fingering was occurred in several passages. In order to improve the model and the cost function, I study the effects of them by measuring the existing qualitative results of the score quantitatively, and seek the better fingering.

■ TC-21

Tuesday, 12:30-14:00

RB-2115

Asset Pricing

Stream: Long Term Financial Decisions

Invited session

Chair: *Andreas Loeffler*, Banking and Finance, Freie Universität Berlin, Boltzmannstr 20, 14195, Berlin, Germany, al@wacc.de

1 - Optimal Stopping for Portfolio Management

Alexandra Spachis, Business School, Imperial College, Exhibition road, SW7 2AZ, London, United Kingdom, alexandra.spachis04@imperial.ac.uk, *Eleni Hadjiconstantinou, Nicos Christofides*

Optimal Stopping problems (OPM) offer a substantial improvement in terminating a procedure at an earlier stage thus in real-life problems saving costs of additional observations. The focus of this paper is on the application of an OPM to the area of Portfolio Management. More specifically, the Portfolio Management Problem (PMP) aims at maximizing the expected return of an investor investing in a portfolio. A Dynamic Programming approach is proposed to solve the PMP and an illustrative example is presented to explain the proposed mathematical formulation and its computational implementation.

2 - Misperceptions of Long-Term Investment Performance: Insights From An Experiment

Michael Stutzer, Finance, University of Colorado, 419 UCB, 80309, Boulder, CO, United States, michael.stutzer@colorado.edu, Susan Jung Grant

The expected cumulative return is a reasonable long-term result indicator for repeated fixed dollar gambles. But long-term investments are better modeled by cumulating percentage returns, which are highly positively skewed, making the median a far better measure of centrality. Our experimental findings show that many subjects, including ones who have authored papers in the area, would make long-term investments in highly volatile assets with high expected return, but regret doing so once they are shown the distribution of long-term cumulative returns resulting from the investment.

3 - A Note On Estimating CAPM-Betas

Andreas Loeffler, Banking and Finance, Freie Universität Berlin, Boltzmannstr 20, 14195, Berlin, Germany, al@wacc.de, Thomas Burkhardt

Any CAPM-test uses an ex post formulation of the capital market line. In our note we show that the distribution of the noise has to be endogenised. To this end we consider a model where assets follow a multi-dimensional Brownian motion. Then we possess a model with multiple price paths that enables us to simulate the beta evaluation. Such, we are able to determine the distribution of betas. Simulations using a very simple Brownian setup already show that the resulting beta distributions have an enormous range. Even with large R^2 empirically estimated CAPM-returns should be carefully interpreted.

■ TC-22

Tuesday, 12:30-14:00

RB-2117

Mathematical Models in Macro- and Microeconomics 2

Stream: Mathematical Models in Macro- and Microeconomics

Invited session

Chair: Ludmilla Koshlai, Systems analysis and OR, Institute of Cybernetics, Gonchar str., 65-a, apt. 20, 01054, Kiev, Ukraine, koshlai@ukr.net

Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: Jean-Francois Emmenegger, Quantitative Economics, University of Fribourg, Bd de Pérolles 90, F440, 1700, Fribourg, Fribourg, Switzerland, Jean-Francois.Emmenegger@unifr.ch

1 - An empirical assessment of customer lifetime value models

Abdulkadir Hiziroglu, Management Information Systems, Sakarya University, Esentepe Campus M-5 Building, Sakarya, 54187, Sakarya, Turkey, khiziroglu@sakarya.edu.tr, Serkan Sengul

Customer lifetime value plays a key role in customer relationship management and has been carried out many sectors for decades. Researchers have proposed specific models for calculating customer lifetime value. Literature lacks of comparative research on assessing the existing models. We evaluate two customer lifetime value models from segmentation perspective. RFM model and basic structural model were compared and an evaluation from segmentation perspective was done. The results indicated that basic structural model was superior to its peer using the same databases and variables.

2 - On one nonlinear optimization problem for Leontief models

Petro Stetsyuk, Nonsmooth optimization methods, Institute of Cybernetics, 40 Prospect Glushkova, 03187, Kiev, Ukraine, stetsyukp@gmail.com

We consider the nonlinear programming problem for Leontief models (NLPL) with a bilinear objective function and linear constraints both for primal and dual Leontief models and two quadratic constraints which normalize final demand and value added. We show that for productive Leontief matrix the set of solutions of NLPL is determined by the eigenvectors corresponding to the maximum eigenvalues of a certain symmetric matrices. For productive and indecomposable Leontief matrices NLPL has a unique solution. Numerical examples for the aggregated 15 sectors Leontief model of Ukraine are given.

3 - Upper bounds for optimization problem of intersectoral planning of structural and technological changes

Tamara Bardadym, Dept. of Nonsmooth Optimization Methods, V.M. Glushkov Institute of Cybernetics, Prospekt Akademika Glushkova, 40, 03187, Kyiv, Ukraine, TBardadym@gmail.com, Oleg Berezovskyi

Two optimisation problems of interbranch planning of structural and technological changes formulated as quadratic type problems are considered: to maximize the total income of consumers, and to maximize Keynesian multiplier "income growth - production growth". Possible ways for finding upper bounds by Shor's technique with the use of superfluous constraints are described. Numerical experiments for 7-branch model were accomplished.

■ TC-23

Tuesday, 12:30-14:00

RB-Delta

Complementarity Problems, Variational Inequalities and Equilibrium

Stream: Mathematical Programming

Invited session

Chair: Sandor Zoltan Nemeth, School of Mathematics, The University of Birmingham, The Watson Building, Edgbaston, B15 2TT, Birmingham, United Kingdom, nemeths@for.mat.bham.ac.uk

Chair: Song Wang, Mathematics & Statistics, The University of Western Australia, 35 Stirling Highway, Crawley, 6009, Perth, Western Australia, Australia, Song.Wang@uwa.edu.au

1 - The Influence of Technical, Market and Legislative Factors on E-Waste Flows

Thomas Nowak, Transport and Logistics Management, Vienna University of Economics and Business, Nordbergstrasse 15, 1090, Wien, Austria, thomas.nowak@wu.ac.at, Fuminori Toyasaki, Tina Wakolbinger, Anna Nagurney

In this paper, we analyze how technical, market, and legislative factors influence the total amount and prices of e-waste that is collected, recycled and (legally and illegally) disposed of. We formulate the e-waste network flow model as a variational inequality problem with four tiers: the model covers the behavior of sources of e-waste, collectors, processors, and demand markets for precious and hazardous materials. In the numerical simulation of our model we can quantify the change of prices and quantities when penalties for illegal dumping for example is varied.

2 - Power penalty methods for nonlinear complementarity problems

Song Wang, Mathematics & Statistics, The University of Western Australia, 35 Stirling Highway, Crawley, 6009, Perth, Western Australia, Australia, Song.Wang@uwa.edu.au

Many real-world problems in classical and financial engineering are governed by nonlinear optimization problems with complex derivative constraints called obstacles. Usually, these problems can be formulated as Nonlinear Complementarity Problem (NCP). We present recent advances in the power penalty approach to NCP. Mixed NCP and bounded NCP and prove converges results at an exponential rate. Numerical results will be presented to demonstrate the theoretical exponential convergence rates.

3 - Necessary conditions for variational relation problems

Anulekha Dhara, Mathematics, Indian Institute of Technology Gandhinagar, Vishwakarma Government Engineering College Complex., Chandkheda, Visat-Gandhinagar Highway,, 382424, Ahmedabad, Gujarat, India, anulekha.dhara@gmail.com

The model of variational relation problem was introduced recently in 2008 by Luc. It englobes several models of fixed points, optimization, variational and quasivariational inequalities, equilibrium and many others. In literature it is well known that if a point is a solution of variational inequality then it is a solution of a projection problem. But such a condition need not hold for a variational relation problem. In this paper we aim to obtain necessary conditions for a point to solve the variational relation problem.

■ TC-24

Tuesday, 12:30-14:00

CC-A11

Judgmental Forecasting

Stream: Forecasting
Invited session

Chair: *Zoe Theocharis*, Cognitive, Perceptual and Brain Sciences, UCL, 26 Bedford Way, WC1H 0AP, London, United Kingdom, zoe.theocharis@gmail.com

1 - Why do people damp trends when using their judgment to make forecasts from time series?

Nigel Harvey, Cognitive, Perceptual and Brain Sciences, University College London, Gower Street, WC1E 6BT, London, London, United Kingdom, n.harvey@ucl.ac.uk, *Stian Reimers*

People's forecasts underestimate the steepness of trends in time series. This trend damping may occur because 1) people anchor on the last data point and make insufficient adjustment to take the trend into account, 2) they adjust towards the average of the trends they have encountered within an experiment, or 3) they are adapted to damped trends in the environment. To eliminate 1), we show anti-damping (the opposite of damping) for series that are negatively accelerated or have shallow slopes. To eliminate 2), we show both damping and anti-damping when people forecast from a single series.

2 - Judgmental interval forecasts: The effects of assessment order and trend direction

Mustafa Sinan Gonul, Business Administration, Middle East Technical University, Universiteler Mah. Dumlupinar Blv. No:1, Cankaya, 06800, Ankara, Turkey, msgonul@metu.edu.tr, *Mary Thomson*, *Dilek Önkâl-Atay*

To generate judgmental forecasts of point, 90% and 50% intervals, five distinct values need to be assessed: i) 90% upper bound, ii) 90% lower bound, iii) 50% upper bound, iv) 50% lower bound and v) point forecast. The interval bounds can either be assessed in an ordinary manner (i&ii first, followed by iii & iv) or concentric manner (i&iii first, followed by ii&iv) with points generated before or after the intervals. This research aims to explore the effects of assessment order and trend direction on the performance of resultant forecasts. Findings are discussed and implications are given.

3 - An exploration of judgmental forecasting biases using dynamic task environments

Zoe Theocharis, Cognitive, Perceptual and Brain Sciences, UCL, 26 Bedford Way, WC1H 0AP, London, United Kingdom, zoe.theocharis@gmail.com, *Nigel Harvey*

Judgmental forecasting tasks, which have mainly employed static displays of graphs or tables, have revealed several robust biases in forecasters' performance. These biases include trend damping, positive autocorrelation illusion and noise introduction. We investigated how people's forecasts are influenced by presenting the data series as a dynamic display of successive bar charts. We found that both forecaster accuracy and the underlying information processing strategies were affected by this. As a result, biases differed substantially from those previously reported.

4 - Change detection training improves time series forecasting

Matt Twyman, Cognitive, Perceptual and Brain Sciences, University College London, United Kingdom, m.twyman@ucl.ac.uk, *Nigel Harvey*

Participants were asked to judge whether changes had occurred in time series, express confidence in those judgments, and forecast eight data points at the end of each series. Different participants performed the change detection or forecasting tasks (on the same set of time series) in different orders. There were no differences in change detection performance or confidence between the two groups, but participants who were asked to forecast first gave elevated and less accurate forecasts, indicating that change detection training improves forecasting.

■ TC-25

Tuesday, 12:30-14:00

CC-A23

Measurement of Sustainability

Stream: Environmental Issues in Operations Management
Invited session

Chair: *Jutta Geldermann*, Chair of Production and Logistics, Universität Göttingen, Platz der Göttinger Sieben 3, D-37073, Göttingen, Germany, geldermann@wiwi.uni-goettingen.de

1 - Developing the data envelopment analysis model with incorporating the carbon footprint to measure the business operational efficiency

Li-Ting Yeh, Business Administration, National Central University, 11-209, NO.300 Jung-da Rd., Jung-li City, Taoyuan, Taiwan 320, R.O.C, Jhongli, Taiwan, dow0623@gmail.com, *Dong Shang Chang*, *Wenrong Liu*

The three scopes of carbon footprint have become most suitable methods to measure the greenhouse gases from the business operating activities. This environmental perspective is considered by previous studies to measure the business operational efficiency. With incorporating the carbon footprint, the slack-based measure model is developed to evaluate environmental performance of business operations. Research sample is adopted from Carbon Disclosure Project with Fortune 500 Top Companies. The finding is useful to the government for amending the industry and energy policy with sustainability.

2 - Strategic and operational implications of climate change for supply chain management

Costas Pappis, Department of Industrial Management, University of Piraeus, 80 Karaoli & Dimitriou str., 18534, Piraeus, Attica, Greece, pappis@unipi.gr, *Cristobal Miralles*, *Tom Dasaklis*, *Nikos Karacapilidis*

Earth's climate is rapidly changing as a result of increases in emissions of greenhouse gases caused by human activities. Escalation in regulations, market forces and shareholders' value are paving the way for the decarbonization of supply chains. In this paper the implications of climate change for supply chain management in terms of strategic and operational planning are identified and insights in the means, by which supply chains could be better positioned to cope with climate change hazards in a low carbon economy, are provided.

3 - Resource efficiency in supply chains: a review of network design and operational planning

Gábor Herczeg, Department of Management Engineering, Technical University of Denmark, Produktionstorvet bygn. 424, 2800, Lyngby, Denmark, gahe@man.dtu.dk

Achieving sustainable development in supply chain management by engaging in green operations is receiving increasing attention. Green supply chain operations can be enhanced by increasing resource efficiency, e.g., through sustainable use of finite raw materials, etc.. We review the state-of-the-art on resource efficiency in supply chains from the aspect of supply chain design and operational planning. Furthermore, we develop a conceptual framework that identifies future directions and tools for enhancing theory and practice to improve green operations.

4 - The varied contexts of environmental multicriteria decision support processes

Jutta Geldermann, Chair of Production and Logistics, Universität Göttingen, Platz der Göttinger Sieben 3, D-37073, Göttingen, Germany, geldermann@wiwi.uni-goettingen.de, *Meike Schmehl, Katharina Amann*

Various tools for analysing the impact of the environmental burden like Life Cycle Assessment have been developed, and the need to apply decision analysis is widely recognised. This paper draws conclusions on the process of multicriteria decision support in various contexts: (1) the development and validation of evaluation criteria for sustainable bioenergy concepts, like a bioenergy village; (2) evolving requirements of electricity supply networks, which arise from projected fluctuating regenerative power generation, from a managerial viewpoint; (3) industrial risk and emergency management.

■ TC-26

Tuesday, 12:30-14:00

CC-A24

OR in Forestry II

Stream: OR in Agriculture, Forestry and Fisheries
Invited session

Chair: *Patrick Hirsch*, Institute of Production and Logistics, University of Natural Resources and Life Sciences, Vienna, Feistmantelstrasse 4, 1180, Wien, Austria, patrick.hirsch@boku.ac.at

1 - On the optimal land allocation

Jussi Uusivuori, Finnish Forest Research Institute Metla, Unioninkatu 40 A, FIN-00170, Helsinki, Finland, jussi.uusivuori@metla.fi

Land allocation between productive land and conservation is studied. Private decision-making is described in two cases: when access to conserved land is closed, and when there is an open access to conserved land. In the latter case the land size designated to conservation will be smaller than in the former. Policy rules are derived for a social optimum. When a closed-access regime is opened, optimal policies become dependent on wealth differentials between land-owning and non-landowning members of society. Utility of both groups is increased if willingness-to-pay for conservation is utilized.

2 - Scheduling sawmill operations using robust optimization

Sergio Maturana, Ingenieria Industrial y de Sistemas, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, Chile, smaturan@ing.puc.cl, *Mauricio Varas, Jorge Vera*

Scheduling sawmills operations is difficult due to the uncertainty of log supply and product demand. In this work robust optimization approach is used to take into account uncertainties in product demand and raw material availability when scheduling sawmill operations. The performance of the robust solutions was tested using Montecarlo's method. Numerical evidence shows an interesting relationship between the product's holding/shortage costs and the level of conservatism, and also provides some insights about the impact of the budgets of uncertainty in the performance of the robust solutions.

3 - Vehicle routing for transporting forest fuel and combined mobile chipper scheduling

Jan Zazgornik, Institute of Production and Logistics, University of Natural Resources and Life Sciences, Vienna, Feistmantelstrasse 4, 1180, Vienna, Austria, jan.zazgornik@boku.ac.at, *Manfred Gronalt*

This work presents a vehicle routing problem for transporting forest fuel including combined mobile chipper scheduling. A mathematical model was formulated as a multi-depot vehicle routing problem with time windows. Additional constraints were used to model the queuing of trucks at a mobile chipper that chips wood directly into a truck. The objective is to minimize total working times of the drivers, which includes to keep waiting times of trucks low at the mobile chipper. Besides the model formulation a dynamic tabu search with alternating strategy was used to solve larger problem instances.

4 - Environmental impacts versus driving times - The routing of log-trucks with a new near-exact solution approach

Marco Oberscheider, Institute for Production and Logistics, University of Natural Resources and Life Sciences, Vienna, Feistmantelstraße 4, 1180, Vienna, Austria, marco.oberscheider@boku.ac.at, *Jan Zazgornik, Manfred Gronalt, Patrick Hirsch*

The routing of log-trucks is compared for two objectives: minimizing total driving times against minimizing the greenhouse gas emissions of timber transport. A new near-exact solution approach (NE) is introduced for this multi depot vehicle routing problem with pick-up and delivery and time windows. As benchmark a Tabu Search strategy with a dynamically alternating neighborhood is used. The extensive numerical studies with real life data - concerning the supply of biomass power plants - reveal the potential of the NE and show how efficient planning can contribute to climate change mitigation.

■ TC-27

Tuesday, 12:30-14:00

CC-A25

Policy Analytics

Stream: Decision Processes
Invited session

Chair: *Alexis Tsoukiàs*, CNRS - LAMSADE, Université Paris Dauphine, 75775, Paris Cedex 16, France, tsoukias@lamsade.dauphine.fr

Chair: *Vivien Kana Zeumo*, MIDO, University Paris Dauphine, LAMSADE, University Paris Dauphine, 75775 Paris Cedex 16, 75775, Paris, Paris, France, vizkana@yahoo.fr

1 - Policy analytics: what it is and how to distinguish it

Valerie Belton, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk, *Alexis Tsoukiàs*

In this talk we discuss the term "policy analytics" as a distinguished field of scientific investigation as well as of decision support practice. We present a policy cycle analysis and we show why decision analysis and analytics need to be specifically conceived in order to take care of the new challenges in this exciting area.

2 - An ANP-based approach for addressing sustainability in urban transformation projects

Valentina Ferretti, Urban and Regional Studies and Planning, Politecnico di Torino, Viale Mattioli 39, 10125, Torino, Italy, valentina.ferretti@polito.it, *Marta Bottero, Andrea Di Maggio, Silvia Pomarico, Marco Valle*

The paper addresses the problem of sustainability assessment of a new transport infrastructure through the use of the Analytic Network Process. The model takes into consideration the different aspects of the decision-making process, namely, economic, environmental, social, transport and urban planning aspects that have been organized according to the categories of Benefits, Costs, Opportunities and Risks. The results of the work are a ranking of alternative solutions and a list of the most important elements of the decision problem that have been represented by means of specific thematic maps.

3 - Poverty measurement: a decision aiding perspective

Vivien Kana Zeumo, MIDO, University Paris Dauphine, LAMSADE, University Paris Dauphine, 75775 Paris Cedex 16, 75775, Paris, Paris, France, vizkana@yahoo.fr, *Alexis Tsoukiàs*

In this paper we present a new methodology aiming at aiding the design, implementation and monitoring of poverty reduction policies. The new methodology extends capabilities theory in a practical way allowing to assess how clusters of similarly "poor" can improve their condition.

4- InViTo: an integrate approach for supporting the evaluation of transport scenarios

Isabella Lami, Polytechnic of Turin, 10125, Turin, Italy, isabella.lami@polito.it, Francesca Abastante, Stefano Pensa, Marta Bottero, Elena Masala

This study presents an innovative approach for integrating the Analytic Network Process (ANP) and the visualisation tools. By the use of Interactive Visualization Tool - InViTo, the work shows the contribution of the proposed approach to the decision-making process in handling the data collected, using specific 2D and 3D maps created by the system. The case study is an application of the ANP and InViTo to a section of the Project CODE24 showing the potentialities of the conjoint use of the two techniques in helping selecting a suitable scenario for transport improvement.

■ TC-28

Tuesday, 12:30-14:00

CC-A27

Boundaries and Interfaces

Stream: Models of Embodied Cognition

Invited session

Chair: *Susie Vrobel*, The Institute for Fractal Research, Ernst-Ludwig-Ring 2, 61231, Bad Nauheim, Hessen, Germany, Susanne.Vrobel@t-online.de

1 - Cold-blooded loneliness: Social exclusion leads to lower skin temperatures

Hans IJzerman, Social Psychology, Tilburg University, Warandelaan 2, 5037AB, Tilburg, Netherlands, h.ijzerman@gmail.com

Recent findings have stressed links between physical warmth and affection (see IJzerman & Koole, 2011). We promote the role of skin temperature, arguing that simulations of temperature are used to interpret communal relationships. The results support that complex social metaphors are scaffolded onto bodily temperature changes: Social exclusion leads to lower finger temperatures (Study 1), while negative affect typically so experienced is alleviated after holding a warm cup (Study 2). We discuss interactions between body and social relations specifically and core cognitive systems in general.

2 - Are Free Association Clusters Ad-Hoc Humanoid Agents ?

Antal Borbely, N.Y. Psychoanalytic Institute, 675 West End Ave, #1A, 10025, New York, NY, United States, anfborbely@gmail.com

During free association in psychoanalysis association clusters are formed. They represent themes relevant at that moment but they can also be compared to ad-hoc humanoid agents. Their functioning and the relationships formed with each other as well as with the analysand and analyst are explored. Agents relate to each other on social, human, and intrapsychic levels. Every agent is constituted by other agents as part of an inexhaustible hierarchy. The spatial and temporal structure of this hierarchy is maintained by metaphoric processes involved in memory, anticipation, and creativity.

3 - Toward a 'rationality' tuned with human life

Marina Alfano, Conservatorio di Musica Girolamo Frescobaldi, Ferrara, Ministero Pubblica Istruzione, Italy, Via Previati 22, 44121, Ferrara, Italy, marina.alfano@conservatorioferrara.it, Rosolino Buccheri

In order to include interaction in physics and to account for the philosophical consequences of Gödel theorems, we have to accept the anthropological datum that, at the dawning of the civilization, human cognition was based on a process of co-oscillatory resonance established by man with his environment as the effect of a hearing amplified by his body and transmitted to his consciousness. By admitting that such 'subjective' knowledge is nowadays disregarded but not lost, we look to a more effective rationality by integrating the 'scientific' one into a wider, more comprehensive wisdom

4- Dimensions of trust involved in human actions against climate change

Annette Hohenberger, Middle East Technical University (METU), Informatics Institute, Cognitive Science Program, Cankaya Ilcesi Universiteler Mah. Dumlupinar Bulvari No:1, 06800, Ankara, Turkey, hohlenberger@ii.metu.edu.tr

This paper explores the spatio-temporal, cognitive, social and emotional dimensions of trust involved in people's actions against climate change. Due to its vast spatio-temporal scale, climate change is a major challenge that necessitates humans to extend their interfaces with the environment on the above-mentioned dimensions. Trust is an essential precondition in this process. To the extent that we can trust in the various environments that embed us and into the available resources, we can reduce and possibly handle the higher complexity with which climate change challenges us.

■ TC-29

Tuesday, 12:30-14:00

CC-A29

MINLP and Nonlinear Network Flows in Gas Transport II

Stream: Mixed-Integer Non-Linear Programming

Invited session

Chair: *Jesco Humpola*, Optimization, Zuse Institute Berlin, Takustrasse 7, 14159, Berlin, Berlin, Germany, humpola@zib.de

1 - An automated method for the booking validation problem

Benjamin Hiller, Optimization, Zuse Institute Berlin, Takustr. 7, 14195, Berlin, hiller@zib.de

We propose an automated approach to solve the booking validation problem faced by gas network operators: Given a set of transmission capacity contracts (a booking), check whether all balanced gas flows that may result from those contracts are technically realizable. Our approach is based on MINLP methods for checking gas flow realizability complemented by a method for generating a representative subset of the gas flows that may arise. This generation method combines a stochastic model for gas offtakes and a deterministic model for the contractual limitations of both injections and offtakes.

2 - Heuristic Long-term Planning of Natural Gas Transportation Networks

Daniel Heuberger, Institute of Power Systems and Power Economics, Schinkelstr. 6, 52056, Aachen, Germany, dh@iaew.rwth-aachen.de, Albert Moser

New challenges for natural gas TSO arise, due to the liberalization of the energy markets and the started regulation of natural gas networks in Europe. Long-term planning is an acknowledged method to quantify the impact of different uncertainties in order to calculate cost efficient network structures. This paper introduces a heuristic method for calculating cost-efficient natural gas transportation networks. In this context requirements for the optimization are presented and the developed method is introduced. Finally, the practical applicability is proved by means of exemplary results.

3 - Design of Hydrogen Transmission Pipe Networks for France

Daniel De Wolf, Economie Gestion, Université du Littoral, 189B avenue Maurice Schumann, B.P. 5526, 59379, Dunkerque Cedex 1, France, daniel.dewolf@univ-littoral.fr

We develop an economic model for the deployment of hydrogen transport network. First, we present a state of the art of the existing methods to design pipe networks. Having established the physical constraints and the specific costs for the transport of hydrogen, we present the mathematical program in order to determine the optimal topology and sizing of the network. A theoretical important result concerning the topology of the networks is demonstrated. Then we present the heuristics used to solve the model. Finally, the model is applied to the development of a new hydrogen network in France.

4 - Stochastic nonconvex MINLP models and global optimization for natural gas production network design under uncertainty

Xiang Li, Chemical Engineering, Queen's University, Dupuis 403, 19 Division Street, K7L 3N6, Kingston, Ontario, Canada, xiang.li@chee.queensu.ca, Asgeir Tomasgard, Paul I. Barton

Scenario-based stochastic nonconvex MINLP models are developed to facilitate the design of natural gas production networks under uncertainty, where the nonconvexity comes from bilinear, quadratic and power functions involved. As a gas network involves large investments, a small performance gain made in the design can translate into significant increase in profits, it is desirable to solve the problem to global optimality. A novel global optimization method, called non-convex generalized Benders decomposition (NGBD), is developed to achieve this goal efficiently.

■ TC-30

Tuesday, 12:30-14:00

CC-A31

Data confidentiality 1

Stream: Data Confidentiality
Invited session

Chair: Robert Garfinkel, OPIM, University of Connecticut, Box U41IM, 06029, Storrs, CT, United States, rgarfinkel@business.uconn.edu

1 - Solving L1-CTA in 3D tables by an interior-point method for block-angular problems

Jordi Cuesta, Chemical Engineering, University Rovira i Virgili, Av. Països Catalans 26, Sant Pere i Sant Pau, 43007, Tarragona, Catalunya, Spain, jordicuest@gmail.com, Jordi Castro

Given a table with sensitive information, CTA looks for the closest safe table. We focus on CTA for 3D tables using the L1 distance between the original and protected tables. The resulting linear programming problems are solved by a specialized interior-point algorithm which solves the normal equations by a combination of Cholesky factorization and preconditioned conjugate gradients (PCG). Quadratic regularizations are used to improve the performance of PCG. Computational results are reported for a set of linear optimization problems of up to 50 million variables and 25 million constraints.

2 - Optimal Data-Independent Noise for Differential Privacy

Josep Domingo-Ferrer, Dept. of Computer Engineering and Maths, Universitat Rovira i Virgili, Av. Països Catalans 26, 43007, Tarragona, Catalonia, Spain, josep.domingo@urv.cat, Jordi Soria-Comas

Differential privacy is a notion offering general and clear privacy guarantees for the individuals in a database. The effect of the presence or absence of any single individual on the response to a query is limited. The response mechanism can be viewed as an output perturbation where the real response is computed and noise-added before release. The usual choice is Laplace noise adjusted to the global sensitivity of the query function. We show that Laplace noise is not optimal, and we construct optimal noise distributions.

3 - Solving L2-CTA by perspective reformulations

Jordi Castro, Statistics and Operations Research, UPC, 08034, Barcelona, Catalonia, Spain, jordi.castro@upc.edu, Claudio Gentile, Antonio Frangioni

Controlled tabular adjustment (CTA) is an emerging technology for the protection of tabular data. CTA minimizes the distance between the (unsafe) original and the protected table. CTA results in challenging MILP or MIQP problems, if, respectively, L1 or L2 distances are considered. We provide a novel analysis of perspective reformulations for the particular MIQP-CTA formulation, with pairs of linked semi-continuous variables. Computational results will be provided, together with a comparison of the utility of the protected tables with L1-CTA and L2-CTA.

4 - On Generating a Secure, Representative Sample from a Database

Robert Garfinkel, OPIM, University of Connecticut, Box U41IM, 06029, Storrs, CT, United States, rgarfinkel@business.uconn.edu

A database manager (DBA) has access to a number of records pertaining to entities. The fields of the database can be partitioned into bins. Each entity can allow its record to be included in a sample, based on a privacy constraint that specifies the minimum number of other participants that satisfy "similarity" conditions. Two measures are given, one local and one global, for the "representativeness" of a sample based on the population of the database. Then it is determined which sample sizes are privacy-feasible, and how to maximize representativeness for these sample sizes.

■ TC-31

Tuesday, 12:30-14:00

CC-A33

Applications of the Neural Networks

Stream: Data Mining, Knowledge Discovery and Artificial Intelligence

Contributed session

Chair: Yoshifumi Kusunoki, Osaka University, Japan, kusunoki@eei.eng.osaka-u.ac.jp

Chair: Anastasia Motrenko, Applied mathematics and management, MIPT, Moscow, Russian Federation, pastt.petrovna@gmail.com

1 - Supplier's performance measurement using intelligent clustering

Meltem Gulserin, Industrial Engineering, Istanbul Technical University, Macka, 34367, Istanbul, Turkey, meltem.gulserin@gmail.com, Mine Isik, Gulgun Kayakutlu

This research aims to propose a supplier performance measurement model including the supplier relations. Factors affecting the performance for procurement are accumulated through the literature survey but improved with the expert support. The proposed model clusters the suppliers according to the performance using Self Organized Maps based on Kohonen networks. This model benefits the historical data to support the future plans in a changing business environment. A case study on automotive suppliers is presented. This research will be valuable for designing the roadmap of supplier management.

2 - Modelling the behaviour of masonry walls under out of plan loading by ANN

M. Sami Donduren, Selcuk University, Turkey, sdonduren@selcuk.edu.tr

In this study, out-of plane failures of two masonry walls having different mortar properties were investigated and the results were modeled with Artificial Neural Networks (ANN). First masonry wall is knitted and plastered by conventional mortar and the second test specimen is knitted and plastered by improved mortar which has Sikalatex as an additive. As a result, the failure strength of the wall increased by 25%, which had improved binding property with additive material. And it has been seemed that the ANN model can produce acceptable results.

3 - Estimating the behaviors of reinforced concrete columns under axial load effect by ANN

M. Tolga Cogurcu, Selcuk University, Turkey, mtolgac@selcuk.edu.tr

The aim of this study is to estimate the load capacity and stress-strain relationship of columns which have the same cross-sectional areas under the effect of axial load by ANN. The results obtained in this study have shown that ANN is a sufficient method to estimate the behaviour of the columns. Results are analyzed with variance analysis on SPSS program and with security edge controls.

4 - Modelling the flexural behaviour of beams by ANN

Mehmet Kamanli, Selcuk University, Turkey,
mkamanli@selcuk.edu.tr

In this study artificial neural network method was used to predict the deflection values of beams and compared with the experimental results of a testing series. For that aim, 6 reinforced concrete beams with constant rectangular cross-section were prepared and tested under pure bending. The neural network procedure was applied to determine or predict the deflection values of 1/1 scaled model beams. The analytical results were compared with the test results and further predictions including different mix designs can be possible at the end of the study.

■ TC-32

Tuesday, 12:30-14:00

CC-A34

Risk and Uncertainty in Energy Models

Stream: Emissions Trading and Energy
Invited session

Chair: Dominik Möst, Chair of Energy Economics, Technische Universität Dresden, Hertzstraße 16, 01062, Dresden, Germany,
Dominik.Moest@tu-dresden.de

1 - An Electricity Market Model with Generation Capacity Investment under Uncertainty

Andreas Schröder, Energy, Transportation, Environment,
DIW Berlin, Mohrenstr. 58, 10117, Berlin, Preussen,
Germany, aschroeder@diw.de

This article presents an electricity dispatch model with endogenous electricity generation capacity expansion for Germany over the horizon 2035. The target is to quantify how fuel price uncertainty impacts investment incentives of thermal power plants. Results point to two findings which are in line with general theory: Accounting for stochasticity increases investment levels overall and the investment portfolio tends to be more diverse.

2 - Wind power in Europe: Modeling of wind feed-in time series with an hourly resolution

Alexander von Selasinsky, TU Dresden, Germany,
Alexander.von_Selasinsky@tu-dresden.de, Michael Zipf

The research to be presented addresses the modeling of wind feed-in for EU27-countries. Based on six hour time series of wind speed that are publically available, it is shown how time series of hourly wind feed-in can be constructed. In this context, an algorithm is presented that enables the transition from six hour to one hour time series. Whereas modeling wind feed-in on an hourly resolution is especially relevant for energy system analyses, the research to be presented evaluates calculated data by discussing the smoothing of wind power output through the spatial distribution of generation.

3 - Power Transmission Grid Expansion using Benders Decomposition

David Gunkel, Chair of Energy Economics, TU Dresden,
Münchner Platz 3, 01069, Dresden, Germany,
david.gunkel@tu-dresden.de, Friedrich Kunz

Power generation and demand of electric power spatially diverge as a result of the proceeding energy transition. Consequently, the network has to be extended to cope with the new requirements. This paper addresses a way to solve large-scaled mixed-integer problems of network expansion planning applying benders decomposition. The results of the algorithm are exemplarily shown in a grid model.

4 - Valuation of Pumped Hydro Storages with respect to the Electricity Spot and Reserve Power Markets

Oliver Woll, Universitaet Duisburg-Essen, Universitaetsstraße
12, 45117, Essen, Germany, oliver.woll@uni-due.de, Bastian
Felix, Christoph Weber

To cope with increasing fluctuating renewable infeed, new pump storage capacity needs to be installed to guarantee the stability of the power grid. Whereas recent scientific publications focus on the electricity spot market for the valuation of pump storages, we propose an approach which combines the spot- with a reserve market optimization. We derive the optimal operating strategy theoretically and solve the optimization problem by applying dynamic programming on a (numerical constructed) recombining price tree. In addition, we calculate the value of a representative pump storage.

■ TC-33

Tuesday, 12:30-14:00

CC-A37

Understanding, Modeling and Implementation of OR for Sustainable Development

Stream: OR for Development and Developing Countries

Invited session

Chair: Alexander Makarenko, Institute for Applied System Analysis, National Technical University of Ukraine "KPI",
Prospect Pobedy 37, 03056, Kiev, Ukraine, makalex@i.com.ua

1 - Foreign Direct Investment Trends and Comparative Analysis for Chosen Transition Countries

Snjezana Pivac, Faculty of Economics, University of Split,
Department of Quantitative Methods in Economics, Matice
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Foreign direct investments (FDI) have high positive impact on economic impetus especially in transition countries. So in the focus of this paper are the structure and forms of FDI and their influence on crucial macroeconomic variables. In the FDI inflow analysis the country risk rating estimation has been essential. FDI efficiency analysis is enriched with correlation between Incremental Capital Output Ratio (ICOR) and GDP increase. Multivariate classification of ten transition countries has been carried out according to all regarding indicators.

2 - Panel data analysis of institutional variables in attracting foreign direct investment in countries of central and south-eastern Europe

Elza Jurun, Faculty of Economics, University of Split,
Department of Quantitative Methods in Economics, Matice
hrvatske 31, 21000, Split, Croatia, elza@efst.hr, Mario
Pecaric, Tino Kusanovic

The aim of the paper is to find out the relevance of institutional factors vis-à-vis traditional variables indicating macroeconomic stability in attracting foreign direct investment as a means of further economic restructuring and international competitiveness improvement. The Arellano-Bond dynamic panel based on multivariate factor analysis of related variables has been carried out for 11 countries from Central and South-Eastern Europe. The results show that after macroeconomic stability is realised institutional reform dynamism gains on the importance

3 - General Sustainable Development Problems and OR

Alexander Makarenko, Institute for Applied System Analysis,
National Technical University of Ukraine "KPI", Prospect
Pobedy 37, 03056, Kiev, Ukraine, makalex@i.com.ua

The sustainable development (SD) concept is one of general recent problems. Many definitions of SD exist: the definition by Brundtland is most recognized and usable, but this definition is verbal. So for computer modeling or quantitative decision—making on SD, further development and formalization of the concept are necessary. So we propose the new formal definition of sustainable development. Also we describe the role which strong anticipation plays in sustainable development. Finally the new prospects for proposed ideas on SD are described, including OR and education problems.

4 - A two-stage approach for distribution network design problem in cosmetic & cleaning industry

Rifat Gürçan Özdemir, Industrial Engineering Department, Istanbul Kültür University, Atakoy Campus, Atakoy-Bakirkoy, 34156, Istanbul, Turkey, rg.ozdemir@iku.edu.tr, *Zeki Ayağ, Ufuk Kula*

The paper proposes a two-stage approach which combines a linear mathematical model and a simulation model to solve the problem of distribution network design in one of the leading cosmetic and cleaning companies. The mathematical model determines number of warehouses, amount of material flows and selects third party logistic companies based on their vehicle fleet size and types of vehicles inside the fleet. The simulation model involving uncertain nature of delivery is used to modify parameters of the mathematical model according to the performance of network system based on service time.

■ TC-34

Tuesday, 12:30-14:00

CC-A39

Optimization for Sustainable Development 2

Stream: Optimization for Sustainable Development
Invited session

Chair: *Herman Mawengkang*, Mathematics, The University of Sumatera Utara, FMIPA USU, KAMPUS USU, 20155, Medan, Indonesia, mawengkang@usu.ac.id

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Multi objective stochastic programming model for waste management in crude palm oil industry

Meslin Silalahi, Mathematics, University of Sisingamangaraja-Tapanuli/Grad School of Mathematics USU, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, meslin_silalahi@yahoo.com, *Hendaru Sadyadharma, Herman Mawengkang*

The crude palm oil process does not need any chemicals as a processing aid. However, there are a number of environmental problems, such as high water consumption, the generation of a large amount of wastewater with a high organic content, and the generation of a large quantity of solid wastes and air pollution. We include constraints involving random parameters of waste, which are required to be satisfied with a pre-specified probability threshold. In this paper we propose a multi-objective stochastic optimization model for tackling such environmental risk production planning problem.

2 - Optimization approach for measuring the ecological suitability of product packaging

Zoran Rakicevic, Faculty of Organizational Sciences, University of Belgrade, Jove Ilica 154, 11000, Belgrade, Serbia, zoran.rakicevic@gmail.com, *Jovana Kojic*

Limitation of available resources in the world and the general need of reducing operating costs create a need to review the entire process of creating each element of the product, such as product packaging. This paper presents a new and different approach to the analysis of the ecological suitability of product packaging, using an optimization model that is focused on its dimensions. General method is further applied to some of the most commonly used consumer products. The study shows that suboptimal packaging leads to higher material consumption and increase of prices of the final products.

3 - Modeling the spread of infectious disease based on dynamic social network

Firmansyah Firmansyah, Mathematics, University Muslim Nusantara, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, fnasution94@yahoo.com, *Herman Mawengkang*

The dynamic of human contact can be considered as a potential point for predicting the spread of infectious disease. In this paper we consider the SIRS model. We include the dynamic of human social interaction and social distance in the model such that it would be possible to control the spread of the disease.

4 - Decomposition-based optimization of a large-scale mesh-structured drinking water supply network

Derek Verleye, Industrial Management, Ghent University, Technologiepark 903, 9052, Zwijnaarde, Belgium, derek.verleye@ugent.be, *El-Houssaine Aghezzaf*

Optimization of production and distribution of drinking water in large networks leads to significant economic savings. However, the resulting optimization model belongs to the class of mixed integer nonlinear problems (MINLP). In addition to this inherent theoretical complexity some hydraulic restrictions are nonconvex. In this presentation we discuss some possible decomposition approaches to solve practical instances of this challenging optimization problem. These instances are generated from an existing drinking water network in Flanders, Belgium.

■ TC-35

Tuesday, 12:30-14:00

CC-A41

Innovation in Logistics

Stream: OR and Real Implementations
Invited session

Chair: *Belarmino Adenso-Diaz*, Engineering School at Gijon, Universidad de Oviedo, Campus de Viesques, 33204, Gijon, Spain, adenso@epsig.uniovi.es

Chair: *Ben Lev*, Decision Sciences, Drexel University, LeBow College of Business, 101 N. 33rd st., 19104, Philadelphia, Pa, United States, blev@drexel.edu

1 - Company-wide Production Planning Using a Multiple Technology DEA approach

Sebastián Lozano, Dept. of Industrial Management, University of Seville, Escuela Superior de Ingenieros, Camino de los Descubrimientos, s/n, 41092, Seville, Spain, slozano@us.es

The proposed centralized-DEA approach aims at minimizing the input costs incurred to attain specified total, company-wide output levels. Specific features of the proposed approach are the consideration of multiple technologies, lower and upper bounds on the production levels of each plant and the possibility of shutting down a plant, if necessary. The consideration of multiple technologies, in particular, takes into account the existence of heterogeneity within the company's facilities. In that scenario, grouping all plants within a single technology gives misleading results.

2 - Bicriteria model for designing a container depots logistic network

Belarmino Adenso-Diaz, Engineering School at Gijon, Universidad de Oviedo, Campus de Viesques, 33204, Gijon, Spain, adenso@epsig.uniovi.es, *Antonio Palacio, Salvador Furió, Sebastián Lozano*

The container is a basic tool for all maritime logistic operations. Once unloaded by the importers, containers must be stored in the terminal port or in a depot, waiting for an exporter needing them. The location of these container depots has an impact on the logistic costs, as well as in the environment of the area, given the heavy traffic load inherent to these operations. In this research we propose a bicriteria model for designing the depots network in a hinterland. Results are applied to the case of the Port of Valencia.

3 - A mathematical model to design an inland network of intermodal terminals

Carlos Andres, Management Department, Polytechnic University of Valencia, Camino de Vera S/N, 46022, Valencia, Spain, candres@omp.upv.es, *Salvador Furió, Julien Maheut*

This paper shows how a mathematical model based on the typical hub location problem has been used to develop a first analysis for the design of a network of intermodal inland terminals giving support to main Spanish container seaports and their traffics. The main objective of the model is to reduce total transport costs through the optimal location of a set of inland terminals connected to seaports by railway. The problem has been successfully solved using Gusek software, allowing an interesting analysis about inland terminals location and their influence area.

■ TC-36

Tuesday, 12:30-14:00

CC-A43

QMPD Session1

Stream: Quantitative Models for Performance and Dependability

Invited session

Chair: *Markus Siegle*, Computer Science, Universitaet der Bundeswehr Muenchen, Universitaet der Bundeswehr Muenchen, 85577, Neubiberg, Germany, markus.siegle@unibw.de

1 - Memory-efficient bounding algorithm for the two-terminal reliability problem

Minh Lê, I10, TU Munich, Boltzmannstraße 3, 85748, Garching b. München, Bayern, Germany, minh@freenet.de

Determining the two-terminal reliability of arbitrary redundancy systems modeled as combinatorial graphs is known to be NP-hard. Thus, bounding algorithms are used to cope with large graph sizes. Still, they have huge demands on memory. We propose a memory-efficient implementation of an extension of the Gobien-Dotson bounding algorithm. Without reducing runtime, the compression of relevant data structures allows to use low-bandwidth high-capacity storage. This way, available hard disk space becomes the limiting factor. We can handle graphs with sizes reaching around 100 components.

2 - An enhanced two-phase MAP fitting method

András Mészáros, Department of Telecommunications, Budapest University of Technology and Economics, Magyar Tudósok Körútja 2., 1117, Budapest, Hungary, meszarosa@hit.bme.hu, *Miklós Telek*

Markov arrival processes (MAPs) are used extensively in traffic modeling. A wide variety of fitting procedures have been developed. Most of these are computationally demanding or not general enough. To resolve this problem, two-step procedures of a specific type have been made, which fit a phase-type distribution (PH) to static parameters in the first step, and extend it to a MAP in the second while fitting dynamic parameters. We present a method that aims at providing a good starting point for the second step by optimizing the representation of the PH that was produced by the first step.

3 - Time-parallel simulation for stochastic automata networks

Jean-Michel Fourné, PRiSM, UVSQ, Université de Versailles, 45 avenue des États Unis, 78000, Versailles, France, jmf@prism.uvsq.fr, *Franck Quessette*, *Thu Ha Dao Thi*

Time Parallel Simulation (TPS) is the construction of the time-slices of a sample-path on a set of parallel processors (see Fujimoto2000, chap. 6 and references therein). TPS has a potential to massive parallelism as the number of logical processes is only limited by the number of times intervals which is a direct consequence of the time granularity and the simulation length. Stochastic Automata Networks allow the construction of extremely large Markov chains. Here we show how we can use TPS to solve efficiently some SAN models. The approach is based on some notions of monotone models.

4 - M/G/c/c state dependent travel time models and properties

J. MacGregor Smith, Mechanical and Industrial Eng. Dep., University of Massachusetts at Amherst, 114 Marston Hall, University of Massachusetts, 1003, Amherst, MA, United States, jmsmith@ecs.umass.edu, *F. R. B. Cruz*

We show that state dependent M/G/c/c queuing models provide a quantitative foundation for three-phase traffic flow theory. An important property shown with the M/G/c/c model is that the travel time function is not convex, but S-shaped (i.e. logistics curve). Extensive analytical and simulation experiments are shown to verify the S-shaped nature of the travel time function and the use of the M/G/c/c model's method of estimation of travel time over vehicular traffic links as compared with traditional approaches.

■ TC-37

Tuesday, 12:30-14:00

CC-Act

OR in Health & Life Sciences 3

Stream: OR in Health & Life Sciences (contributed)

Contributed session

Chair: *Yw Chen*, DYU, Taiwan, pauldyu57@gmail.com

1 - Planning in a regional blood distribution network

Jose Luis Andrade, Industrial Management, School of Engineering, University of Seville, Camino de los Descubrimientos s/n, 41092, Seville, Spain, jlandrade@esi.us.es, *Pedro L. Gonzalez-R*

We present an optimization model to plan the supply of blood products to hospitals in a regional blood distribution network. Blood units are fixed shelf life resources to be used for the demanded surgeries, considering urgency and blood substitution rules. The model outcomes weekly decisions on the inventory levels of blood products and the amount of units transferred from one location to another, to perform low wastage and shortage levels. Our plan offers a single strategy providing an average good performance with uncertain demands and outcomes the needed level of donation promotion.

2 - A cloud service to allocate emergent patients by affinity set

Yuh-Wen Chen, Institute of IE and MOT, Da-Yeh University, 112 Shan-Jeau Rd., Da-Tsuen., Chang-Hwa 51505, Taiwan., 51505, Chang-Hwa, Taiwan, profchen@mail.dyu.edu.tw

A large disaster always generates numerous trauma patients in a very short time. This study develops a cloud service to allocate these patients to appropriate hospitals in order to save their lives and guarantee the service level of emergency medicine. First, the web-platform of capturing vital signs of emergent patients is established. Second, a decision model of multi-attribute decision making based on affinity set is developed. Finally, the decision model is practically launched in the web-platform to aid the transport decision for allocating emergent patients to hospitals.

3 - A business model for synchronized and patient-centered Tele-health service

Jiun-Yu Yu, Business Administration, National Taiwan University, No. 85, Sec. 4, Roosevelt Road., 106, Taipei, Taiwan, jyyu@ntu.edu.tw, *Kwei-Long Huang*

Tele-health is a promising solution to take care of patients with cardiovascular disease. In this study, an integrated approach is applied to construct a self-sustainable business model for a newly established Tele-Health Center (THC) to dynamically measure and continuously improve its performance. With process analysis, VISOR framework, and balanced scorecard, a business model in the form of key performance indicator (KPI) matrix is constructed. The causal structure of KPIs is investigated so that the growth-stimulating loops are identified, helping THC prioritize its tasks to move forward.

■ TC-38

Tuesday, 12:30-14:00

HH-Colombus

Theory of Set-valued Optimization and Applications

Stream: Multiobjective Optimization

Invited session

Chair: *Tamaki Tanaka*, Mathematics, Niigata University, Ikarashi 2, 8050, 950-2181, Niigata, Niigata, Japan, tamaki@math.sc.niigata-u.ac.jp

Chair: *Gue Myung Lee*, Department of Applied Mathematics, Pukyong National University, 599-1 Daeyeon 3-dong Nam-gu, 608-737, Busan, Korea, Republic Of, gmlee@pknu.ac.kr

1 - On Nonsmooth Optimality Theorems for Robust Multiobjective Optimization Problems

Gue Myung Lee, Department of Applied Mathematics, Pukyong National University, 599-1 Daeyeon 3-dong Nam-gu, 608-737, Busan, Korea, Republic Of, gmlee@pknu.ac.kr

In this talk, we present optimality theorems for the robust counterparts (the worst-case counterparts) of nonsmooth multiobjective optimization problems with uncertainty data, which are called robust multiobjective optimization problems. The involved functions in the problems are locally Lipschitz. Moreover, we give examples showing that the convexity of the uncertain sets and the concavity of the constraint functions are essential in the optimality theorems.

2 - On DC set optimization problems

Daishi Kuroiwa, Shimane University, Japan, kuroiwa@math.shimane-u.ac.jp

Set optimization is a minimization problem whose objective function is set-valued and criteria of solution are based on set-relations. In this presentation, we propose a notion of DC set-valued functions and we study optimization problems with an objective DC set-valued function.

3 - Unified scalarization for sets and Ekeland's variational principle for set-valued maps

Tamaki Tanaka, Mathematics, Niigata University, Ikarashi 2, 8050, 950-2181, Niigata, Niigata, Japan, tamaki@math.sc.niigata-u.ac.jp

In this paper, we introduce a certain mathematical methodology on the comparison between sets and Ekeland's variational principle for set-valued maps via several scalarizing functions. The original idea on the sublinear scalarization for vectors was dealt by Krasnosel'skij in 1962 and by Rubinov in 1977, and then it was applied to vector optimization with its concrete definition by Tammer (Gerstewitz) in 1983. Recently, Kuwano, Tanaka, and Yamada define twelve types of unified scalarizing functions for sets based on six kinds of set-relations proposed by Kuroiwa, Tanaka, and Ha in 1997.

■ TC-39

Tuesday, 12:30-14:00

HH-Cousteau

Latest advances on MCDA software

Stream: Innovative Software Tools for MCDA

Invited session

Chair: *Bertrand Mareschal*, Solvay Brussels School of Economics and Management, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be

1 - On Multi-Criteria Clustering

Alexandru-Liviu Olteanu, CSC, University of Luxembourg, Luxembourg, alexandru.olteanu@uni.lu, *Patrick Meyer*, *Raymond Bisdrff*

A closely related type of problem in MCDA to that of sorting is clustering. As in Data Mining, in MCDA too, no unanimous definition of clustering is given. We address this by formally defining several types of clustering in a MCDA context. We base our definitions on any outranking relation from which different preferential situations can be extracted between the alternatives. We define the ideal result with respect to these definitions and develop a method to find them. We present the implementation of this approach in the diviz software and illustrate it using a well-known problem in MCDA.

2 - A new web service for the stable sorting of a set of alternatives

Thomas Veneziano, CSC, University of Luxembourg, Université du Luxembourg, FSTC, 6, rue Richard Coudenhove-Kalergi, 1359, Luxembourg, Luxembourg, thomas.veneziano@uni.lu, *Patrick Meyer*, *Raymond Bisdrff*

We present a new web service which computes the stable sorting of some alternatives into predefined categories, bounded with some given profiles, according to the principles of the outranking methods. It takes into account the notion of stability, which informs on the dependency of the outrankings to the preorder of the weights, and defines for each alternative an interval of categories on which it is affected in a stable manner: knowing the preorder of the weights only, not a precise setting, we ensure that the alternative will be sorted in one of the categories of the interval.

3 - Visual PROMETHEE - A New Multicriteria Decision Aid Software

Bertrand Mareschal, Solvay Brussels School of Economics and Management, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be

Visual PROMETHEE is the latest software implementation of the PROMETHEE and GAIA multi-criteria decision aid methods. It includes all the standard features of the methods: PROMETHEE I and II rankings, GAIA descriptive analysis, weight sensitivity analysis and data management tools. New features are introduced: visual representations of the partial and complete PROMETHEE rankings, 3-dimensional GAIA analysis, visual weight stability intervals, GAIA-web action profile display, input-output analysis, GIS (Google Maps) integration and an enhanced multi-scenarios model for GDSS capabilities.

■ TC-40

Tuesday, 12:30-14:00

HH-Livingstone

Preference Learning 2

Stream: Preference Learning

Invited session

Chair: *Krzysztof Dembczynski*, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, kdembczynski@cs.put.poznan.pl

1 - Efficient algorithms for robust ordinal regression

Tommi Tervonen, Econometric Institute, Erasmus University Rotterdam, PO Box 1738, 3033HA, Rotterdam, Netherlands, tervonen@ese.eur.nl, *Remy Spliet*

UTAGMS is an ordinal regression method that evaluates necessary and possible preference relations caused by holistic preference statements on a set of decision alternatives evaluated in terms of multiple criteria. Traditionally the relations are computed by defining appropriate LPs and using a solver. In our presentation we show that the relations' computation can be formulated differently and asymptotically faster algorithms used. We also present and evaluate an MCMC sampling technique for uniform sampling of the general value functions used in stochastic extensions of UTAGMS.

2 - Multicriteria sorting functions using valued assignment examples

Olivier Cailloux, Laboratoire Génie Industriel, École Centrale Paris, Grande Voie des Vignes, 92295, Châtenay-Malabry, France, olivier.cailloux@ecp.fr, *Brice Mayag*, *Vincent Mousseau*, *Luis C. Dias*

We propose to extend a classical elicitation technique for learning MCDA sorting functions. Such a function assigns each alternative from a set of alternatives, evaluated on multiple criteria, to a category in a set of preference ordered categories. We ask the decision maker for a set of assignment examples where each example contains several possible destination categories for an alternative, each associated with credibility. We propose procedures to deduce from this information several sorting functions, giving more or less precise results depending on the chosen credibility level.

3 - On the estimation of the parameters of Electre Tri model in multi criteria ordinal sorting problem: a proposal of new approach in two phases

Valentina Minnetti, Scienze Statistiche, Università La Sapienza, Italy, valentina.minnetti@uniroma1.it

In this paper we are interested in the Multi Criteria Sorting Problem; to solve it we use the Electre Tri method, based on the outranking relation created through the Decision Maker's preference information in terms of the Assignment Examples (AEs). This method requires the elicitation of preferential parameters (weights, thresholds, profiles, cutting level) in order to construct a preference model which best matches the AEs. We propose a new methodology in two phases, taking into account that the core of the analysis is the profiles' estimation made by linear programming problem.

4 - A ranking approach based on outranking relations using mathematical programming

Selin Ozpeynirci, Industrial Systems Engineering, Izmir University of Economics, Sakarya Cad. No156, 35330, Izmir, Turkey, selin.ozpeynirci@ieu.edu.tr, *Ozgur Ozpeynirci*, *Yigit Kazancoglu*

We consider the problem of ranking alternatives evaluated on multiple criteria, which may arise in many real life applications such as ranking countries, projects, universities and students. Several outranking methods in the literature require the explicit definition of all parameters in advance, which can be difficult for the decision maker. In this study, we develop an outranking based ranking method that uses mathematical modeling approach and requires only a subset of the parameters defined by the decision maker. A real life example is used to illustrate the method.

■ TC-41

Tuesday, 12:30-14:00

HH-Heyerdahl

AHP/ANP 6

Stream: Analytic Hierarchy Process, Analytic Network Process

Invited session

Chair: *Pekka Korhonen*, Economics and Management Science, Helsinki School of Economics, Runeberginkatu 22-24, 100, Helsinki, Finland, korhonen@hkkk.fi

1 - R&D Personnel Selection with Fuzzy Analytic Hierarchy

Erhan Berk, Defence Science, Hava Duragi Lojmanlari 4.Blok Daire:1, 06790, Ankara, Turkey, erhanberk@hotmail.com

In the 21st century where the competitive environment becomes very tough for companies in parallel with the drastic development in technology, only innovative companies became prominent. The R&D personnel in particular have played the major role in these emerging innovations. In this study a Fuzzy Analytical Hierarchy Process (AHP) method for the selection of R&D personnel has been proposed. A case study has been conducted by using the weights obtained from the Fuzzy AHP method and the results have been compared.

2 - Determining effective criteria of Customers' satisfaction in kitchen worktops by using AHP

Majid Azizi, Department of Wood and Paper, Faculty of Natural Resources, University of Tehran, Daneshkadeh St., 31585-4314, Karaj, Tehran, Iran, Islamic Republic Of, mazizi@ut.ac.ir, *Vahid Nabavi*, *Mehdi Faezipour*

Determination of effective criteria in customer satisfaction of worktops is very important for any company that produces this product. To identify effective criteria for customers' satisfaction five major groups which are selling condition and price, delivery condition, guaranty, raw material quality and technological specification were selected. These major groups have 19 sub-criteria. The priority rate of these criteria and sub-criteria was obtained by AHP. Sub-criteria of price, payment condition, top veneer quality, MDF quality and fast delivery had the highest priorities, respectively.

3 - Analysing numerically three different methods to estimate a priority vector from inconsistent pairwise comparison matrices in AHP

Attila Poesz, Corvinus University of Budapest, Fovam ter 8, 1093, Budapest, Hungary, attila.poesz@uni-corvinus.hu, *Pekka Korhonen*

In our paper we present a simulation framework in which the performance of the estimating methods used to determine priority vector could be analysed in various inconsistency levels. Furthermore, we study whether the implementation of the "Condition of Order Preservation" (COP) defined by Bana e Costa and Vasnick (2008) could provide a better solution for the decision makers. The importance of our analysis is based on the author's claim that the COP has to be satisfied by any priority methods, otherwise the method has a fundamental weakness.

■ TC-42

Tuesday, 12:30-14:00

BW-Amber

Queueing Systems I

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science

Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: *Büsra Temocin*, Middle East Technical University, 06531, Ankara, Turkey, busras@gmail.com

Chair: *Devin Sezer*, Middle East Technical University, Institute of Applied Mathematics, Eskişehir Yolu, 06531, Ankara, devin@metu.edu.tr

1 - The Availability and Separability of Unreliable Networks

Yat-wah Wan, Institute of Logistics Management, National Dong Hwa University, 1 Sec. 2, Da-Hsueh Road, Shou-Feng, 974, Hualien, Taiwan, ywan@mail.ndhu.edu.tw

Many networks of reliable stations have their steady-state distributions in product form. Similar separable results exist for networks with unreliable stations, where arrivals finding stations unavailable are blocked, and the ups and downs of stations are reversible processes independent of numbers of customers at stations. We show that the steady-state distribution of an unreliable network can still be separable when ups and downs of stations are dependent in some strong sense. We also look for general separable results for state-dependent arrivals and ups and downs of stations.

2 - Inequality of Stability in the M2/M2/1 Queue with Preemptive Priority

Hamadouche Naima, Recherche Operational, LAMOS, University of Bejaia, Algeria, Bejaia, naima_maths@yahoo.fr

This paper studies the M2/M2/1 queue with preemptive priority. We use the strong stability method to approximate the characteristics of the M2/M2/1 queue with preemptive priority by those of the M/M/1 queue. When the arrival intensity of the priority request is sufficiently small. First we give conditions of this approximation, second we give the bound of approximation, in the last, we include a numerical example and simulation results.

3 - Transient queues with correlated arrivals. Algorithmic approach

Claus Gwiggner, Information Systems, FU Berlin, Garystr. 21, 14195, Berlin, Germany, claus.gwiggner@fu-berlin.de, *Sakae Nagaoka*

We look into a queueing system where customers are pre-scheduled but arrive with a certain delay. This is an old problem with few analytical results. In particular, the arrival counting process contains serial correlation. We identify this correlation structure for some special cases. Based on this we obtain transient solutions of the queue length. As an application we derive decision rules for aircraft delay management under uncertainty.

4 - Optimal control by unreliable queueing systems with broadcasting service

Alexander Dudin, Applied Mathematics and Computer Science, Belarusian State University, 4, Independence Ave., Minsk-30, 220030, Minsk, Belarus, dudin@bsu.by, *Bin Sun*

We consider an unreliable MAP/PH/N type queueing system where each customer may be served in parallel by several available servers. We show such advantages of this service discipline in comparison to the classical service discipline as smaller average sojourn time and higher probability of the correct service. Problem of the optimal choice of the limiting number of servers, which can be involved into the service of an arbitrary customer, is numerically solved. Numerical examples illustrating effect of correlation in arrival process are presented.

In this talk we present a Stochastic Capacitated Traveling Salesmen Location Problem in which a single facility has to be located in a given area. This facility is used to serve a set of customers with unknown position by traveling salesmen. The aim is to determine the service zone that minimizes the expected cost of the traveled routes. We propose a two-stage stochastic second order cone program where scenarios are represented by different sets of customers. Optimal solutions are compared with the Capacitated Traveling Salesmen Location Problem heuristic proposed by Simchi-Levi (1991).

3 - Optimal timing and capacity choice for pumped hydropower storage

Ane Marte Heggedal, ENOVA, 7491, Trondheim, Norway, Norway, ane.marte.heggedal@enova.no, *Emily Fertig*, *Gerard Doorman*, *Jay Apt*

Pumped hydropower storage can smooth output from intermittent renewable electricity generators, facilitating their large-scale use in energy systems. Pumped storage ramps quickly enough to smooth wind power and could profit from arbitrage on the short-term price fluctuations wind power strengthens. We consider five capacity alternatives for a pumped storage facility in Norway that practices arbitrage in the German spot market. Real options theory is used to value the investment opportunity, since unlike net present value, it accounts for uncertainty and intertemporal choice.

4 - Mathematical Optimization of an Industrial-Scale Engineering System

Selis Onel, Chemical Engineering, Hacettepe University, Department of Chemical Engineering, Beytepe Campus, 06800, Beytepe, Ankara, Turkey, selisonel@gmail.com

Performance of the drying section of a paper machine is analyzed based on desired production rate while keeping drying parameters within the limits. A steady state analytical model is developed by employing material and energy balances on the system and is solved using data collected for several paper grades to determine the drying parameters most effective on energy consumption and the drying efficiency. A linear programming method is used for the optimization of the parameters minimizing the total cost for electricity, natural gas, and steam while maximizing the efficiency.

■ TC-43

Tuesday, 12:30-14:00

BW-Granite

Stochastic programming in industry II

Stream: Stochastic Programming

Invited session

Chair: *Csaba I. Fabian*, Operations Research, Eotvos Lorand University, Pazmany Peter setany 1/C, 1117, Budapest, Hungary, fabian@cs.elte.hu

Chair: *Achim Koberstein*, DS&OR Lab, University of Paderborn, 33098, Paderborn, Germany, akober@upb.de

1 - On integrating financial hedging decisions into a model for global production network design

Achim Koberstein, Business Administration, Goethe-University of Frankfurt, Grueneburgplatz 1, 60323, Frankfurt am Main, Germany, koberstein@wiwi.uni-frankfurt.de, *Elmar Lukas*, *Marc Naumann*

In this talk we present a multi-stage stochastic programming model for integrated planning of strategic production network design and financial hedging under uncertain demands and exchange rates. Financial portfolio planning decisions on two types of financial instruments, namely forward-contracts and options, are explicitly represented by multi-period decision variables and a multi-stage scenario tree. We show computational results on an illustrative case study, which indicate that the integrated model can result in better planning decisions compared to the traditional separated approach.

2 - A Stochastic Second Order Cone Model for a Stochastic Capacitated Traveling Salesmen Location Problem with Recourse

Francesca Maggioni, Dept. of Mathematics, Statistics, Computer Science and Applications, University of Bergamo, Via dei Caniana n. 2, 24127, Bergamo, Italy, Italy, francesca.maggioni@unibg.it

■ TC-44

Tuesday, 12:30-14:00

BW-Marble

Ensemble Learning and Artificial Neural Networks

Stream: Machine Learning and its Applications

Invited session

Chair: *Sureyya Ozogur-Akyuz*, Department of Mathematics and Computer Science, Bahcesehir University, Bahcesehir University, Dept of Mathematics and Computer Science, Ciragan cad.

Besiktas, 34353, Istanbul, Turkey, sureyya.akyuz@bahcesehir.edu.tr

Chair: *Terry Windeatt*, Electronic Engineering, Surrey University, Faculty of Engineering & Physical Sciences, University of Surrey, GU2 7XH, Guildford, Surrey, United Kingdom, T.Windeatt@surrey.ac.uk

1 - New Considerations on Bias-variance Decomposition in Ensemble Classifier Fusion

David Windridge, FEPS, University of Surrey, United Kingdom, d.windridge@surrey.ac.uk

Much progress has been made in the area of decision fusion though the separation of the process into its effects on the bias and variance of the ensemble. We investigate a previously unconsidered aspect of this process when feature spaces within the constituent processes are non-overlapping, drawing an analogy between the processes of classifier fusion and tomographic reconstruction. We demonstrate that standard classifier fusion introduces a morphological bias at the same time as reducing variance. By taking this into account we can substantially improve classification performance.

2 - Ensemble Pruning via DC Programming

Sureyya Ozogur-Akyuz, Department of Mathematics and Computer Science, Bahcesehir University, Bahcesehir University, Dept of Mathematics and Computer Science, Ciragan cad. Besiktas, 34353, Istanbul, Turkey, sureyya.akyuz@bahcesehir.edu.tr, *Terry Windeatt*, *Raymond Smith*

Ensemble learning is a method of combining learners, however the ensemble sizes are sometimes unnecessarily large which causes extra memory usage and decrease in effectiveness. Error Correcting Output Code (ECOC) is one of the well known ensemble techniques for multi-class classification which combines the outputs of binary base learners to predict the classes for multiclass data. We formulate ECOC for ensemble selection problem by using difference of convex functions (dc) programming and zero norm approximation to cardinality constraint. Experiments show that it outperforms the standard ECOC.

3 - Short-term forecasting of light rail passenger demand by artificial neural networks

Gökhan Sürmeli, Management Engineering, Istanbul Technical University, ITU İşletme Fakültesi Oda No: A406, Macka Kampusu-Besiktas, 34357, Istanbul, Turkey, gsurmeli@itu.edu.tr, *Dilay Çelebi*, *Demet Bayraktar*

Accurate demand information is a key factor for the scheduling of public transportation systems. In this study, ANN is applied to passenger demand forecasting problem for the light rail service in Istanbul. Due to its success of solving forecasting problems and its simple architecture, an MLP model is preferred. Daily demand data is split into four time slots and neural networks are developed for each of them. The performance of the models is compared to the best fitting ARIMA or exponential smoothing models in terms of root mean squared error and mean absolute percentage error.

4 - Optimizing the Backpropagation Algorithm for Training Artificial Neural Networks

Geraldo Miguez, COPPE / PESC, Universidade Federal do Rio de Janeiro, Brazil, R Mariz e Barros, 652/502, 20270-002, Rio de Janeiro, RJ, Brazil, geraldomiguez@yahoo.com, *Nelson Maculan*, *Adilson Elias Xavier*

This paper uses a new activation function, the Bi-Hyperbolic function, which offers a higher flexibility, and a faster evaluation time. It improves the performance of the Backpropagation algorithm acting straight at the topology of the network. Computational experiments with traditional problems of the literature show greater generalization capacity, faster convergence, higher computational speed and smaller number of neurons network architecture. The network configuration is also simplified, making this process faster and easier to be completed.

2 - Confidence-based Optimization for the Newsvendor Problem

Roberto Rossi, Business School, University of Edinburgh, 29 Buccleuch place, EH8 9JS, Edinburgh, United Kingdom, robros@gmail.com, *Steven Prestwich*, *Armagan Tarim*, *Brahim Hnich*

We consider a Newsvendor problem in which the decision maker is given a set of past demand samples. We employ confidence interval analysis in order to identify a range of candidate order quantities that, with prescribed confidence probability, includes the real optimal order quantity for the underlying stochastic demand process with known distribution and unknown parameter(s). For these order quantities, we also produce cost upper and lower bounds. We apply our approach to Binomial, Poisson, and Exponential demand. For two of these distributions we discuss the case of unobserved lost sales.

3 - Economic order quantity of an inventory control system with order backlog

Eline De Cuypere, TELIN, University Ghent, St-Pietersnieuwstraat 41, 9000, Ghent, Belgium, eline.decuypere@telin.ugent.be, *Koen De Turck*, *Dieter Fiems*

We present a mathematical model which evaluates the performance of inventory control systems with order backlog. In terms of cost, we account for holding, set-up and backlog costs. Production of units starts when the inventory level drops below the threshold value and stops when stock capacity is reached. Moreover, orders are backlogged and coupled to the completion of the units. The inventory problem is studied in a Markovian setting. Set-up times are phase-type distributed while order and product arrivals are modelled by a Markovian arrival process.

4 - Two Modified Preventive Maintenance Models in a Finite Time Span with Failure Rate Reduction

Chun-Yuan Cheng, Dept. of Industrial Engineering & Management, Chaoyang University of Technology, 168 Gifong E. Rd., Wufeng., 413, Taichung County, Taiwan, cycheng@mail.cyut.edu.tw, *Min Wang*, *Mei-Ling Liu*

For a preventive maintenance (PM) model over a finite time span, shorter PM interval can result in a better expected total maintenance cost (TC). However, the original optimal PM policies shown in literature are obtained by searching the optimal PM interval over a constrained range. We propose two modified failure-rate-reduction optimal PM policies: one is developed by releasing the constraint of the PM interval searching range; another is constructed by postponing the starting time of the PM program based on the fact that equipment is not easily fail in the early stage of its useful life.

■ TC-45

Tuesday, 12:30-14:00

BW-Water

Logistics and stochastics 2

Stream: Stochastic Modelling in Logistical Networks
Invited session

Chair: *Dieter Fiems*, Ghent University, St-Pietersnieuwstraat 41, 9000, Gent, -, Belgium, df@telin.UGent.be

Chair: *Eline De Cuypere*, TELIN, University Ghent, St-Pietersnieuwstraat 41, 9000, Ghent, Belgium, eline.decuypere@telin.ugent.be

1 - Estimating Repair Effects in Failing Systems

Ernie Love, Segal Graduate School of Business, Simon Fraser University, 500 Granville Street, Vancouver, Canada, V6C 1W6, Vancouver, British Columbia, Canada, love@sfu.ca

Abstract The purpose of this research is to estimate the repair effects a repairable system undergoes repeated failures and repairs. Data was collected on a cement kiln incurring 150 failures and 5 shutdowns for overhaul. Causes of failure were identified as operational, mechanical or electrical. The unit was restarted but with an (expected) improved failure rate by virtue of the repair. Repair improvements are modeled as a Kijima Type-II virtual age framework. Covariate data was also used to better estimate the failure/repair process.

Tuesday, 14:30-16:00

■ TD-01

Tuesday, 14:30-16:00

RB-Alfa

Tutorial Lecture: Professor Jitka Dupacova

Stream: Keynote, Tutorial and Plenary Lectures
Tutorial session

Chair: *Stein W. Wallace*, Management Science, Lancaster University Management School, LA1 4YX, Lancaster, United Kingdom, stein.w.wallace@lancaster.ac.uk

1 - Stochastic programming - a flexible tool for decision making under uncertainty

Jitka Dupacova, Probability and Math. Statistics, Charles Univ, Faculty of Math. and Physics, Sokolovska 83, CZ-18675, Prague, Czech Republic, dupacova@karlin.mff.cuni.cz

The development of stochastic programming started six decades ago when Beale (1955), Dantzig (1955), Charnes and Cooper (1959) and others observed that for many linear programs to be solved, the values of the coefficients were not available. To solve these problems, the unknown values of coefficients were mostly replaced by their observed past values. The obtained solutions were then feasible and optimal with respect to one, maybe very rare set of observed coefficients. The suggestion was to replace the deterministic view by a stochastic one and to assume that the unknown coefficients or parameters, say u , are random and that their probability distribution P is known and independent of the decision variables. A decision has to be taken before the realization of the random coefficients is known, using the knowledge of probability distribution P .

The prototype stochastic program (we focus on in the sequel) aims at the selection of the "best possible" decision x belonging to a decision space X subject to certain constraints. To build a decision model means to specify the set of feasible decisions and to define a real objective function which generates, independently of individual realizations of random factors, a preference relation on the set of feasible decisions. "Hard" constraints are usually reflected in definition of X . The outcome of the decision x which satisfies them depends on realization of random parameter u and is quantified as $f(x,u)$. For different realizations one obtains different optimal values and different optimal solutions and the question is which of these decisions should be accepted. The common way is to use the expectation $Ef(x,u)$ of the random objective function $f(x,u)$ as the overall objective function, which is then independent of realizations of random parameters and exploits solely their probability distribution P . Numerous other criteria of optimality with such property can be constructed. The risk-adjusted expected return objective function of the Markowitz model, Markowitz (1952), is a well known early example. Of course, the choice of the criterion should reflect the purpose of the solved real-life problem.

When the random factors appear also in constraints, one may require that the constraints are satisfied for all possible realizations, a request common in robust optimization. In this case, the set of feasible solution could be unnecessarily small or even empty whereas, depending on the solved problem, some violation of constraints might be tolerable. Hence, we have to specify which decisions will be accepted as feasible. Again several approaches can be utilized:

- * To use the expected values of the random constraint functions;
- * To require that the constraints are satisfied with prescribed probabilities for each constraint separately – individual probabilistic or chance constraints, the idea of Charnes and Cooper (1958), or jointly for several constraints – joint probabilistic or chance constraints;
- * To penalize constraints violations by a penalty $q(x, u)$ assigned to decision x when it violates the constraints for the realization u and to incorporate the penalty term into the final objective function.

For stochastic linear programs a special type of penalty was designed: $q(x, u)$ equals the optimal value of the second stage linear program which evaluates the effort for the cheapest possible compensation of discrepancies caused by the decision x when the realization u occurs. This approach is known as stochastic linear programming with recourse. The simplest choice of the second stage program, called now

the simple recourse problem, appeared independently in Beale (1955) and Dantzig (1955); they suggested to distinguish and penalize two types of violations only.

The significant progress in the seventies happened thanks to Prékopa (1971) who opened applications of models with joint probabilistic constraints. Another important extension, to multistage stochastic programs, has aimed at a more realistic treatment of the dynamic or sequential structure of real-life decision problems: When the information becomes known sequentially period-by-period, recourse decisions responding to the new information can be made; see e.g. Dupacová (1995) for a brief introduction.

The theoretical results for various types of stochastic programming models were influenced and supported by achievements in optimization, probability and statistics and in computer technologies. In the 1980's, a special care to software development was initiated and has resulted in the IIASA volume edited by Ermoliev and Wets (1988). Areas of further prospective applications have been delineated.

At present there are standardized types of stochastic programming models (e.g., two-stage and multistage stochastic programs with recourse, models with individual and joint probabilistic constraints, integer stochastic programs) with links to statistics and probability, to parametric and multiobjective programming, to stochastic dynamic programming and stochastic control with relevant software systems available or in progress. We refer to recent monographs and textbooks Birge and Louveaux (1997, 2011), Kall and Mayer (2005, 2011), Shapiro, Dentcheva, and Ruszczyński (2009), handbook edited by Shapiro and Ruszczyński (2003), collection edited by Infanger (2011) and to the stochastic programming bibliography by van der Vlerk (1996–2007).

The first applications appeared already in the fifties of the last century, e.g. Ferguson and Dantzig (1956), Charnes, Cooper, and Symonds (1958). They were based on simple types of stochastic programming models, such as stochastic linear programs with simple recourse and models with individual probabilistic constraints. Moreover, special assumptions about the probability distribution P were exploited.

By now, significant applications of stochastic programming have been made in many areas, such as transportation, production planning and allocation of resources, management of hydropower and water resources, energy production and transmission, optimization of technological processes, telecommunications, financial modeling and risk management.

There are many excellent recent papers on successful large-scale real-life applications of stochastic programming. We refer to collections Ziemba and Mulvey (1999) for a selection of financial problems, Wallace and Ziemba (2005) devoted to non-financial applications, to Conejo, Carrión, and Morales (2010) focused on energy markets and collection edited by Bertocchi, Consigli, and Dempster (2011) on applications in finance and energy.

Stochastic programming is an example of a field which connects various areas of optimization, probability and statistics, numerical mathematics and computer science with the broad territory of operations research. The success of applications is conditioned by a close collaboration with users and it benefits from the team work. Even if implementation of complex stochastic programming models frequently requires simplifications and/or approximations, their outcome may point at new decision strategies.

We shall focus on the modeling issues. From the modeling point of view, stochastic vehicle routing, stochastic networks and stochastic facility location problems have been mostly treated as a natural extension of the stochastic transportation problem with simple recourse, whereas individual probabilistic constraints have appeared in the context of the stochastic nutrition model and in water resources management models. The impressive early collection of case studies related to real-life applications of joint probabilistic constraints was edited by Prékopa (1978, 1985); it reflects the prevailing interest in applications to water resources problems at that time.

To apply stochastic programming means primarily to be familiar with the real-life problem in question, its purpose, constraints, and with the available level of information concerning the influential random factors. It is important to exploit the problem structure and to be aware of alternative models. One can consider different objective functions and to model the same problem using probabilistic constraints or penalizing the constraints violation or to combine both. Very often there is no convincing reason why to prefer one approach to another. The choice of model is tied to the data structure and it is frequently influenced by the decision maker's individual attitude and the software available. To use the penalty or recourse approach means to quantify the losses caused by the considered discrepancies, which may be a difficult task for the decision maker, who often prefers to assign probabilities ad hoc

and to solve a stochastic program with individual probabilistic constraints. This model, however, does not distinguish the magnitudes of constraints violations.

We shall illustrate the modeling issues and the interplay between the problem setting and the stochastic programming model building by selected examples related mainly to water resources management and planning; see e.g. Prékopa (1978, 1985), Dupacová (1979), Dupacová et al. (1991), Escudero (2000), Edirisinghe et al. (2000) and references therein.

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■ TD-02

Tuesday, 14:30-16:00

RB-Beta

Scheduling in Transport

Stream: Scheduling

Invited session

Chair: *Jose M. Framinan*, Industrial Management, School of Engineering, University of Seville, Avda. de los Descubrimientos s/n, Seville, Spain, jose@esi.us.es

1 - The problem of minimization maximum weighted lateness of orders for two railway stations/

Dmitry Arkhipov, ORSOT, Institute of Control Sciences, Pervomayskaya str., 28a - 53, 141707, Dolgoprudny, Moscow, Russian Federation, miptrafter@gmail.com, *Alexander Lazarev*

The following scheduling problem is considered. There are two railway stations with double track. In each station there exists a variety of orders. Each order is a wagon with its release date, value(weight) and due date. Wagons are delivered by train. All trains consist of the same number of wagons and overcome the distance between stations in the same amount of time. Dynamical programming algorithm constructing the optimal schedule in compliance with criterion of minimal maximum weighted lateness in $O(n^6)$ operations.

2 - Public transport system route reliability estimation using macromodelling

Irina Pticina, Transport and Telecommunication institute, Lomonosova 1, LV-1039, Riga, N/A, Latvia, Pticina.I@tsi.lv, *Irina Yatskiv*

The main purpose of this research is to investigate the possibility of estimation the Arrived Time (ATR) and Travel Time Reliability (TTR) for a single route on the macromodel of urban transport system. The experiments were conducted at the macromodel (VISUM) of Riga transport system. The actual travel trip time between stops and between route's end stops and the vehicle arrived time at the end stop were obtained as the results of the experiments. According to obtained data have been calculated ATR and TTR for the single bus route and for its each stops.

3 - Scheduling interfering jobs in a permutation flowshop

Paz Perez Gonzalez, Industrial Management, University of Seville, Camino de los descubrimientos s/n, 41092, Sevilla, Spain, pazperez@esi.us.es, *Jose M. Framinan*

Most contributions regarding scheduling interfering jobs refer to one-machine setting. This paper studies the problem of scheduling two sets of jobs on permutation flowshop with the objectives of total completion times for both sets. Since one machine case is known to be NP-hard and there are some approximate algorithms, we analyze their adaptations to the flowshop setting. The methods are compared in an extensive test bed and computational results are provided.

4 - A Variable Neighbourhood Search (VNS) algorithm for solving Read Mix Concrete Production and Delivery Scheduling Problem (RMCPDSP)

Anna M. Coves, Institute of Industrial and Control Engineering, UPC, Diagonal 647, 08028, Barcelona, Spain, anna.maria.coves@upc.edu, *M. Antonia de los Santos*

In this communication we present a VNS algorithm for solving RMCPDSP. Integration of production and delivery is critical in the case of Ready Mix Concrete, as it expires approximately an hour and a half after it is produced. We propose three rules of VNS based on coding that includes the following aspects: plant order assignment; delivery priority; and time of first delivery for each order. We then combined this VNS algorithm with an MS algorithm that we had previously designed. We have found that using the two algorithms together provides better results by running only the VNS algorithm.

■ TD-03

Tuesday, 14:30-16:00

RB-L1

Sustainable Road Transport and Vehicle Routing

Stream: Sustainable Transport Planning

Invited session

Chair: *U. Mahir Yildirim*, Industrial Engineering, Sabanci University, Sabanci University, Faculty of Engineering and Natural Sciences, Tuzla, 34956, Istanbul, Turkey, mahiryldrm@sabanciuniv.edu

1 - Minimum cost VRP with time-varying speed data and congestion charge

Richard Eglese, The Management School, Lancaster University, Department of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, R.Eglese@lancaster.ac.uk, *Liang Wen*

A heuristic algorithm is introduced for vehicle routing and scheduling problems to minimize the total travel cost, including fuel, driver and congestion charge costs. The fuel cost depends on the speed for a vehicle to travel along any road in the network and varies according to the time of travel. If a vehicle enters the congestion charge zone during the daytime, a fixed charge is applied. The approach is tested on a constructed data set and also using real traffic data for the London area. The results are also evaluated in terms of the CO₂ emissions.

2 - Analysis of optimal vehicle speed: from supersonic wave devices to GPS transceivers

Hiroyuki Kawano, Department of Systems Design and Engineering, Nanzan University, Seirei-cho 27, Seto, 4890863, Seto, Aichi, Japan, kawano@nanzan-u.ac.jp

In Hanshin Expressway Company, vehicle traffic is monitored by supersonic wave detection devices along 500 meter intervals, but it is not possible to observe accurate traffic conditions. Recently, traffic log of highway patrol vehicles equipped GPS transceivers are stored into a database system. We integrate the log data, including vehicle speed, latitude and longitude, and weather data. Based on optimal vehicle speed model, we calculate continuous complement positions of vehicles. We analyze optimal traffic volume and flows depending on different lines and time zones.

3 - A bi-objective Pollution-Routing Problem: trade-offs between fuel consumption and driving time

Emrah Demir, School of Management, University of Southampton, 67 Kitchener Road, Portswood, SO17 3SF, SOUTHAMPTON, Hampshire, United Kingdom, e.demir@soton.ac.uk, *Tolga Bektas*, *Gilbert Laporte*

This paper studies a bi-objective Pollution-Routing Problem, an extension of the Vehicle Routing Problem with Time Windows, where one objective is to minimize fuel consumption, and the other total driving time. A solution method is described where an Adaptive Large Neighborhood Search algorithm, combined with a specialized speed optimization algorithm, is used as a search engine for the application of four a posteriori methods to generate Pareto-optimal solutions to the problem. Results of extensive computational experimentation show the efficiency of the proposed approaches.

4 - Greenest paths in time-dependent transportation networks

U. Mahir Yildirim, Industrial Engineering, Sabanci University, Sabanci University, Faculty of Engineering and Natural Sciences, Tuzla, 34956, Istanbul, Turkey, mahiryldrm@sabanciuniv.edu, *Bülent Çatay*

The literature on the shortest path algorithms (SPA) on time-dependent networks is mainly focused on finding the fastest (minimum time) path. Yet the current approaches are not applicable to determine the greenest (minimum greenhouse gas emitting/fuel consuming) path on a real transportation network. We discuss new approaches to find the greenest path given the speed profile of the network and an appropriate emission function of speed. Computational test using random data show the potential savings and sustainability benefits of the new approaches over the existing time-dependent SPA.

■ TD-04

Tuesday, 14:30-16:00

RB-L2

Routing problems

Stream: Combinatorial Optimization

Invited session

Chair: *Eleni Hadjiconstantinou*, Business School, Imperial College London, South Kensington Campus, SW7 2AZ, London, United Kingdom, e.hconstantinou@imperial.ac.uk
Chair: *Vladimir Ejov*, School of Computer Science, Engineering and Mathematics, Flinders University, Sturt Road, 5042, Bedford Park, SA, Australia, vladimir.ejov@flinders.edu.au

1 - An Adaptive Memetic Algorithm using Large Neighbourhood Search for the Multi-Depot Pickup and Delivery Problem

Pairoj Chaichiritikul, Business School, Imperial College London, 18, Elvaston Place, SW7 5QF, London, United Kingdom, pairoj.chaichiritikul06@imperial.ac.uk, *Eleni Hadjiconstantinou*

The objective of this NP-hard problem is to minimise the routing cost of the fleet of vehicles serving transportation requests in a large geographical coverage, subject to customer requirements. We propose a new heuristic approach that involves hybridisation between Adaptive Large Neighbourhood Search (ALNS) and Adaptive Memetic Algorithm (AMA). The proposed heuristic is computationally tested on standard benchmark instances from the literature. The preliminary computational results are promising; the proposed heuristic is capable of obtaining improved feasible solutions for some instances.

2 - The capacitated minimum spanning tree problem with time windows

Manolis Kritikos, Department of Management Science and Technology, Athens University of Economics and Business, 76, Patission street, 10434, Athens, Athens, Greece, kmn@aub.gr, *George Ioannou*

We address the Capacitated Minimum Spanning Tree Problem with Time Windows (CMSTPTW). The CMSTPTW is an extension of the Capacitated Minimum Spanning Tree Problem (CMSTP). In the CMSTPTW, it is required to form the capacitated minimum-cost tree network such that the time windows constraints on the demand nodes are satisfied. For the solution of the CMSTPTW, we propose a greedy method. Our proposed method outperforms the greedy approach of Solomon for MSTPTW. This is an indication of the quality of our greedy method for the CMSTPTW.

3 - "Snakes and Ladders" heuristic algorithm (SLH) for the Hamiltonian cycles problem.

Vladimir Ejov, School of Computer Science, Engineering and Mathematics, Flinders University, Sturt Road, 5042, Bedford Park, SA, Australia, vladimir.ejov@flinders.edu.au, *Serguei Rossomakhine*

We place the vertices of an undirected graph in some order on a circle. Arcs between adjacent vertices on the circle are called snakes, while other arcs represented by chords are called ladders. The SLH algorithm uses operations inspired by the Lin—Kernighan heuristic to reorder the vertices on the circle so as to transform some ladders into snakes. The use of a suitable stopping criterion ensures that the heuristic terminates in polynomial time. We have observed that SLH is successful even in cases where such cycles are extremely rare. Online demonstration will accompany the presentation.

■ TD-05

Tuesday, 14:30-16:00

RB-L3

Problems on graphs III

Stream: Discrete Optimization, Geometry & Graphs (contributed)

Contributed session

Chair: *Peter Recht*, OR und Wirtschaftsinformatik, TU Dortmund, Vogelpothsweg 87, 44227, Dortmund, Germany, peter.recht@tu-dortmund.de

1 - A Coloring Algorithm for Triangle-Free Graphs

Mohammad Jamall, Mathematics and Statistics, Zayed University, UAE, United Arab Emirates, dr.mohammad.shoai.jamall@gmail.com

We give a randomized algorithm that properly colors the vertices of a graph G on n vertices with girth greater than 3 using $O(D / \log D)$ colors, where D is the maximum degree of G . The algorithm succeeds with high probability, provided D is large enough. The number of colors is best possible up to a constant factor for triangle-free graphs. The existence of such a proper coloring was established by Kim and Johansson respectively.

A complete version of our paper can be found at arXiv:1101.5721.

2 - An Efficient Algorithm for Stopping on a Sink in a Directed Acyclic Graph

Grzegorz Kubicki, Mathematics, University of Louisville, Natural Sciences 227, 40292, Louisville, Kentucky, United States, gkubicki@louisville.edu, *Wayne Goddard*, *Ewa Kubicka*

We consider an unordered version of the classical secretary problem. Vertices of an unknown directed acyclic graph of order n are revealed one by one in some random permutation. At each point, we know the subgraph induced by the revealed vertices. Our goal is to stop on a sink, a vertex with no out-neighbors. We show that this can be achieved with probability inversely proportional to the square root of n . This is best possible because the optimal stopping time on a sink in a directed path has the probability of success of that order of magnitude.

3 - On the Cubic Dimension of certain Classes of Balanced Binary Trees into Hypercube

Kamal Kabyl, Laboratory of Modeling and Optimization of Systems LAMOS, Commercial Sciences Department, University of Bejaia, Algeria, 06000, Bejaia, Algeria, k_kabyle2000@yahoo.fr, *Abdelhafid Berrachedi*

The problem of embedding trees into the hypercube is much studied in graph theory. In fact many efforts have been devoted to find sufficient conditions for which a tree T is a subgraph of the hypercube. In this paper, we introduce some new classes of balanced binary trees by giving their cubical dimensions. Furthermore, these classes of trees satisfy the conjecture of Havel [1984], which states that every balanced binary tree with 2 to the power of n vertices can be embedded in an n -dimensional hypercube.

4 - A "min-max-theorem" for the cycle packing problem in Euler graphs

Peter Recht, OR und Wirtschaftsinformatik, TU Dortmund, Vogelpothsweg 87, 44227, Dortmund, Germany, peter.recht@tu-dortmund.de, *Eva-Maria Sprengel*

We look for a set of edge-disjoint cycles of maximum cardinality in a graph $G=(V,E)$. The problem is tackled by considering local traces $T(v)$ of G . Local Traces are not uniquely defined but their packing numbers are. We prove that if G is Eulerian every maximum edge-disjoint cycle packing of G induces maximum local traces $T(v)$ or every v in V . In the opposite, if the total size of the local traces is minimal then the packing number of G must be maximum. The determination of such traces leads to multi-commodity flow-problem with quadratic objective function.

■ TD-06

Tuesday, 14:30-16:00

RB-Gamma

Relaxation Adaptive Memory Programming

Stream: Metaheuristics

Invited session

Chair: *Dorabela Gamboa*, CIICESI-GE CAD, ESTGF, Instituto Politécnico do Porto, Casa do Curral, Rua do Curral, Apt. 205, 4610-156, Felgueiras, Portugal, dgamboa@estgf.ipp.pt

1 - A RAMP Algorithm for Generalized Assignments

Cesar Rego, University of Mississippi, University, 38677, Oxford, MS, United States, crego@bus.olemiss.edu, *Lutfu Sagbansua*

We introduce a primal-dual RAMP algorithm for the solution of the multi-resource generalized assignment problems. The algorithm combines cross-parametric relaxation with the scatter search evolutionary procedure as a way to create compound memory structures that effectively integrate information from the primal and dual solution spaces. We present extensive computation results that clearly support the merit of the proposed algorithm when compared with the best alternative approaches.

2 - RAMP for the Capacitated Facility Location Problem

Telmo Matos, CIICESI, ESTGF, Instituto Politécnico do Porto, Casa do Curral, Rua do Curral, Apt. 205, 4610-156, Felgueiras, Portugal, 8090467@estgf.ipp.pt, *Dorabela Gamboa*, *Cesar Rego*

We present a relaxation adaptive memory programming (RAMP) approach for the capacitated facility location problem (CFLP). The algorithm uses dual ascent with tabu search to explore primal-dual relationships in a RAMP framework. A comparative analysis with the best performing algorithms of the literature is presented and discussed.

3 - A PD-RAMP Algorithm for the UFLP

Dorabela Gamboa, CIICESI-GE CAD, ESTGF, Instituto Politécnico do Porto, Casa do Curral, Rua do Curral, Apt. 205, 4610-156, Felgueiras, Portugal, dgamboa@estgf.ipp.pt, *Telmo Matos*, *Fábio Maia*, *Cesar Rego*

We address the well-studied uncapacitated facility location problem (UFLP) aimed at determining the set of possible locations where facilities should be established in order to serve a set of customers with minimum cost. A relaxation adaptive memory programming (RAMP) approach is developed by combining dual relaxation with scatter search. The results obtained on a standard testbed show the advantages of this approach over the current state-of-the-art algorithms for the UFLP.

4 - A Parallel RAMP Algorithm for the Set Covering Problem

Tabitha James, Business Information Technology, Virginia Tech, 1007 Pamplin Hall, 24061, Blacksburg, VA, United States, tajames@vt.edu, *Cesar Rego*, *José Humberto Ablanedo Rosas*

The relaxation adaptive memory programming (RAMP) framework allows for the combination of (primal) heuristic search methods with exact solution methodologies that solve a (dual) relaxation of the original problem in order to create an algorithm that leverages both approaches for difficult combinatorial optimization problems. In this study, we propose a parallel RAMP algorithm for the solution of large scale set covering problems.

■ TD-07

Tuesday, 14:30-16:00

RB-Eta

Manufacturing Issues

Stream: Supply Chain Planning

Invited session

Chair: *Ignacio Eguia*, School of Engineering, Dpt. of

Management Science, University of Seville, Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, ies@esi.us.es

1 - Transportation scheduling in assembly lines under storage constraints: A case study of the automobile industry

Masood Fathi, Organziación Industrial, TECNUN Universidad de Navarra, School of Engineering (Tecnum), P Manuel Lardizabal 13., 20018, San Sebastian, Guipuzcoa, Spain, fathi.masood@gmail.com, María Jesús Alvarez, Victoria Rodríguez

Study attempts to introduce an integrated model for production, inventory and transportation in assembly lines under storage constraints. An integrated optimization model which is a mixed integer linear programming formulation is presented with multiple objectives such as minimizing the number of tours, inventory level. To validate the presented model, it has been tested in a real case study in Volkswagen Navarra plant, Spain. Given that different priorities for objectives defined in the discussed real case study exist, it has been tried to solve the model through a goal programming framework.

2 - Modelling machine loading problem in reconfigurable manufacturing systems

Ignacio Eguia, School of Engineering. Dpt. of Management Science, University of Seville, Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, ies@esi.us.es, Jesus Racero, Fernando Guerrero

A Reconfigurable Manufacturing System (RMS) is designed to produce a family of parts that share some similarities using modular Reconfigurable Machines. When modules are changed in a RM, different operations can be performed on the new machine configuration. This work is concerned with the loading problem in a RMS. This problem deals with the allocation of the operations and the associated modules of a set of selected parts' families among the RM, subject to the technological and capacity constraints of the RMS. A MILP model is developed with an objective function of balancing the workload.

3 - Manufacturing process flexibility and capacity expansion using Robust Optimization features in AIMMS

Ovidiu Listes, Paragon Decision Technology, Paragon Decision Technology, Schipholweg 1, 2034 LS, Haarlem, Netherlands, o.listes@aimms.com, Frédéric Babonneau, Christian Van Delft, Jean-Philippe Vial

We address the problem of manufacturing process flexibility and capacity expansion under uncertain demands using Robust Optimization. The model involves binary product-to-plant assignments and decisions for expanding capacity. Affine decision rules are used for capacity expansion and the amounts of processed products. We illustrate how AIMMS can accommodate the model formulation under uncertainty and generate the robust counterpart automatically. We also show how the intuitive modeling concepts in AIMMS allow for flexible experiments and comparison of results based on various uncertainty sets.

4 - Multi-objective synchronized planning in dynamic collaborative manufacturing networks

Şenay Sadıç, University of Porto, Porto, Portugal, shenay@gmail.com, Jorge Pinho de Sousa, José Crispim

In manufacturing networks, collaboration and information sharing may strongly contribute to the global system performance. Dynamic network planning by synchronizing operations and allocating activities is a very hard problem due to its complex nature and increasing product complexity. In this study we develop a multi-objective MILP model tackling this problem to minimize the overall operational costs of the network and provide some flexibility to the units. The main drivers of the model are cost minimization and the concept of flexibility, as a way to deal with different types of uncertainty.

■ TD-08

Tuesday, 14:30-16:00

RB-Epsilon

Graph cut algorithms in Computer Vision

Stream: Boolean and Pseudo-Boolean Optimization
Invited session

Chair: Ramin Zabih, Cornell, Computer Science, 4130 Upson Hall, 14853, Ithaca, New York, United States, rdz@cs.cornell.edu

1 - Graph Cuts for Scene Understanding

Philip Torr, computing, oxford brookes university, Department of Computing, School of Technology, Design and Environment Oxford Brookes, OX33 1HX., oxford, oxon, United Kingdom, philiptorr@brookes.ac.uk

Within this talk I will describe how graph cuts can be used as the basic optimization algorithm for scene understanding. The problem of scene understanding is a basic one in computer vision which involves recognizing and recovering the shape of objects within a still image or video.

2 - Proposal selection in higher-order graph cuts

Hiroshi Ishikawa, Department of Computer Science and Engineering, Waseda University, Okubo 3-4-1, Shinjuku, 169-8555, Tokyo, Japan, hfs@waseda.jp

Recently, optimization of higher-order MRF with more than two labels became practical using higher-order graph cuts: the combination of i) the fusion move algorithm, ii) the reduction of higher-order binary energy minimization to first-order, and iii) the roof dual algorithm. We discuss the choice of proposal labeling for fusion move to improve the efficiency of the higher-order graph cuts and present a simple technique for generating proposal labelings that speeds up the algorithm dramatically.

3 - Submodular Relaxations for Pseudo-Boolean Optimization

Fredrik Kahl, Centre for Mathematical Sciences, Lund University, 22100, Lund, Sweden, fredrik@maths.lth.se, Petter Strandmark

We show how to use submodular relaxations for solving large-scale boolean optimization problems. The maximum lower-bounding relaxation is defined and analyzed. A method for constructing such relaxations using generators of the cone of submodular functions is given, leading to a polynomial-time solution procedure via graph cuts. The approach is applied to several challenging vision problems, e.g. stereo and denoising. Experimental results confirm that our relaxations perform better than state-of-the-art, both in terms of tighter lower bounds and increased number of assigned variables.

■ TD-09

Tuesday, 14:30-16:00

RB-Zeta

EURO/ROADEF Challenge Session 1

Stream: EURO/ROADEF Challenge
Invited session

Chair: Christian Artigues, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, France, artigues@laas.fr

Chair: H. Murat Afsar, Industrial Systems, University of Technology of Troyes, 12 rue Marie Curie, BP 2060, 10010, Troyes, France, murat.afsar@utt.fr

Chair: Ender Özcan, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, exo@cs.nott.ac.uk

Chair: Emmanuel Guere, Google, 38 Avenue de l'Opera, 75002, Paris, France, guere@google.com

Chair: Eric Bourreau, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr

Chair: *Kedad-Sidhoum Safia*, LIP6 - UPMC, 4 Place Jussieu, 75005, Paris, France, safia.kedad-sidhoum@lip6.fr
 Chair: *Marc Sevaux*, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - ROADEF/EURO Challenge 2012 : Machine Reassignment

Eric Bourreau, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr, *H. Murat Afsar*, *Christian Artigues*, *Emmanuel Guere*, *Ender Özcan*, *Kedad-Sidhoum Safia*

We present the ROADEF/EURO 2102 challenge, an international optimization contest propose jointly by EURO, the French OR society (ROADEF) and an industrial partner (GOOGLE). The subject is to improve the usage of a set of machines. A machine has several resources as for example RAM and CPU, and runs processes. You can move it from one machine to another. More than 80 teams from 33 different countries were initially registered. 30 teams are still competing for the final round and will present their work during all the dedicated Stream. Results will be announced during the last session.

2 - Attacking Google's machine reassignment problem using mathematical programming, metaheuristics and heuristics.

Christos Gogos, Finance and Auditing, Technological Educational Institute of Epirus, Psathaki, Nea Ktiria TEI, 48100, Preveza, – Please select one –, Greece, chgogos@gmail.com, *Christos Valouxis*, *Panayiotis Alefragis*, *Efthymios Housos*

Machine Reassignment is the problem of finding the best possible assignment of processes to machines. Each process move incurs cost that has to be won back by better assignments of processes to machines. Through the use of mathematical programming and metaheuristics our approach reaches good results. It consists of an Integer Programming Module (IPM) and a Metaheuristic Module (MM). The IPM is capable of solving partitions of the problem involving subsets of processes and machines. The MM exploits a set of moves under the Late Acceptance metaheuristic. The two modules are activated in turn.

3 - Hybrid Method for Machine Reassignment Problem

Said Hanafi, ISTV2, LAMIH-SIADE, University of Valenciennes, Le Mont Houy, 59313, Valenciennes, France, said.hanafi@univ-valenciennes.fr, *Hideki Hashimoto*, *Koji Nonobe*, *Michel Vasquez*, *Yannick Vimont*, *Mutsunori Yagiura*

Our algorithm combines exact and heuristic approaches for solving the machine reassignment problem (ROADEF/EURO challenge 2012). We employ ILS, tabu search, relaxation and projection technique. Local search uses two neighborhoods: shift and swap neighborhood, and incorporates an automatic control mechanism of the weights in the evaluation function. Exploration of the search space avoids the trap of local optimality by using the reverse elimination method to provide an exact tabu list management (Glover 1990). This method allows our team to be qualified for the final phase with rank 5.

■ TD-10

Tuesday, 14:30-16:00

RB-Theta

Cutting and Packing 7

Stream: Cutting and Packing
Invited session

Chair: *Silvio de Araujo*, Departamento de Ciências da Computação e Estatística-DCCE, Universidade Estadual Paulista-UNESP, R. Cristovao Colombo, 2265 - Jd Nazareth, 15054-000, São José do Rio Preto, São Paulo, Brazil, saraujo@ibilce.unesp.br

1 - How to deal with alternative cutting lengths in a one-dimensional cutting stock problem

Markus Siepermann, Business Information Management, TU Dortmund, 44221, Dortmund, Germany, markus.siepermann@tu-dortmund.de, *Richard Lackes*, *Torsten Noll*

The input material of the tubes production process consists of steel bars that have to be cut into pieces before they are heated and rolled. In order to avoid waste of input material the cuts of the input material have to be optimized which is a classical one-dimensional cutting problem. A special characteristic of the tubes production is that the same output can be reached with different cutting lengths. Thus, the minimization of input material gets more difficult. This paper presents a solution how the optimization and the known algorithms have to be adapted.

2 - A pseudo-polynomial time algorithm for a subclass of the Variable-Sized BPP with Conflicts

Mohamed Maiza, Applied Mathematics Laboratory, Military Polytechnic School of Bordj El Bahri, EMP (Ex-ENITA), BP 17, Bordj El Bahri, 16111, Algiers, Algeria, m_maiza77@yahoo.fr, *Mohammed Said Radjef*, *Sais Lakhdar*

We propose a pseudo-polynomial time algorithm for the Variable Sized BPP with Conflicts in the case where the size of the items is at least equal to one third of the largest bin capacity. After assigning each three compatible items with size equal to one third of the largest bin to the same largest bin, the algorithm solves the problem as a minimum-weight matching problem in the weighted compatibility graph where nodes are the items and adjacent items are mutually compatible. The weight of a given edge is the minimum cost for packing the corresponding two items in the same or in separate bins.

3 - Multiobjective genetic algorithms to the one-dimensional cutting stock problem

Silvio de Araujo, Departamento de Ciências da Computação e Estatística-DCCE, Universidade Estadual Paulista-UNESP, R. Cristovao Colombo, 2265 - Jd Nazareth, 15054-000, São José do Rio Preto, São Paulo, Brazil, saraujo@ibilce.unesp.br, *Helenice Florentino*, *Kelly Poldi*

This paper deals with the one-dimensional integer cutting stock problem. The case in which there is just one type of object in stock available in unlimited quantity is studied. A heuristic method based on the multi objective genetic algorithms concept is proposed to solve the problem considering two conflicting objective functions: minimization of the number of objects and the number of different cutting patterns. This heuristic is empirically analyzed by solving randomly generated instances and the results are compared with other methods from the literature.

4 - Optimization of the outbound boxes dimensions of mobile phones in a factory located in the Industrial Park of Manaus in Amazon State, Northern of Brazil.

Fabricio Costa, Nokia Institute of Technology - INdT, +559232365418, +559281065960, Manaus, Amazon, Brazil, fabricio.costa@indt.org.br

The mobile phone is a device with high value added. Those products are transported by airplane, volume and weight of boxes influences the freight costs. Therefore the dimensions of outbound packages are very important to that business. We considered three different types of constraints, such as dimensions, weight of boxes and operations. The results of new dimensions were: reduction of empty spaces inside boxes and freight costs, reduction of the product damages in operation, transport and collaborate to reduce the environment impacts. This industry is located in Manaus, Amazon state, Brazil.

■ TD-11

Tuesday, 14:30-16:00

RB-Iota

Heuristic Methods for Arc Routing Problems

Stream: Arc Routing
Invited session

Chair: *Ana Catarina Nunes*, Dep. Métodos Quantitativos, ISCTE -

IUL / Centro IO, Portugal, Av. das Forças Armadas, 1649-026, Lisbon, Portugal, catarina.nunes@iscte.pt

1 - Metaheuristics for household refuse collection

Ana Catarina Nunes, Dep. Métodos Quantitativos, ISCTE - IUL / Centro IO, Portugal, Av. das Forças Armadas, 1649-026, Lisbon, Portugal, catarina.nunes@iscte.pt, Maria Cortinhal, Cândida Mourão

The household refuse collection in large urban areas may be modeled by the sectoring-arc routing problem (SARP). The SARP groups two families of problems: sectoring (or districting) problems and capacitated arc routing problems (CARP). The SARP is defined over a mixed graph. Its aim is to identify a given number of similar sectors (sub-graphs) and to build a set of collecting trips in each sector such that the total duration of the trips is minimized. Metaheuristics are presented, and computational results over a set of benchmark instances are reported.

2 - Solving a location-arc routing problem using a TS-VNS approach

Rui Borges Lopes, Dep. of Economics, Management and Industrial Engineering, CIO / University of Aveiro, Campus Universitário de Santiago, 3810-143, Aveiro, Portugal, rui.borges@ua.pt, Carlos Ferreira, Beatriz Sousa Santos

Within location-routing it is easy to consider scenarios where the demand is on the edges of a network, rather than on the nodes (referred in the literature as location-arc routing problems — LARP). Examples include locating facilities for postal delivery, garbage collection, road maintenance and street sweeping. For the LARP we present an iterative approach (TS-VNS) composed of a tabu search (TS) and a variable neighbourhood search (VNS), respectively, for the location and (arc) routing phases. Results are obtained for a set of test instances and compared with other approaches.

■ TD-12

Tuesday, 14:30-16:00

RB-Omicron

Rescheduling

Stream: Optimization in Public Transport
Invited session

Chair: Leo Kroon, Rotterdam School of Management, Erasmus University Rotterdam, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, lkroon@rsm.nl

Chair: Anita Schöbel, Institute for Numerical and Applied Mathematics, Georg-August University Göttingen, Lotzestrasse 16-18, 37083, Göttingen, Germany, schoebel@math.uni-goettingen.de

1 - Recovery from disruptions with recovery length controlled

Luis Cadarso, Matemática Aplicada y Estadística, Universidad Politécnica de Madrid, Pz. Cardenal Cisneros, 3, 28040, Madrid, Spain, luis.cadarso@upm.es, Ángel Marín, Gabor Maroti

This paper studies the disruption management problem of rapid transit rail networks. The task is to simultaneously adjust the timetable and the rolling stock schedules, also dealing with the dynamic nature of demand. The objective is to minimize passenger inconvenience, operational costs and the length of the recovery period (after which operations are back to the undisturbed schedules). We apply a discrete choice model for computing passenger demand, and we propose an integrated MIP model for timetable and rolling stock recovery. We study problem instances of the Spanish operator RENFE.

2 - Robustness in crew re-scheduling

Dennis Huisman, Econometric Institute, Erasmus University, Rotterdam, Netherlands, huisman@ese.eur.nl, Lucas Veelenturf, Daniel Potthoff, Leo Kroon, Gabor Maroti, Albert Wagelmans

We present a framework that shows how the re-scheduling problem can be solved in a robust way. This means that the new schedule is to some extent insensitive to further changes in the environment. We demonstrate our framework with a partial application in disruption management, namely the railway crew rescheduling problem. Tests on several instances of Netherlands Railways demonstrate that our approach can be useful: if the crew schedule has to be modified more than once, then the later rescheduling costs are lower.

3 - A geometric approach for rescheduling railway timetables by considering passenger transfers in the system

Francisco A. Ortega Riejos, Applied Mathematics I, University of Seville, 41012, Seville, Spain, riejos@us.es, Juan A. Mesa, Miguel Angel Pozo, Justo Puerto

This paper considers a transit line where trains circulate and stop at the stations according to a predetermined schedule which is known by the users. At any instant, passengers arrive to different stations in order to board these vehicles according to a model of distribution of passenger arrivals that is assumed deterministic. In this scenario, a service rescheduling forced by an incidence is determined in order to minimize the loss of passengers who require transfers between different line runs at the interchange stations (supported by Spanish/FEDER projects MTM2009-14243 and P09-TEP-5022).

4 - Railway crew rescheduling on ultra-short term

Pieter Fioole, PI, Netherlands Railways, stalpaertstraat 56, 3067 XS, Rotterdam, Netherlands, pieterjan.fioole@ns.nl

When extreme weather is predicted, Netherlands Railways switches to a different timetable in order to be more robust. The corresponding rolling stock and crew duties must be changed then as well, which leads to changing over 1,000 crew duties several hours before executing the plan. We will discuss the process of how this is done, as well as the OR techniques that are used to achieve this. We will also discuss the benefits of a changed timetable compared to the original one on a day with extreme weather, as well as the benefits of OR techniques for rescheduling compared to manual dispatching.

■ TD-13

Tuesday, 14:30-16:00

RB-Tau

Logistics and Manufacturing & Warehousing

Stream: Inventory Management
Invited session

Chair: Luca Bertazzi, Dept. of Quantitative Methods, University of Brescia, C.da Santa Chiara, 50, 25122, Brescia, Italy, bertazzi@eco.unibs.it

1 - Stochastic Dynamic Programming Algorithms for an Integrated Logistic System with Outsourced Transportation

Demetrio Laganà, DEIS, University of Calabria, Ponte Pietro Bucci, 41/C, 87036, Rende, Italy, dlagana@deis.unical.it, Adamo Bosco, Luca Bertazzi

We propose an exact dynamic programming and a rollout algorithm for a logistic system with one product, one supplier, a set of retailers and outsourced deliveries over a time horizon. Each retailer has an initial inventory level, a fixed storage capacity and a random demand. An order-up-to level policy is applied. An inventory cost is charged if the inventory level is positive, a penalty otherwise. The supplier has an initial inventory level and a production at each time. The problem is to minimize the expected total cost over the horizon. Experiments were carried out on benchmark instances.

2 - A modelisation for multimodal network design: application to the hinterland of a port

Arnaud Knippel, Laboratoire de Math, INSA Rouen, INSA Rouen - LMI, Avenue de l'Universit, 76801, Saint-Etienne du Rouvray, France, arnaud.knippel@insa-rouen.fr, *Sophie Michel*, *Ibrahima Diarrassouba*, *Cédric Joncour*

We are interested on the evacuation of the containers towards the hinterland of a port. The transport modes tend to evolve by developing the alternative modes with the road: river or railway. The way in which these modes must be organized put the question of the design of a multimodal network. In addition to choosing the mean of transport, one must decide where install the sites of transshipment and their dimensioning. To model the strategic problem, we propose a gadget to transform a multiple non oriented graph to a simple oriented graph. Preliminary numerical results are shown.

3 - Approximated neighborhood evaluation for complex logistics support design problems

Emanuele Manni, Department of Engineering, University of Salento, via per Monteroni, 73100, Lecce, Italy, emanuele.manni@unisalento.it, *Abdallah Alalawin*, *Gianpaolo Ghiani*, *Chefi Triki*

This paper deals with the design of the logistics support of complex systems, based on a Level of Repair Analysis (LORA). We model a multi-echelon and multi-indenture LORA variant with the simultaneous definition of the spare parts at stock and the maintenance resource management policy. The goal is to minimize the life-cycle cost, subject to constraints on the expected availability. The solution approach uses an optimization via simulation method to explore the search space efficiently through an Approximated Neighborhood Evaluation model, relying on the estimation of a number of parameters.

4 - Combinatorial optimization techniques for the design of reconfigurable machines

Olga Battaia, IE & Computer Science, Ecole des Mines de Saint Etienne, Saint Etienne, France, battaia@emse.fr, *Alexandre Dolgui*, *Nikolai Guschinsky*, *Genrikh Levin*

The problem is to design machine modules, such as working positions, turrets and spindle heads, suitable for the given production process. This problem is formulated as a combinatorial optimization problem where a known set of machining operations is partitioned into subsets which are assigned to the pieces of equipment under precedence, inclusion, exclusion constraints among operations as well as productivity and location constraints. The objective is to minimize the total equipment cost. The solution method is based on searching the shortest path in a specific graph.

2 - A Model for the Vessel Crew Scheduling Problem

Alexander Leggate, Management Science, University of Strathclyde, Graham Hills Building, 40 George Street, G1 1QE, Glasgow, United Kingdom, alexander.leggate@strath.ac.uk, *Tibor Illés*, *Robert Van der Meer*, *Kerem Akartunali*

Crew scheduling problems have been widely studied in various transportation sectors — airlines, railways, urban buses, etc. However to date there appear to be no applications of these problems in a maritime setting. Here, we explore key differences between the maritime problem and problems in other transport settings, and present formulations for both the crew scheduling and re-scheduling problems for a company operating a fleet of vessels on a global scale. Computational results are given, along with proposals for implementing this model as a tool within the company's scheduling process.

3 - Heuristic Solution Approaches for Check-in Counters' Workforce Scheduling with Heterogeneous Skills

Emilio Zamorano de Acha, Chair of Production Management, University of Mannheim, Schloss SO 230, University of Mannheim, 68161, Mannheim, Baden-Württemberg, Germany, ezamoran@mail.uni-mannheim.de, *Raik Stolletz*

Ground-handling agencies deal with the allocation of check-in counters' employees to shifts and day-offs in order to meet airlines' demand. Since airlines use different computer systems they schedule differently qualified agents for the check-in process, thus ground-handlers need to assign multiskilled staff. To this problem we propose a MILP model and develop several heuristic solution approaches. Using real-world demand scenarios from a ground-handler at a German airport, we analyze the influence of different qualification sets among employees in the workforce scheduling process.

4 - Scheduling Preventive Maintenances for Semiconductor Manufacturing Using CP

Jan Lange, TU Dresden, Germany, Lange@avt.et.tu-dresden.de

Scheduling preventive maintenance tasks is complex when also regarding human resource limits and effects to the manufacturing process. In this research a CP-based model for advanced maintenance scheduling is presented. Besides machines it comprises partly ordered maintenances which are restricted to individual time frames and are performed by several engineers having specific qualifications and availabilities. The objectives are the balancing of engineer activities, maintenance minimization and best fit to the expected WIP. The proposed approach is examined based on real manufacturing data.

■ TD-14

Tuesday, 14:30-16:00

RB-Omega

Workforce Scheduling I

Stream: Timetabling and Rostering
Invited session

Chair: *Jan Lange*, TU Dresden, Germany, Lange@avt.et.tu-dresden.de

1 - Ants for the Integrated Vehicle and Crew Scheduling Problem

David Pash, University of Primorska, PINT, 6000, Koper, Slovenia, david.pas@upr.si, *Andrej Brodnik*

We present an ACO (ant colony optimization) based meta-heuristic for the integrated vehicle and crew scheduling problem. The qualities of the produced solutions are compared to the optimal solutions of an IP based approach. We show on real-world instances that the meta-heuristic finds solutions of better quality than the sequential IP approach. Moreover, our meta-heuristic method can be applied to the integrated vehicle-crew scheduling and rostering problem.

■ TD-15

Tuesday, 14:30-16:00

RB-2101

Vector and Set-Valued Optimization II

Stream: Vector and Set-Valued Optimization
Invited session

Chair: *Vicente Novo*, Matematica Aplicada, Universidad Nacional de Educacion a Distancia, Juan del Rosal no. 12, 28040, Madrid, Spain, vnovo@ind.uned.es

Chair: *Enrico Miglierina*, Dipartimento di Discipline Matematiche, Finanza Matematica ed Econometria, Università Cattolica del Sacro Cuore, via Necchi 9, 20123, Milano, Italy, enrico.miglierina@unicatt.it

1 - Lower and upper Ginchev derivatives of vector functions and their applications to multiobjective optimization

Marcin Studniarski, Faculty of Mathematics and Computer Science, University of Lodz, ul. S. Banacha 22, 90-238, Lodz, Poland, marstud@math.uni.lodz.pl, *El-Desouky Rahmo*

Based on the definitions of lower and upper limits of vector functions introduced in our earlier paper, we extend the lower and upper Ginchev directional derivatives to functions with values in finite-dimensional spaces where partial order is introduced by a polyhedral cone. This allows us to obtain some new higher-order optimality conditions for a cone-constrained multiobjective optimization problem.

2 - Saddle point results for approximate proper efficiency in vector optimization problems

Lidia Huerga, Applied Mathematics, UNED, C/Juan del Rosal, 12, 28040, Madrid, Spain, lhuerga@bec.uned.es, *César Gutiérrez*, *Vicente Novo*

We consider a constrained vector optimization problem on a locally convex Hausdorff topological linear space with generalized cone convexity assumptions. We introduce a new concept of approximate proper saddle point based on a new set-valued Lagrangian function and we give necessary and sufficient conditions for a type of approximate Benson proper efficiency through approximate proper saddle point results, where the complementary slack condition is bounded.

3 - Global optimization in R^n with box constraints and applications

Miguel Delgado Pineda, Matemáticas Fundamentales, UNED, Edificio de Ciencias. UNED, C/ Senda del Rey, 9, 28040, Madrid, Spain, miguel@mat.uned.es

An algorithm is presented for global optimization of nonconvex nonsmooth multiobjective optimization programs, $\min f_s(x)$ with box constraints and all functions f_s are Lipschitz. A Maple code is attached for this monotonic set contraction algorithm. It converges onto the entire exact Pareto set and yields its approximation with given precision. Approximations for the ideal point and for the function values over Pareto set are obtained. The code does not create ill-conditioned situations and it is ready for engineering and economic applications. Results of examples are presented, with graphs.

4 - A notion of condition number in multiobjective optimization

Enrico Miglierina, Dipartimento di Discipline Matematiche, Finanza Matematica ed Econometria, Università Cattolica del Sacro Cuore, via Necchi 9, 20123, Milano, Italy, enrico.miglierina@unicatt.it, *Monica Bianchi*, *Elena Molho*, *Rita Pini*

We introduce a condition numbers for a multiobjective optimization problem. Since, in multiobjective optimization, the solution set almost always is not a singleton, we develop an approach where the solution set is considered as a whole. A pseudodistance between function is defined such that the condition number provides an upper bound on how far from a well-conditioned function a perturbed function can be chosen in order that it is well-conditioned also. An extension of classical Eckart-Young distance theorem is proved, even if taking in account only a special class of perturbations.

This paper is an exercise in computational economics, applied to a stochastic game model of climate policy. We aim to demonstrate the numerical implementation of an approximate dynamic programming approach to compute Nash equilibrium solutions in a climate model with two groups of non-cooperating nations, via piecewise deterministic differential games. We characterize equilibrium strategies through the solution of a family of interconnected deterministic equivalent differential games, propose an approximation method and describe its implementation and analyze 2 case studies.

2 - Modeling Climate Negotiations as a Game Design Problem

Guillaume Jean Tarel, Ordecys, Place de l'Étrier 4, 1224, Chêne-Bougeries, Switzerland, guillaume.tarel@gmail.com, *Alain Haurie*, *Frédéric Babonneau*, *Marc Vielle*

An international emissions trading scheme is implemented and a global safety emission budget is shared according to an equity rule which favors developing or emergent countries with large populations. They have the possibility to use strategically their emission rights to maximize the economic benefit from the supply of the emission rights market. We propose a meta-model built from statistical emulation of a computable general equilibrium model. The optimal design of this game is formulated and solved. The solution is interpreted in terms of stable international agreement.

3 - Meta-modelling of coupled climate-economic dynamics

Frédéric Babonneau, EPFL-ORDECSYS, Switzerland, fbabonneau@gmail.com, *Neil Edwards*, *Phil Holden*, *Amit Kanudia*, *Maryse Labriet*

This paper applies the oracle-based method ACCPM for the coupling of the climate simulation model GENIE with the world energy model TIAM. The objective is to compute a solution that maximizes the TIAM economic utility function subject to a constraint on global warming. In this paradigm, a meta-model controls the global iteration between the models which are treated as oracles. Here we use emulations in place of the simulation models to permit direct control over the smoothness of data exchanged in the process, while accelerating the overall process (emulated models are very fast).

4 - Climate Statistics for Energy Meteorology

John Boland, School of Mathematics and Statistics, University of South Australia, Mawson Lakes Blvd., 5095, Mawson Lakes, South Australia, Australia, john.boland@unisa.edu.au

This will be a survey of the statistical tools I and my team have employed in evaluating the performance of energy systems subject to the influence of climate variables. It will include the following topics: Probabilistic forecasting of solar radiation time series at daily and hourly time scales; Estimation and forecasting of wind farm output volatility; Construction of a model for prediction of diffuse solar radiation; Interpolation of time series using Fourier Series. Keywords: Time Series, Dynamical Systems, Volatility, Diffuse Solar Radiation, Interpolation Methods

■ TD-16

Tuesday, 14:30-16:00

RB-2103

Statistical, Games and Optimization Analysis in Climate Meta-Models

Stream: Uncertainty and Perturbations in Optimization and in Environmental and Energy Modelling
Invited session

Chair: *Alain Haurie*, ORDECSYS, Place de l'étrier 4, 1224, Chêne Bougeries, Switzerland, ahaurie@gmail.com
Chair: *Frédéric Babonneau*, Ordecys and EPFL, CH-1224, Geneva, Switzerland, fbabonneau@ordecys.com

1 - Computational Analysis of a Stochastic Climate Game Model

Alain Haurie, ORDECSYS, Place de l'étrier 4, 1224, Chêne Bougeries, Switzerland, ahaurie@gmail.com, *Olivier Bahn*, *Roland Malhamé*, *Julien Thénié*

■ TD-17

Tuesday, 14:30-16:00

RB-2105

Global Optimization 1

Stream: Global Optimization
Invited session

Chair: *Herman Mawengkang*, Mathematics, The University of Sumatera Utara, FMIPA USU, KAMPUS USU, 20155, Medan, Indonesia, mawengkang@usu.ac.id

1 - On solving non-convex mixed-integer nonlinear programming problems using active constraint strategy

Hardi Tambunan, Mathematics, Quality University, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, harditambunan29@yahoo.com, *Herman Mawengkang*

The nonlinear mathematical programming problem addressed in this paper has a structure characterized by a subset of variables restricted to assume discrete values, which are linear and separable from the continuous variables. The strategy of releasing nonbasic variables from their bounds, combined with the "active constraint" method, has been developed. This strategy is used to force the appropriate non-integer basic variables to move to their neighbourhood integer points. Successful implementation of these algorithms was achieved on various test problems.

2 - Developing an integrated model for river water quality to estimate wastewater removal efficiencies

Syafari Syafari, Mathematics, University Negeri Medan, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, syafari79@yahoo.com, *Herman Mawengkang*

Rivers and streams are an important component of the natural environment, and need to be protected from all sources of pollution. Rivers, however, are increasingly under threat from different pollutants, which include conventional pollutants and hazardous substances. In this paper, dynamic integrated modelling of basic water quality and organic contaminant fate in rivers are explored. In this framework, a basic river water quality model and organic contaminant submodel were developed and then linked in order to estimate the wastewater removal efficiencies at each wastewater discharge site.

3 - Modeling the dynamic interaction of social networks

Maya Silvi Lydia, Computer Science, University of Sumatera Utara, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, lmayasilvi@yahoo.com, *Herman Mawengkang*

In terms of graph, social interactions can be modeled as networks. The characteristic of the interactions is dynamic, changing continuously over time. Most research are on static social networks. This paper proposes a mathematical model to analyze the dynamic interactions in the social networks.

4 - Comparison of Novel Optimization Algorithms on Intelligent Well Production Performance

Morteza Hassanabadi, Mathematics, Amirkabir University of Technology, 424 Hafez Ave, Tehran, Iran., 15875-441, Tehran, Iran, Islamic Republic Of, m_hassanabadi@aut.ac.ir, *Ali MirHassani*, *Mahdi Nadri Pari*, *Seyyed Mahdia Motahhari*

A main challenges of oil and gas reservoir management is production optimization. We employed 3 methods of Response Surface, Taguchi and Neural Network to model reservoir behavior. Optimization algorithms were applied over the output of the foregoing methods: Quadratic Programming, NLP as a Gradient optimization algorithm implemented in Response Surface and Taguchi methods, and Particle Swarm Optimization implemented in NN. We present results and a comparison, and we recommend on applicability of our algorithms for other type of reservoirs.

■ TD-18

Tuesday, 14:30-16:00

RB-2107

Location Analysis

Stream: Continuous Location

Invited session

Chair: *Burak Boyacı*, ENAC, EPFL, EPFL ENAC INTER LUTS, GC C2 406 (Bâtiment GC) Station 18, 1015, Lausanne, Vaud, Switzerland, burakboyaci@gmail.com

1 - Operational Research connecting Statistics and Cartography

José L. Pino, Estadística e Investigación Operativa, Universidad de Sevilla, Avenida Reina Mercedes s/n, 41012, Sevilla, Spain, jlpino@us.es, *M^a Teresa Cáceres*

Official statistics has the requirement to produce and disseminate disaggregated information that responds to the management demands of public administration and the society. Cartography is an indispensable

tool to disseminate spatial information. GIS and Statistical Software evolution has enabled the approximation of activities of the statistical and cartographical Public Bodies. In this paper the contribution of the application of Operational Research techniques (such as the location analysis) to the integration of the Institutes of Statistics and Cartography of Andalusia is shown.

2 - A parametric analysis on optimal locations for an entering firm under delivered price competition

Blas Pelegrin, Statistics and Operations Research, University of Murcia, Spain, pelegrin@um.es, *Pascual Fernandez*, *María D. García*

Facility location is a strategic decision for an entering firm which competes on delivered pricing with some pre-existing firms. In this paper, we analyze the effect on the optimal locations of the entering firm produced by variations of the marginal delivered price. For different scenarios in the transportation network of the Region of Murcia (Spain), we study how optimal locations can change with delivered price, and how the profits obtained by the entering firm and its competitors vary with delivered price. Finally, some conclusions are presented.

3 - Extended Hypercube Queuing Models for Stochastic Facility Location Problems

Burak Boyacı, ENAC, EPFL, EPFL ENAC INTER LUTS, GC C2 406 (Bâtiment GC) Station 18, 1015, Lausanne, Vaud, Switzerland, burakboyaci@gmail.com, *Nikolas Geroliminis*

In this research, we are modeling the facility location problem for systems with many servers and stochastic demand, such as emergency response and on-demand transportation systems, by using spatial queues, specifically hypercube queuing models (HQMs). We are proposing two extended HQMs and a heuristic method which uses an approach similar to dynamic programming. Briefly, the heuristic solves a sub problem for each sub region which is generated by using similarities in demand and then combines them accordingly. Preliminary analysis gives promising results for some real life instances.

■ TD-19

Tuesday, 14:30-16:00

RB-2111

Heuristics

Stream: Nonlinear Programming

Invited session

Chair: *Edite M.G.P. Fernandes*, Algoritmi R&D Centre, University of Minho, School of Engineering, Campus de Gualtar, 4710-057, Braga, Portugal, emgpf@dps.uminho.pt

1 - Using neural networks to map beam angles into intensity objective function values in IMRT optimization problems

Joana Matos Dias, FEUC / INESCC, University of Coimbra, Av. Dias da Silva, 165, 3004-512, Coimbra, Portugal, joana@fe.uc.pt, *Humberto Rocha*

In IMRT (Intensity Modulated Radiation Therapy) optimization problems radiation angles need to be found so that the prescribed radiation doses are reached. The choice of optimization algorithms is limited due to the computational time needed to evaluate a given solution. Neural networks (NN) can be used as a black box mapping from radiation angles to intensity problem objective function values. NN can be used inside several optimization algorithms, providing a fast way of estimating the objective function values, allowing a near optimal solution to be found in reasonable computational times.

2 - A study of derivative-free optimization techniques for handling the sampling aspect in automated algorithm configuration

Zhi Yuan, IRIDIA, Université libre de Bruxelles, Av. F. Roosevelt 50, CP194/6, 1050, Brussels, Belgium, zyuanyuan@ulb.ac.be, *Thomas Stützle*

Automated algorithm configuration problem (ACP) has become an emerging application of operations research, and has proved its importance. Finding a good setting for numerical parameters of an algorithm can be regarded as a stochastic continuous optimization problem. This work focuses on the sampling aspect of ACP, and advanced derivative-free optimization techniques such as BOBYQA, CMA-ES, and MADS are applied. We study their behavior on the ACP landscape, and extend them with specific techniques for handling the simulation stochasticity in the ACP.

3 - Solving Quadratic 0-1 Knapsack Problem Using an Artificial Fish Swarm Algorithm

Edite M.G.P. Fernandes, Algorithmi R&D Centre, University of Minho, School of Engineering, Campus de Gualtar, 4710-057, Braga, Portugal, emgpf@dps.uminho.pt, *Md. Abul Kalam Azad, Ana Maria A.C. Rocha*

The quadratic 0-1 knapsack problem finds a subset of items that yields maximum profit without exceeding the knapsack capacity. Some exact as well as heuristic methods have been proposed for solving this type of problem. Recently, a population-based artificial fish swarm (AFS) algorithm that simulates the behaviors of fish swarm inside water has emerged. We propose a binary version of AFS for solving quadratic 0-1 knapsack problems. To make infeasible solutions to feasible ones we use the decoding algorithm. We test the method with a benchmark set of problems available in literature.

■ TD-20

Tuesday, 14:30-16:00

RB-2113

Decision Theory and Analysis

Stream: Decision Making Modeling and Risk Assessment in the Financial Sector

Invited session

Chair: *Tina Comes*, Institute for Industrial Production (IIP), Karlsruhe Institute of Technology (KIT), Hertzstr. 16, 76187, Karlsruhe, Germany, comes@kit.edu

1 - Assessing the Impact of Stock Volatility on the Efficiency of Listed Commercial Banks: A Conditional Nonparametric Approach

Anamaria Aldea, Economic Informatics and Cybernetics, The Bucharest Academy of Economic Studies, 010374, Bucharest, Romania, anamaria_aldea@yahoo.com, *Luiza Badin, Carmen Lipara*

In this paper we employ nonparametric conditional methodology to assess the impact of external factors like stock volatility on the efficiency of commercial banks. The approach allows decomposing the impact of external factors in impact on the attainable set in the input-output space, and/or impact on the distribution of the efficiency scores. We analyze listed commercial banks from FactSet database, as their reduced activity on financial markets is usually associated with lower risk. The results provide a perspective on how listed commercial banks performed in 2009, after the crisis.

2 - Explaining Results and Uncertainties of a Robust Scenario-Based Multi-Criteria Decision Support System: Generation of Natural Language Reports

Tina Comes, Institute for Industrial Production (IIP), Karlsruhe Institute of Technology (KIT), Hertzstr. 16, 76187, Karlsruhe, Germany, comes@kit.edu, *Frank Schultmann*

In decision support systems, the purpose of generating natural language reports is explaining the results of the analysis and complementing numeric results and visualisations. Natural language reports add transparency and clearness to the evaluation. To extend these approaches for scenario-based decision support, a framework for the characterisation of uncertainties within the scenarios and the identification of the most significant uncertainties that drive the evaluation is presented. This novel approach is used to generate reports, which describe the reliability of scenarios and explain the results and of a scenario-based multi-criteria decision support system.

3 - Implausible alternatives in the elicitation of multi-attribute value functions

Rudolf Vetschera, Dept. of Business Administration, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, rudolf.vetschera@univie.ac.at, *Elisabeth Wolfsteiner, Wolfgang Weitzl*

Many elicitation methods for multiattribute value functions require holistic evaluations of hypothetical alternatives. Generation of such alternatives often ignores correlation between attributes present in real alternatives. We conducted an empirical study to test the effect of implausible alternatives on response consistency. Using a constraint-based approach, we found that respondents facing implausible alternatives are more consistent with an additive model, and with stated intra-attribute preferences. All subjects had a low level of consistency with stated inter-attribute preferences

4 - Modified BIPOLAR Method for Multi-criteria Decision Analyses under Risk

Olena Sobotka, Operations Research, Wroclaw University of Economics, Komandorska str., 118/120, 53-345, Wroclaw, Poland, osobotka@poczta.ue.wroc.pl, *Ewa Konarzewska-Gubala*

The multi-criteria decision problems with uncertainty outcomes of alternatives with known probability distributions are considered. We propose the outranking procedure for such alternatives based on the multi-criteria decision method BIPOLAR. The procedure is: 1) to define the multi-criteria preference relations on the set of all alternative's outcomes by comparing with sets of "good" and "bad" objects defined by decision maker and 2) to outrank the alternatives according to defined multi-criteria preference relations using the stochastic dominance relations.

■ TD-21

Tuesday, 14:30-16:00

RB-2115

Risk Management

Stream: Long Term Financial Decisions

Invited session

Chair: *Ulla Hofmann*, Institute for Management, University Koblenz, Universitätsstraße 1, 50670, Koblenz, Germany, uhofmann@uni-koblenz.de

1 - The general approach to the modeling of the risk management procedures and its specification for investment problems

Tatiana Zolotova, Chair of Applied mathematics, State University of the Ministry of Finance of the Russian Federation, 127006, Moscow, Nastasinski lane, house 3, case 2, Research financial institutions, 127006, Moscow, Russian Federation, tgold11@mail.ru

The work is devoted to the description of the general model of the risk management, including two submodels: the model of an estimation of system effectiveness and the model of an estimation of the risk of its functioning. The general model can be applied to decision-making in conditions of risk for various complex systems and processes. Problems of management are considered for stochastic processes at the strategic and share investment, using various estimations of risk. Methods of these problems decision in view of criteria of efficiency and risk are offered.

2 - Growth Optimal Portfolio Insurance — does it pay

Ursula Walther, FB 1, Berlin School of Economics and Law, Badensche Str. 50-51, 10825, Berlin, Germany, u.walther@frankfurt-school.de

Growth optimal portfolio insurance (GOPI) is a very promising idea because it combines the attractive features of growth optimality with curbing the high risk of such portfolios. Recent research has proposed implementation rules in discrete time. We explore the empirical potential of GOPI in comparison to classic CPPI and option based portfolio

insurance. For this purpose we perform extensive simulations with several types of underlyings (time-series based and real world). Performance is evaluated based on the entire return distribution applying a large set of risk and return figures.

3 - Analysis of Measurement Methods of the Utility Function in context of Prospect Theory

Ulla Hofmann, Institute for Management, University Koblenz, Universitätsstraße 1, 50670, Koblenz, Germany, uhofmann@uni-koblenz.de, *Thomas Burkhardt*

In the literature, we find several experimental methods to measure the value function as well as the probability weighting function of prospect theory. We compare several of those methods with regard to accuracy, practicability, and theoretical foundation. Our aim is to identify accurate and practical methods for individual PT-Utility functions, with a particular focus on the assessment of risk attitudes in investment decisions.

4 - Long-term Investment Behaviour Considering Financial Constraints — An Analysis in the Context of Information Technology

Stefan Pfosser, FIM Research Center Finance & Information Management, University of Augsburg, Universitätsstraße 12, 86159, Augsburg, Germany, stefan.pfosser@wiwi.uni-augsburg.de, *Vasko Isakovic*

In line with existing studies, this paper explains the observable investment behaviour of firms in the context of Information Technology (IT) by considering their financial constraints as well as specific aspects of IT investments. By applying a dynamic optimization model, the scarce financial resources are optimally allocated to IT investments using a cash reserve, so that their value contribution is maximized. Since we show that a financially constrained firm can achieve a higher value contribution by holding cash, we make an important contribution towards making better long term decisions.

■ TD-22

Tuesday, 14:30-16:00

RB-2117

Experimental Economics and Game Theory

Stream: Experimental Economics and Game Theory
Invited session

Chair: *Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Reputation of arbitrators in bargaining models

Vladimir Mazalov, Karelia Research Center of Russian Academy of Sciences, Institute of Applied Mathematical Research, Karelia Research Center, Pushkinskaya st. 11, 185910, Petrozavodsk, Karelia, Russian Federation, vmazalov@krc.karelia.ru, *Julia Tokareva*

We consider final-offer arbitration procedure in case where there is more than one arbitrator. Two players, 1 and 2, are interpreted as Labor and Management and in dispute about an increase in the wage rate. They submit final offers to a Jury with N arbitrators, each of them has her own assessment presented by some CDF and reputation in Jury. Then we find the assessment distributed with weighted CDF of Jury and select the offer which is closest to this assessment. The Nash equilibrium in this arbitration game is derived. We compare the optimal strategies with voting procedure solution.

2 - The effects of honesty and social preferences on reporting behavior

Ulrike Leopold-Wildburger, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at, *Arleta Mietek*

Reporting is an important issue in management accounting. In situations characterized by information asymmetry in an organization, e.g., in the situation of upper and lower management, reporting is necessary to ensure that the upper management has all the necessary information. In our experimental study we analyze the reporting behavior in different settings. We want to know how an agent's participation in the reporting process influences his/her willingness to truthful communication of private information, if there are (no) financial incentives to misrepresentation.

3 - Finding a fair cost allocation mechanism in flexible horizontal supply chains

Christine Vanovermeire, University of Antwerp, 2000, Antwerp, Belgium, christine.vanovermeire@ua.ac.be, *Kenneth Sörensen*

As companies are faced with more stringent demands of clients and environmental laws, new logistics solutions such as horizontal collaboration among shippers are emerging. The total gain of such initiative ranges from 9%-30%. Moreover, more optimization opportunities exist as companies can be more flexible towards the aspects of delivery (e.g. delivery date) in order to create a better 'fit' with their partners. However, one of the main implementation issues of such a collaboration is dividing those gains. The ability of the Shapley value to give incentives to be flexible is investigated.

■ TD-23

Tuesday, 14:30-16:00

RB-Delta

Recent Advances of Mathematical Programming in Supply Chain Management

Stream: Mathematical Programming
Invited session

Chair: *Turan Paksoy*, Industrial Engineering, Science, Selcuk University Industrial Engineering Department, Campus, 42100, Konya, Turkey, tpaksoy@yahoo.com

Chair: *Eren Ozceylan*, Industrial Engineering, Natural and Applied Sciences, Selcuk University Industrial Engineering Department, Campus, 42031, Konya, Turkey, eozceylan@selcuk.edu.tr

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - An exact algorithm for the green vehicle routing problem

Çağrı Koç, Industrial Engineering, Selcuk University, Turkey, cagrikoc@selcuk.edu.tr, *Ismail Karaoglan*, *Sevgi Erdogan*

The Green Vehicle Routing Problem (G-VRP) accounts for the additional challenges associated with operating a fleet of Alternative Fuel Vehicles (AFVs). This study offers a mixed integer programming formulation, an effective branch-and-cut algorithm and a simulated annealing algorithm for solving the G-VRP. The proposed branch-and-cut algorithm implements several valid inequalities adapted from the literature for the problem and a heuristic algorithm based on simulated annealing algorithm to obtain upper bounds.

2 - Artificial Bee Colony Algorithm for Solving Uncapacitated Facility Location Problems

Mustafa Servet Kiran, Computer Engineering, Science, 42075, Konya, Turkey, mskiran@selcuk.edu.tr, *Eren Ozceylan*, *Turan Paksoy*

Artificial bee colony (ABC) algorithm is first investigated for solving numerical optimization problems, inspired waggle dance and foraging behaviors of honey bee colonies. In this study, an adapted version of ABC is proposed to solve binary optimization problems such as uncapacitated facility location problem (UFLP). The accuracy and performance of ABC have been examined on well-known twelve small, medium and large sizes UFLPs and compared with particle swarm optimization (PSO). The experimental results show that ABC is better than PSO in terms of solution quality and robustness.

3 - Comparisons of Different Fuzzy Mathematical Programming Approaches on Supply Chain Network Design Problem

Nimet Yapici Pehlivan, Statistics, Selcuk University, Selcuk University Science Faculty, Campus Konya/TURKEY, 42075, Konya, Turkey, nimet@selcuk.edu.tr, *Eren Ozceylan*, *Turan Paksoy*

In most realistic supply chain network (SCN) design problems, environment coefficients, model parameters and objectives are frequently imprecise. Fuzzy set theory provides an appropriate framework to describe uncertainty. The aim of this paper is investigating the effects of different fuzzy mathematical programming approaches on a SCN design problem. A fuzzy mathematical model is developed for a multi-echelon SCN which has uncertainty in capacity, demand and objectives. A test problem is presented and comparison of results of different approaches is made using proposed problem.

4 - Integration of Reverse Supply Chain Optimization and Disassembly Line Balancing

Eren Ozceylan, Industrial Engineering, Natural and Applied Sciences, Selcuk University Industrial Engineering Department, Campus, 42031, Konya, Turkey, eozeceylan@selcuk.edu.tr, *Turan Paksoy*

While reverse supply chain (RSC) optimization includes recycling and disassembling activities through a supply chain; disassembly line balancing (DLB) problem involves determination a line design in which used products are disassembled. The aim of this study is to optimize and design the RSC that minimizes the transportation costs while balancing the disassembly lines in disassembly centers, which minimizes the total fixed costs of opened stations, simultaneously. A numerical example and different scenarios are conducted to illustrate the applicability of the proposed model.

■ TD-24

Tuesday, 14:30-16:00

CC-A11

Forecasting methods

Stream: Forecasting

Invited session

Chair: *Aris Syntetos*, Centre for Operational Research and Applied Statistics - Salford Business School, University of Salford, Maxwell Building, The Crescent, M5 4WT, SALFORD, United Kingdom, a.syntetos@salford.ac.uk

1 - Boot.EXPOS:Strength and sensibility

Clara Cordeiro, CEAUL, University of Algarve, Campus Gambelas,, FCT, DM, 8005-139, Faro, Portugal, ccordei@ualg.pt, *Manuela Neves*

Exponential smoothing methods are the launch platform for modelling and through bootstrap several sample paths for a time series are created. Since its beginning, Boot.EXPOS algorithm has showed promising results. For dependent data is well-know the bootstrap vocation in obtaining forecast intervals and now we also deviate this attention for point forecast proposes. We will illustrate the performance of our procedure for some well-know data sets and will emphasize its recent adaptation for forecasting time series with complex seasonal patterns.

2 - Complexity of exponential smoothing models and its influence on forecast quality in retail

Johannes Püster, University of Münster - ERCIS, Leonardo-Campus 3, 48149, Münster, NRW, Germany, johannes.puester@ercis.uni-muenster.de, *Axel Winkelmann*, *Justus Holler*, *Jörg Becker*

Retail poses several challenges on sales forecasting. The combination of broad assortment and high number of stores leads to a high amount of time series, which need to be forecasted on a daily basis at providers of fast moving consumer goods. Appropriate forecasting models need to be of good forecasting quality and of low complexity in order to allow for fast execution. This work presents a structured overview on complexity-influencing parameters of exponential smoothing models. Based on a data set of 250 retail time series the influence of model complexity on forecast quality is elaborated.

3 - Estimating autoregressive models in the presence of missing data and non-normally distributed error terms

Korneel Bernaert, MOSI, VUB, Pleinlaan 2, 1030, Brussels, Belgium, korneel.bernaert@vub.ac.be, *An Peeters*

Estimation of the parameters of an autoregressive model in the presence of missing data is typically performed using the Kalman filter to obtain maximum likelihood estimators. These rely on the error term being normally distributed. This paper constructs estimators using the method of moments estimators which do not rely on this normality of the error term. The performance of the method of moments estimator is then compared to the maximum likelihood and some often-used ad hoc (mean imputation, deletion) estimators in a simulation study for a first-order autoregressive model.

4 - Neural networks for streamflow series forecasting: A comparative study between echo state networks and MLP's

Hugo Siqueira, Department of Systems Engineering, University of Campinas, College of Electrical Engineering, Cidade Universitária Zeferino Vaz, Barão Geraldo District, 13083-970, Campinas, São Paulo, Brazil, hugovaladares@hotmail.com, *Levy Boccato*, *Romis Attux*, *Christiano Lyra*

The forecast of seasonal streamflow series is fundamental for the sustainable use of water resources and it is a key information for hydroelectric generation planning. Echo state networks, recurrent structures characterized by a tradeoff between generation of memory from feedback and straightforwardness, are a contemporaneous alternative to address the problem. However, the possible benefits of this approach in the problem still need proper clarification. This talk gives a contribution by discussing a comparative study of different ESN architectures and a MLP, in several practical scenarios.

■ TD-25

Tuesday, 14:30-16:00

CC-A23

Pathways toward low carbon transport

Stream: Long Term Planning in Energy, Environment and Climate

Invited session

Chair: *Sandrine Selosse*, Centre for Applied Mathematics, MINES ParisTech, Rue Claude Daunesse, 06904, Sophia Antipolis, France, sandrine.selosse@mines-paristech.fr

1 - GHG emissions cap impact on French biofuel mix using MARKAL/TIMES Model

Paul Hugues, Centre for Applied Mathematics, MINES ParisTech, Rue Claude Daunesse, BP 207, 06904, Sophia Antipolis, France, paul.hugues@mines-paristech.fr, *Edi Assoumou*, *Nadia Maïzi*

One of the main reasons of biofuels development has been carbon mitigation. However, greenhouse gas emissions related to biofuel production are dependent on the whole production pathway as well as land use change. To consider the wide impact of biofuel production in long-term prospective, a full range of diverse but integrated aspects have to be considered, such as: biomass supply, transportation, packaging, and transformation to biofuel. In this work, we investigate how a CO2 emissions cap or a carbon tax would impact the French pathway to low emissions, and the biofuel mix.

2 - Impact of a carbon tax on french transports sector: A TIMES model for mobility.

Jean-Michel Cayla, EDF/Mines ParisTech, Paris, France, jeanmichel.cayla@gmail.com

In order provide insights about realistic pathways to low-carbon transports in 2050, we have developed a TIMES model with a strongly detailed module for transports in France. In particular we have developed

an original approach that takes households heterogeneity and households investment behavior as well as daily consumption behavior into account. We are then able to better design realistic technology diffusion curves. Then we study the impact of a carbon tax in transports sector and its ability to reduce CO2 emissions.

3 - The option value of electrified vehicles from a welfare perspective

Adrien Vogt-Schilb, CIREAD, 75011, Paris, France, vogt@centre-cired.fr, *Manon Solignac*, *Céline Guivarch*

We evaluate how much it is desirable to pay today to have the option of buying electrified vehicles (EVs) tomorrow. From exogenous fuel and electricity prices distributions, we model total costs of ownership and market shares of a set of technologies. We compare scenarios where EVs are available with scenarios without EVs. We quantify how EV's availability reduces the expected cost of the automotive system and its exposure to oil prices variability. Adding an economy-wide carbon constraint on the model, we show that EV's availability also reduces the expected carbon price.

4 - Technology and social factors in passenger transport: a comparative assessment of different lever-ages

François Briens, Centre for Applied Mathematics, MINES ParisTech, 06904, Sophia Antipolis, France, francois.briens@mines-paristech.fr, *Edi Assoumou*

This prospective research evaluates and compares the sensitivity of CO2 emissions and energy consumption of the French passenger vehicles fleet up to 2035, to different technological and sociological parameters, such as electric and hybrid technology penetration rates, the shares of the different power class in the fleet, the annual average mileage, and households' motorisation levels. The results highlight the importance of sociological factors and advocate for integrated approaches to engage in ambitious pathways toward low energy and carbon societies.

■ TD-26

Tuesday, 14:30-16:00
CC-A24

OR in Agriculture, Forestry and Fisheries

Stream: OR in Agriculture, Forestry and Fisheries
Invited session

Chair: *Marcela Gonzalez-Araya*, Departamento de Modelación y Gestión Industrial, Universidad de Talca, Merced 437, s/n, Curicó, Región del Maule, Chile, mgonzalez@utalca.cl

1 - Multiple criteria and group decision methods to valuate ecosystem services

Marina Segura Maroto, Applied Statistics, Operations Research and Quality, Universitat Politècnica de València, Camino de Vera S/n, 46071, Valencia, Valencia, Spain, masema@posgrado.upv.es, *Concepcion Maroto*, *Baldomero Segura*

The traditional procedure of economic valuation is based on individual utility maximization. Nevertheless, many ecosystem services are considered as public goods, affecting people and groups in society. Multiple Criteria and Group Decision Making have been used mainly in environmental decision making, more than to explicit economic values for ecosystem goods and services. This paper presents an exhaustive up-to-date review with a classification of approaches and applications, pointing out its main strengths and drawbacks to contribute to the valuation of ecosystem services in the future.

2 - Optimal control models for sustainable fishery management

Joao Lauro D. Faco, Dept. of Computer Science, Universidade Federal do Rio de Janeiro, Av. do PEPE, 1100 / 203, 22620-171, Rio de Janeiro, RJ, Brazil, jldfaco@ufrj.br

Sustainable management of fisheries is a pressing need for fish increasing importance as a high quality protein source. Stocks of the last wild food are collapsing in many regions of the ocean. Optimal Control theory is used to build spatial/temporal models for complex marine ecosystems problems. Dynamic population interactions for competitor/predator/prey multispecies are coupled discrete-time nonlinear difference equations. A hyperbolic smoothing Nonlinear Programming method defines specific clusters; a reduced-gradient method is applied to search the solution, and to parameters estimation.

3 - A mixed integer linear model for planning harvest applied to apple orchards

Marcela Gonzalez-Araya, Departamento de Modelación y Gestión Industrial, Universidad de Talca, Merced 437, s/n, Curicó, Región del Maule, Chile, mgonzalez@utalca.cl, *Wladimir Soto-Silva*

An optimization model to support planning decisions of harvest in apple orchards is developed. The model seeks to minimize the costs of hiring and firing work labor, machinery use and loss of fruit quality by not harvesting in the maturity date, subject to restrictions demand for packaging plants, processing capacity packing plants, constraints about production in each field of the orchard, time window constraints for the harvest according to the apple variety planted in each field, among others. This model was applied to three apple orchards of Maule Region.

4 - Sustainability of agriculture - only a dream considering the world population growth?

Joern Hamann, Food quality and safety, University of Veterinary Medicine, Hannover, FRG, Platanenring 10, 24119, Kronshagen, Schleswig-Holstein, Germany, jha911@hamann-kronshagen.de

Sustainability of agriculture tries to meet mankind's needs of the present without compromising the future. The agricultural sector - cornerstone of food security - has to provide food for almost 35 % more people globally by mid-century. Without doubt, this can and will be reached. However, the question is whether it is possible with a sustainable agriculture. In any case, a lot of money must be spent on agricultural innovations in order to reach the goal of sufficient food for all especially without any further impairment of biological systems.

■ TD-27

Tuesday, 14:30-16:00
CC-A25

Uncertainties in Decision Processes

Stream: Decision Processes
Invited session

Chair: *Ahti Salo*, Systems Analysis Laboratory, Aalto University School of Science and Technology, P.O. Box 11100, Otakaari 1 M, 00076, Aalto, Finland, ahti.salo@aalto.fi

1 - Sources and management of uncertainty in investment appraisals influenced by corporate social responsibility

Aron Larsson, Computer and System Sciences, Stockholm University, 16440, kista, Stockholm, Sweden, aron@dsv.su.se, *Sara Vickman*, *Leif Olsson*

In an exploratory study, we assess how managers try to account for corporate social responsibility in investment appraisals. We focus on how they manage uncertainty and the source of the uncertainties they emphasize, and conclude that they are generally exposed to and also consider both aleatory and epistemic uncertainty and need to handle aspects beyond ROI. There is a mix of macro and micro variables to consider, creating a diversified environment where real options in combination with decision analysis modeling could help in structuring the problem and enlighten different areas and aspects.

2 - Bayesian evaluation and selection strategies in portfolio decision analysis

Eeva Vilkkumaa, Department of mathematics and systems analysis, Aalto University, School of science, Systems analysis laboratory, Aalto University, P.O.Box 11100, 00076 Aalt, Espoo, Finland, eeva.vilkkumaa@aalto.fi, *Juuso Liesiö, Ahti Salo*

In project portfolio selection, the projects' future values are typically uncertain. We show how the Bayesian modeling of these uncertainties increases the expected value of the selected portfolio, raises the expected number of optimal projects in the selected portfolio and decreases post-decision disappointment. We also show that it pays off to re-evaluate only those projects which can be re-evaluated relatively accurately and which have particularly uncertain initial value estimates that are close to the selection threshold.

3 - Uncertain mine clearance quality and how it affects the decision to perform quality control in humanitarian demining

Tobias Fasth, Department of Computer and Systems Sciences, Stockholm University, Forum 100, SE-164 40, Kista, Sweden, tobi-fas@dsv.su.se, *Aron Larsson, Love Ekenberg*

The IMAS standard for mine actions conforms to the ISO 2859 standard for quality control of cleared land. ISO 2859 is primarily aimed for use in the sampling of traditional industrial products, and not on cleared land. The sampling plans are dependent on the acceptable quality limit. This quality limit is subject to uncertainty and we specifically address the problem of the deviance in the actual and acceptable quality of cleared land, and how this influence the decision process and the cost of quality control, leading to the question if whether quality control should be conducted at all.

4 - Action Research for assessing the impact of scenario-based multi-criteria interventions on the strategic decision-making process

Camelia Ram, Operational Research Group, London School of Economics, Houghton Street, WC2A 2AE, London, c.ram@lse.ac.uk

The literature on the combined use of scenarios and multi-criteria decision analysis (MCDA) continues to grow. While action research has been advocated as an appropriate method for studying interventions involving MCDA, guidelines on applying the methodology to provide unique insights for future interventions remain limited. This paper explores how action research was used to assess the value of a scenario-based MCDA intervention. The methodology was applied to support the evaluation and enhancement of strategic options for a regional corporation in a developing country.

■ TD-28

Tuesday, 14:30-16:00

CC-A27

Anticipation and Synchronization

Stream: Models of Embodied Cognition

Invited session

Chair: *Susie Vrobel*, The Institute for Fractal Research, Ernst-Ludwig-Ring 2, 61231, Bad Nauheim, Hessen, Germany, Susanne.Vrobel@t-online.de

1 - Trust as Embodied Anticipation

Susie Vrobel, The Institute for Fractal Research, Ernst-Ludwig-Ring 2, 61231, Bad Nauheim, Hessen, Germany, Susanne.Vrobel@t-online.de

Trust is defined as a temporal observer-participant extension. This extension is described in terms of succession and simultaneity, i.e. the length and depth of time: mutually exclusive temporal dimensions as defined in my Theory of Fractal Time. While succession increases temporal complexity from an endo-perspective, simultaneity reduces it through embodied anticipation. Successful incorporation of parts of the environment leads to the formation of a new systemic whole.

2 - Distortions of spatial phase and temporal-synchronism disorders in amblyopia

Uwe Kämpf, Research Unit, Caterna GmbH, Biensdorf 78, D-01825, Liebstadt, Saxonia, Germany, uwe.kaempf@googlemail.com

Amblyopia is a functional impairment of visual performance which is partially due to coherence losses in the cooperation of visual frequency-filter channels. Chaotic instead of synchronized states in reverberating feed-forward loops (i.e. a lack of perceptual anticipation) induce disorders of temporal synchronism in the visuo-cortical system's neuronal "synfire chains". The result is a distortion in the visual filters' spatial phase. Accordingly, a narrow-band frequency-selective pattern stimulation is proposed as a supportive treatment of amblyopia.

3 - Effects of accuracy feedback on fractal characteristics of time estimation

Sebastian Wallot, MINDLab, Aarhus University, Jens Chr. Skous Vej 20, 8000, Aarhus C, Denmark, sebastian.wallot@gmail.com, *Nikita Kuznetsov*

The current experiment investigated the effect of visual accuracy feedback on the variability of time interval estimates. To assess the impact of feedback, the likelihood of receiving visual feedback was manipulated. Inter-tap intervals were analyzed with fractal and multifractal methods to quantify complex long-range correlation patterns in the timing performance. Increased amounts of feedback lead to a decrease in fractal long-range correlations, as well to a decrease in the magnitude of local fluctuations in the performance. Also, most data sets show significant multifractal signatures.

■ TD-29

Tuesday, 14:30-16:00

CC-A29

DEA and Performance Measurement: Methodology 3

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Chris Tofallis*, Business School, University of Hertfordshire, College Lane, AL10 9AB, Hatfield, Herts., United Kingdom, c.tofallis@herts.ac.uk

1 - Constructing rankings in DEA - a goal programming approach

Paulo Morais, Engenharia Industrial e Gestão, Faculdade de Engenharia da Universidade do Porto; Universidade Lusófona do Porto, Rua Roberto Frias, Rua Augusto Rosa, 24, 4200-465, Porto, Portugal, pauloteixeirademorais@gmail.com, *Ana Camanho*

This paper presents a goal programming model that allows comparing units assessed with DEA. In classical models, given the fact that each unit is assessed with a unique set of weights that aims to maximize its efficiency, the construction of rankings is not possible. Weights restrictions to establish a common set of weights is widely discussed in literature. Using the evaluation of quality of life of 206 European cities as an example, we propose a goal programming model that minimizes the deviations in relation to a composite indicator score obtained in a previous stage.

2 - On the Environmental Variables Analysis in Two Stages DEA

Rafael C Leme, Federal University of Itajuba, UNIFEI-IEPG, CP 50, 37500-903, Itajuba, MG, Brazil, leme@unifei.edu.br, *Anderson Paulo Paiva, Pedro Paulo Balestrassi, Paulo Eduardo Steele Santos*

Benchmarking plays a central role under regulatory scene. DEA is a non-parametric efficiency performance technique usually used for benchmark analysis. The frontier is defined by the efficient firms that envelop the less efficient firms, defining efficiency gap. An issue arises when some environmental variables may influence the results. In this

work, we propose an approach based in Design of Experiments and Desirability method to identify the impact of environmental variables on inefficiency gap, and define which most affect inefficiency. The results are obtained using real Brazilian data.

3 - Value Efficiency for the FDH model

Merja Halme, Information and Service Economy, Aalto School of Economics, PI 11000, 00076, Aalto, Finland, merja.halme@aalto.fi, *Pekka Korhonen*, *Juha Eskelinen*

An approach to supplement preference information in the FDH model is introduced. We assume the Decision Maker (DM) evaluates the units using an implicit value function reaching its maximum at his/her most preferred unit as in Value Efficiency Analysis (VEA). The value function is assumed to be quasi-concave and we use convex cones to approximate its contours. Pairwise comparisons are used as preference information. As in VEA the distance of each unit from the value function's contour passing through the most preferred unit is approximated. We discuss a real case of bank branches.

4 - Economic efficiency of european air traffic control systems

Kenneth Button, School of Public Policy, George Mason University, 3351 Fairfax Drive, (MS 3B1), 20124, Arlington, Virginia, United States, kbutton@gmu.edu, *Rui Neiva*

Much analysis has been conducted on the efficiency of airlines, but less has been done on air traffic control systems (ANSs). The diversity of ANSs regimes in Europe allows rigorous comparison of 36 European systems from 1998 to 2010. The bootstrapped DEA framework assumes a multifaceted output function (safety and delay objectives) with both physical inputs (traffic volumes, labor, investment, flight hours controlled) and policy (ownership and financing systems). Attention is paid to the relative efficiencies of different types of partnerships and the implications of financial structures.

show that although the back-tracking heuristics can handle multi-dimensional non-hierarchical tables they fail to adequately protect hierarchical ones. On average having one hierarchical dimension will leave 30% of primary cells unprotected, two will leave 60% unprotected and three will leave 90% unprotected.

3 - On data protection for graphs: application to social networks

Vicenc Torra, IIIA-CSIC, Campus UAB s/n, 08193, Bellaterra, Catalonia, Spain, vtorra@iia.csic.es, *Klara Stokes*

Graphs are versatile structures that can be used to represent several types of information. In particular, the structure and the content of social networks can be represented in terms of graphs, where nodes correspond to users and edges correspond to the relationships established between them. Data protection for graphs requires a proper definition for disclosure risk and information loss, as well as adequate data protection methods. In this talk we will discuss k-anonymity for graphs, some information loss measures, and the performance of protection methods with respect to the measures.

4 - Improving the solution of CTA through valid inequalities

José Antonio González Alastrué, Dept. Estadística e Investigación Operativa, UPC, Edificio C5, Campus Nord, Jordi Girona 1-3, 08034, Barcelona, Spain, Jose.A.Gonzalez@upc.edu, *Jordi Castro*

Controlled tabular adjustment solves a mixed integer linear problem for protecting statistical tables against the risk of disclosure, which is a key concern for National Statistical Agencies. In this work we obtain some valid inequalities for CTA and show they may be useful in significantly improving exact (branch and bound) and heuristic (block coordinate descent) procedures for CTA. Valid inequalities are derived from a search through the standard constraints of the table, whenever they include some sensitive cells.

■ TD-30

Tuesday, 14:30-16:00

CC-A31

Data confidentiality 2

Stream: Data Confidentiality

Invited session

Chair: *José Antonio González Alastrué*, Dept. Estadística e Investigación Operativa, UPC, Edificio C5, Campus Nord, Jordi Girona 1-3, 08034, Barcelona, Spain, Jose.A.Gonzalez@upc.edu

1 - A Fix and Relax Heuristic for Controlled Tabular Adjustment

Daniel Baena Mirabete, Statistics and Operations Research, Universitat Politècnica de Catalunya, Spain, daniel.baena@upc.edu, *Jordi Castro*

Controlled Tabular Adjustment (CTA) is an emerging protection technique for tabular data. CTA results in a mixed integer linear programming problem, which can be challenging even for tables of moderate size. In this work the Fix and Relax (FR) strategy, based on partitioning the set of binary variables into clusters to selectively explore a smaller branch and bound tree, is applied to large CTA instances. We report computational results on a set of real and random CTA instances. FR is competitive compared to Cplex in terms of finding a good upper bound in difficult instances.

2 - Potential Breaches of Confidentiality in Statistical Tables containing Magnitude Data

Martin Serpell, Department of Computing, University of the West of England, Frenchay Campus, Coldharbour Lane, BS16 1QY, Bristol, United Kingdom, Martin2.Serpell@uwe.ac.uk, *Jim Smith*, *Alistair Clark*

The purpose of this paper is to highlight potential unintended breaches in confidentiality in published statistical tables that have been protected using cell suppression. In order to protect large tables some cell suppression algorithms employ back-tracking heuristics. Tests

■ TD-31

Tuesday, 14:30-16:00

CC-A33

Data Mining in Economics and Ecology

Stream: Data Mining, Knowledge Discovery and Artificial Intelligence

Contributed session

Chair: *Ivan Reyer*, Dorodnicyn Computing Centre of RAS, ul. Pererva d. 58, kv. 153, 109451, Moscow, Russian Federation, reyer@forecsys.ru

Chair: *Renato Bruni*, Dip. Ingegneria Informatica, Automatica e Gestionale, University of Roma "Sapienza", Via Ariosto 25, 00185, Roma, Italy, renato.bruni@dis.uniroma1.it

1 - Predicting the customer churn in Social Network games based on multiple criteria decision making models

Chiao-Chen Chang, International Business, National Dong Hwa University, No. 1, Sec. 2, Da Hsueh Rd., Shoufeng, 97401, Hualien, Taiwan, aka@mail.ndhu.edu.tw, *Yang-Chieh Chin*

Customer churn has become a critical issue, especially in the competitive and mature social network game industry. This study applies rough set theory, a rule-based decision-making technique, to extract rules related to customer churn; then adopts the Decision Making Trial and Evaluation Laboratory (DEMATEL) technique to analyze the relationship among characteristics in customer churn; and finally uses the flow graph, a path-dependent approach, to present the relationships between rules and different kinds of churn. Practical and research implications are also offered.

2 - Modeling partial customer churn: on the value of first product-category purchase sequences

Vera Miguéis, DEIG, Faculdade de Engenharia da Universidade do Porto, Porto, Portugal, vera.migueis@fe.up.pt, Dirk Van den Poel, Ana Camanho, João Cunha

Retaining customers has been considered one of the most critical challenges among those included in Customer Relationship Management (CRM). This paper proposes to include in partial churn detection models the succession of first products' categories purchased as a proxy of the state of trust and demand maturity of a customer towards a company in grocery retailing. We use logistic regression as the classification technique. A real sample of approximately 75,000 new customers taken from the data warehouse of a European retail company is used to test the proposed models.

3 - Electricity consumption and economic growth causality in OECD countries: a panel cointegration approach

Kasirga Yildirak, IAM, METU, 06531, Ankara, Turkey, kasirgayildirak@gmail.com.tr, Ali Sabri Taylan, Cumhuriyet Ekinci

This paper examines the long-run, short-run and causal relationship between electricity consumption and economic growth for a set of OECD countries. We also investigate the presence of any directional causality between real economic activity and electricity consumption. For testing the relationship between electricity consumption and economic growth, we make use of use panel unit roots, panel cointegration test, panel causality and panel vector autoregressive model.

4 - Predicting the fundamental value of financial assets by ridge regression

Michael Kamp, IAIS.KD.CAML, Fraunhofer IAIS, Schloss Birlinghoven 1, 53754, Sankt Augustin, NRW, Germany, michael.kamp@iais.fraunhofer.de, Mario Boley, Thomas Gaertner

Assessing the fundamental value of financial assets is crucial for investment as well as for market regulation. This problem is difficult, because present fundamental values depend on disclosed information and future value developments. Therefore, estimating them is essentially a prediction task that can be addressed by machine learning. We show that good predictions can be achieved by performing ridge regression based on novel correlation features that capture intra- and inter-dependencies of market segments. Despite their expressive power, these features can be extracted from public data.

ecosystems. This involves using a life cycle analysis approach to reflect the emissions arising from the development and operation of CCS and associated storage systems. The scenarios extend to 2050 and include comparison of both pre- and post-combustion CCS

2 - A simulation-based approach for a national integrated assessment model for Germany

Patrick Breun, Institute for Industrial Production, Karlsruhe Institute of Technology (KIT), Hertzstraße 16, D-76187, Karlsruhe, Germany, patrick.breun@kit.edu, Rebecca Ilsen, Magnus Fröhling, Frank Schultmann

The talk describes the otello model, a national integrated assessment model (IAM) to support clean air policy in Germany. The model aims at providing a tool to assess instruments for control of SO_x, NO_x, NH₃, and CO₂ emissions from industrial production, energy supply, transport and residential buildings with respect to sustainability. Different types of policy instruments are evaluated considering criteria from the three dimensions of sustainability. The simulation-based model, especially the industry sub model, are introduced and examples of scenario calculations are presented.

3 - Managing without Growth: Italian Scenarios

Simone D'Alessandro, Scienze Economiche, University of Pisa, via Ridolfi 10, 56124, Pisa, Italy, s.dale@ec.unipi.it, Giorgio Gallo, Giovanni Bernardo

This paper presents a structural model for the Italian economy by applying system dynamics to scenario analysis. Government affects the performance of the economy, through the use of instruments such as taxation, labour policies and market regulation. The aim is twofold. First, we investigate the impact of public policies on six main performance indexes: rate of growth, unemployment, poverty, fiscal position, GHG emission, and inequality. Second, we evaluate whether it is possible to disjoint wellbeing and economic growth.

4 - Computer modeling of urban air quality and related health effects

Piotr Holnicki, Systems Research Institute of the Polish Academy of Sciences, Newelska 6, 01-447, Warsaw, Poland, holnicki@ibspan.waw.pl, Zbigniew Nahorski, Marko Tainio

An important application of air pollution models is air quality management and decision support. Modelling techniques allow us to assess ecological impact of emission sources and benefits of emission abatement. Complexity of such forecasting systems involves uncertainty of the model outputs. This paper addresses the problem of uncertainty of emission inventory and the impact on air pollution predictions and adverse health effects. The computational experiment was implemented for Warsaw Metropolitan Area, Poland, with the CALPUFF air dispersion model used as the forecasting tool.

■ TD-32

Tuesday, 14:30-16:00

CC-A34

National Integrated Assessment Models

Stream: Emissions Trading and Energy
Invited session

Chair: Magnus Fröhling, Institute for Industrial Production (IIP), Karlsruhe Institute of Technology (KIT), Hertzstraße 16, D-76187, Karlsruhe, Germany, magnus.froehling@kit.edu

1 - Environmental assessment of energy scenarios for the deployment of carbon capture and storage (CCS) on coal fired power plants in the UK

Konstantinos Tzanidakis, Department of Power and Propulsion, Cranfield University, Building 183, Room 803, MK430AL, Bedford, United Kingdom, k.tzanidakis@cranfield.ac.uk, Tim Oxley, Helen ApSimon

Looking to 2030 and beyond integrated assessment modelling needs to be extended to cover new energy technologies. We describe application of the UKIAM to different scenarios for the introduction of carbon capture & storage (CCS) in the UK up to 2050, and investigate greenhouse gas emissions and air quality implications for human health and

■ TD-33

Tuesday, 14:30-16:00

CC-A37

OR for Education and Sustainable Development

Stream: OR for Development and Developing Countries
Invited session

Chair: Alexander Makarenko, Institute for Applied System Analysis, National Technical University of Ukraine "KPI", Prospect Pobedy 37, 03056, Kiev, Ukraine, makalex@i.com.ua
Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Self-organization processes in the European Higher Education Area

Marek Frankowicz, Faculty of Chemistry, Jagiellonian University, ul. Ingardena 3, 30-060, Krakow, Poland, marek.frankowicz@gmail.com

Usefulness and applicability of the theory of complexity to characterize evolution and structural changes in European higher education is discussed. Intrinsic dynamics of various processes induced by Bologna reforms is highlighted. Three cases are analyzed in more detail: dynamics of international mobility flows, the concept of self-extracting quality management systems, and sectoral qualification frameworks viewed as complex adaptive systems. Particular attention is paid to possibilities of applying OR techniques to support decision making processes at the national and European level.

2 - Industrial heritage as an educational polygon for development strategies

Vladimir Hain, Institute of History and Theory of Architecture and Monument Restoration, Slovak university of technology, Faculty of architecture, Námesť slobody 19, 812 45, Bratislava, Slovakia, Slovakia, vladimirhain@gmail.com, *Eva Kralova*

Industrial heritage provides one of the most important records on development of cities and towns last two centuries. The basic purpose of the "Educational polygon" is to develop a model and operational tools to raise the awareness of the importance of valuable buildings as a part of the cultural and technological history to stimulate social, economical and political decision to protect them in a new creative way. Its prioritize conservation is a necessary aspect of a city development and study shows example how to set up an appropriate framework for its integration within existing structure.

3 - A hybrid MCDM approach to assess the sustainability of students' preferences for university selection

Metin Dagdeviren, Department of Industrial Engineering, Engineering Faculty, Celal Bayar Bulvar, Gazi Univ. MMF, Endustri Muh., 06570, Ankara, Turkey, metindag@gazi.edu.tr, *Kabak Mehmet*

An integrated approach which employs ANP and PROMETHEE together is proposed. It is concerned with criteria influencing student choice in Turkey to establish a model for predicting students' preference for universities. The ANP is used to analyze the structure of the problem and to determine weights of the criteria, and the PROMETHEE is used to obtain final ranking, and to make a sensitivity analysis. The results indicate that three factors, future career prospects and opportunities, scholarship and university's social life at the top in the university selection.

4 - Competitive market vs. central planning economy and long-run growth

Kenji Miyazaki, Faculty of Economics, Hosei University, 4342 Aihara, 194-0298, Machida, Tokyo, Japan, miya_ken@hosei.ac.jp

We use a simple model with an endogenous discounting rate and a linear technology to investigate whether a competitive equilibrium has a higher balanced growth path (BGP) than a social planning solution. The implications are as follows. People with an inclination to compare themselves with others have an endogenous discounting rate. Such an inclination affects the economic growth rate in a competitive market economy. A competitive market economy sometimes achieves a higher economic growth than a central planning economy, but it sometimes fluctuates due to self-fulfilling prophecy.

■ TD-34

Tuesday, 14:30-16:00

CC-A39

OR for Sustainable Living and Development

Stream: Sustainable Living: Cognitive, Social, Economical, Ecological and World View
Invited session

Chair: *Pedamallu Chandra Sekhar*, Department of Medical Oncology, Dana-Farber Cancer Institute, Boston, 02115, Ipswich, MA, United States, pcs.murali@gmail.com

Chair: *Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Healthy housing environment in small towns in Southeastern Poland

Justyna Kobylarczyk, Cracow University of Technology, Poland, j.kobylarczyk@op.pl

The threats of contemporary civilization make it more and more difficult to live in the city. Therefore, sustainable development is becoming a profound need of modern times. The author's environmental research carried out in some small towns of Southeastern Poland made it possible to enumerate the most important needs of the inhabitants of this region. They influence the creation of a healthy housing environment which is the imperative objective of sustainable development. Among other features, they include safety and privacy as well as the nearness of nature.

2 - Combined multicriteria and scenario analysis as aid to sustainable development

Theodor Stewart, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, theodor.stewart@uct.ac.za

Evaluation of sustainable policies in the developing world context requires consideration of many divergent criteria related to balancing social, environmental, equitability and economic issues. Furthermore, this occurs typically in a context of major levels of uncertainty, to a larger extent than in the developed world. We critically examine means by which multicriteria decision analysis and scenario planning can be combined into an integrated approach to address all issues. Illustrations of the use of the integrated approach in the development context will be discussed.

3 - The Antecedents and the Benefits of Partnership in PEF (Private Equity Fund) of South Korean Industries: The Sustainability Perspective

Hansuk Lee, Sangmyung Univeristy, Korea, Republic Of, hansuk@smu.ac.kr, *Seongtae Hong, In-Young Lee*

In recent years, Sustainable Operations Management(SOM) has been receiving attention from many researchers. Most of the research on SOM has been limited to conceptual frameworks, case studies and some empirical papers. Social dimension of sustainability is concerned with the well being of people and communities. This paper presents a study aimed at quantifying the antecedents and benefits of partnership in PEF(Private Equity Fund). With this research we made efforts to study the social dimension of sustainability in the corporate social responsibility context.

4 - The effect of organizational communication in intrapreneurship and business performance

Şükran Öktem, Business Administration, Başkent University, Ankara, Turkey, gonga2311@gmail.com, *Hakan Turgut, İsmail Tokmak, Gözde Kubat*

For achieving a sustainable competitive advantage in global competition, organizational communication for businesses and intrapreneurship has gained importance. To identify the presence of the effect of organizational communication in both intrapreneurship and business performance in Ankara (Turkey), a survey has been carried out in different sectors for manufacturing industry companies. Analysis of data from the survey with the help of the relations between these variables will be conducted.

■ TD-35

Tuesday, 14:30-16:00

CC-A41

Robust logistic applications

Stream: OR Applications in Industry
Invited session

Chair: *Tobias Winkelkotte*, IT, zooplus AG, Sonnenstraße 15, 80331, München, Germany, tobias.winkelkotte@zooplus.com

1 - Robust Model for Dynamic Multilevel Capacitated Facility Location under uncertainty

Vincenzo De Rosa, Chair of Business Administration and Logistics, Universität Erlangen-Nürnberg, Lange Gasse 20, 90403, Nürnberg, Germany, Vincenzo.Rosa@wiso.stud.uni-erlangen.de, Marina Gebhard, Jens Wollenweber

A new model formulation for the robust capacitated facility location problem for distribution systems under uncertainty is presented. Minimizing the expectation of the relative regrets across scenarios over a multi-period planning horizon is set as objective. It is achieved by dynamically assigning multi-level production allocations, facility locations and capacity adjustments for uncertain parameter development over time. The robustness and effectiveness of the MIP-model is shown by comparison to a deterministic planning approach in an exemplary setting where the future is assumed certain.

2 - Scheduling Long Distance Transports in a Postal Distribution Network

Tobias Winkelkotte, IT, zooplus AG, Sonnenstraße 15, 80331, München, Germany, tobias.winkelkotte@zooplus.com, Li Sun

Postal distribution consists of the sorting of big amounts of items and the transporting over long distances. Transports have to be scheduled such that the sortings can be completed in time. The question is, when to send transports from one sorting facility to another, while achieving a certain service level. We present an appropriate mixed-integer linear programming model to schedule transports such that a service level is achieved and the costs are minimal. We present a heuristic approach which searches a wide range of the solution space by systematically varying the desired service level.

3 - New approach to The Single Track Railway Scheduling Problem

Maya Laskova, The Institute of Control Sciences V. A. Trapeznikov Academy of Sciences, Moscow, Russia, Russian Federation, laskovayamaya@moscow-index.ru, Alexander Lazarev, Elena Musatova

We consider the single track railway scheduling problem with two stations. Two subsets of trains are given, where trains from station one go to station two, and trains from station two go to station one. All trains have the same speed. At most one train from station one or two can be on the track at any time. We consider the single track railway scheduling problem with two stations with optimization criteria of minimizing additional completion time for each trains. We propose a heuristic approach to The Single Track Railway Scheduling Problem.

of the paper is to develop a hysteretic model for hop-by-hop overload control in SIP server networks. A two-class priority queuing system is considered. The model has a buffer with three thresholds and hysteretic load control. We obtained the algorithm for calculating the main performance measures of the system.

2 - Dependability assessment of large railway systems

Grégory Buchheit, A3SI, Arts et Métiers Paristech, 4, rue Augustin Fresnel, 57078, Metz, France, gregory.buchheit@ensam.eu, Olaf Malassé, Nicolae Brînzei

The performance evaluation of systems and in particular their availability depends on the dysfunctional behaviors and maintenance policies of its subsystems and components. Our approach is based on automatic generation of large scale Petri Nets, which are colored, timed and hierarchical, from a meta-model leaning on atomic and elementary components of both French and European railway signalling systems whose behavior respects the specifications that are validated by a formal method. Metrics are defined for performance analysis from the design, operation and maintenance point of view.

3 - Colored Petri Nets based modeling and simulation of bandwidth allocation

Julija Asmuss, Institute of Telecommunications, Riga Technical University, Azenes str. 12, Riga, Latvia, julija.asmuss@rtu.lv, Gunars Lauks, Viktors Zagorskis

We present the design and simulation of dynamically adaptive bandwidth allocation protocols in a changing network environment using Colored Petri Nets. The proposed approach as an example of DaVinci architecture allows describing how a single physical network can support multiple traffic classes with different performance objectives by means of multiple virtual networks constructed over the physical one. We consider the problem of bandwidth allocation as a maximization problem for the aggregate performance and analyze simulation results for delay sensitive and throughput sensitive traffics.

4 - SFERA: A Simulation Framework for the Performance Evaluation of Restart Algorithms in service-oriented systems

Alexandra Danilkina, Institute for Computer Science, Freie Universität Berlin, Takustr. 9, 14195, Berlin, Germany, danilkin@zedat.fu-berlin.de, Philipp Reinecke, Katinka Wolter

Restart is a well-known client-side technique for improving performance and service availability. We illustrate SFERA framework features with an evaluation of the optimal restart timeout in a complex SOA system. We simulate different configurations using workflows and model component response-times by phase-type distributions fitted to measurements from a SOA tested. Several service-policies including ageing servers and infinite servers are considered as well as different arrival processes and restart algorithms. We compare completion times and service availability for different scenarios.

■ TD-36

Tuesday, 14:30-16:00

CC-A43

QMPD Session2

Stream: Quantitative Models for Performance and Dependability

Invited session

Chair: Markus Siegle, Computer Science, Universitaet der Bundeswehr Muenchen, Universitaet der Bundeswehr Muenchen, 85577, Neubiberg, Germany, markus.siegle@unibw.de

1 - Queuing model of hop-by-hop overload control in SIP signaling network

Yuliya Gaidamaka, Telecommunication Systems Department, Peoples' Friendship University of Russia, 115419, Moscow, Russian Federation, ygaidamaka@sci.pfu.edu.ru, Pavel Abaev, Konstantin Samouylov, Alexandr Pechinkin, Sergey Shargin

Major standards organizations, ITU, ETSI, and 3GPP have all adopted SIP as a basic signalling protocol for NGN. The current SIP overload control mechanism is unable to prevent congestion collapse and may spread the overload condition throughout the network. The purpose

■ TD-37

Tuesday, 14:30-16:00

CC-Act

OR in Health & Life Sciences 4

Stream: OR in Health & Life Sciences (contributed)

Contributed session

Chair: Fabricio Sperandio, INESC-TEC, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-465, Porto, Portugal, frsperandio@fe.up.pt

1 - Optimal timing of joint replacement using mathematical programming and stochastic programming models

Baruch Keren, Industrial Engineering and Management Department, SCE - Shamoon College of Engineering, Bialik/Basel Sts., P.O.B. 950, 84100, Beer Sheva, Israel, baruchke@sce.ac.il, Joseph Pliskin, Yossi Hadad

The optimal timing for radical medical procedures as joint replacement must be seriously considered. We show that under deterministic assumptions the optimal timing for joint replacement is a solution of a mathematical programming problem, and under stochastic assumptions the optimal timing can be formulated as a stochastic programming problem. For the case where the patient's remaining life is normally distributed along with a normally distributed survival of the new joint, the expected benefit function from surgery is completely solved. This enables practitioners to find the optimal timing.

2 - Probabilistic Risk Assessment methods application for medical device reliability

Robertas Alzbutas, Lithuanian Energy Institute, Kaunas University of Technology, LT-44403, Kaunas, Lithuania, robertas@mail.lei.lt, *Darius Naujokaitis*, *Vytautas Janilionis*, *Giedr Alzbutien*

In this paper the main techniques and methods of Probabilistic Risk Assessment as well as their application for risk and reliability analysis of medical devices are introduced. The focus is set on the Fault Tree Analysis (FTA) technique and related quantification methods based on Minimal Cut-Sets (MCS) and Binary Decision Diagram (BDD). Also, an example of probabilistic assessments of simple system failure and comparison of produced outcomes is presented. The main advantages and disadvantages of MCS and BDD as well as FTA application for Risk Informed Decision Making are described too.

3 - Integrating probability distribution elicitation with Markov decision modeling: a case study in the treatment of patients with heart failure

Qi Cao, Department of Epidemiology, University Medical Centre Groningen, P.O. Box 30001, 9700 RB, Groningen, Netherlands, q.cao@umcg.nl, *Douwe Postmus*, *Hans Hillege*, *Erik Buskens*

Early-stage economic evaluations of novel medical equipment are characterized by evidence scarcity as data from clinical research is still missing. These evaluations must therefore be based on evidence from less direct sources, such as early bench or animal testing and expert judgement. In this study, we discuss how the resulting uncertainty in the model parameters can be incorporated in a probabilistic way by integrating probability distribution elicitation with Markov decision modeling. The method is illustrated in a case study in the treatment of patients with heart failure.

4 - Robust surgery scheduling via simulation optimization

Fabricio Sperandio, INESC-TEC, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, s/n, 4200-465, Porto, Portugal, frsperandio@fe.up.pt, *Bernardo Almada-Lobo*, *José Borges*

Surgery scheduling problems are characterized by strong uncertainty, compromising the results of deterministic optimization methods. This work presents a Simulation Optimization approach to the surgery scheduling problem at the operational level. The system is composed by a multi-objective optimization search procedure and a stochastic simulation model, which is used to estimate the performance of alternative schedules under uncertainty (variable surgery duration, cancellations, and emergencies). The approach aims to devise robust schedules, better fitting the stochastic nature of the problem.

1 - IND-NIMBUS Framework for Interactive Multiobjective Optimization

Vesa Ojalehto, Department of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014 University of Jyväskylä, Finland, Finland, vesa.ojalehto@jyu.fi, *Jussi Hakanen*, *Kaisa Miettinen*

We present a framework for interactive multiobjective optimization (IMO) called IND-NIMBUS. IND-NIMBUS is a stand-alone system for solving real-world nonlinear multiobjective optimization problems and contains implementations of several IMO methods. Development principles of IND-NIMBUS have been interaction with the decision maker, computational efficiency, ability to change methods during the solution process and utilization of the same modules with different methods e.g. for visualizing and storing solutions. Applications include radiotherapy treatment planning and chemical engineering.

2 - State of Multiobjective Optimization Software

Heinz Roland Weistroffer, Information Systems Department, Virginia Commonwealth University, Snead Hall, 301 West Main Street, 23284-4000, Richmond, VA, United States, hrweistr@vcu.edu, *Yan Li*

We present an overview and a comprehensive survey of current multi-objective optimization (MOO) software. The purpose of this work is two-fold: For the academic researcher we provide an annotated compendium of MOO implementations to show what has been done and where there are gaps. For the practitioner interested in solving specific MODM problems, we provide a selection guideline to find the most suitable software to meet his or her needs.

3 - On Developing User Interface for Interactive Multiobjective Optimization

Jussi Hakanen, Dept. of Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014, University of Jyväskylä, Finland, jussi.hakanen@jyu.fi, *Kaisa Miettinen*, *Suvi Tarkkanen*, *Hannakaisa Isomaki*

By using interactive multiobjective optimization (IMO), a decision maker (DM) progressively provides preference information in order to find the most satisfactory compromise between the conflicting objectives. In this paper, we consider possibilities the research field of visual analytics can provide for supporting the decision making process and information exchange between IMO methods and a DM. The implementation of an IMO method Pareto Navigator is used as an example to demonstrate concrete challenges of interaction design and we describe the incremental development of the user interface.

4 - Laplacian Regular Multiple Criteria Linear Programming for Semi-supervised Classification

Zhiqian Qi, Graduate University of Chinese Academy of Sciences, 200062, Beijing, China, qizhiqian@gucas.ac.cn

In this paper, inspired by the success of RMCLP, we proposed a novel Laplacian RMCLP (called Lap-RMCLP) method for semi-supervised classification problem. Unlike other methods based on graph, Lap-RMCLP is a natural out-of-sample extension, which can classify data that becomes available after the training process, without having to re-train the classifier or resort to various heuristics. Furthermore, by adjusting the parameter, Lap-RMCLP can convert to RMCLP naturally. All experiments on synthetic and real data sets show that Lap-RMCLP is a competitive method in semi-supervised classification.

■ TD-38

Tuesday, 14:30-16:00

HH-Colombus

Multiobjective Optimization for Decision Support

Stream: Multiobjective Optimization

Invited session

Chair: *Heinz Roland Weistroffer*, Information Systems Department, Virginia Commonwealth University, Snead Hall, 301 West Main Street, 23284-4000, Richmond, VA, United States, hrweistr@vcu.edu

■ TD-39

Tuesday, 14:30-16:00

HH-Cousteau

MCDA software for real-world MCDA problems

Stream: Innovative Software Tools for MCDA

Invited session

Chair: *Brian Reddy*, SchARR, University of Sheffield, 30 Regent Court, S1 4DA, Sheffield, United Kingdom, b.reddy@sheffield.ac.uk

1 - a MCDA tool for evaluating the overall comfort on-board the French high speed trains (TGV)

Mohamed, Lounes Mammeri, Innovation and research, SNCF, 7 square des tilleuls, 92350, le plessis robinson, France, lounes.mammeri@gmail.com

Comfort being one of the main reasons why passengers like travelling by train, it is important for railway operators to be able to estimate the overall comfort for various types of trains. We describe the first steps of a study aiming at constructing a tool based on a multiple criteria decision aiding approach. We consider the comfort as a judgment based on a set of complex elements by taking into account the passengers' point of view. We have proposed a hierarchical model of the comfort components and defined the associated scales and some interactions between components.

2 - Eliciting ElectreTri category limits for a group of decision makers

Vincent Mousseau, LGI, Ecole Centrale Paris, Grande voie des vignes, 92 295, Chatenay Malabry, France, vincent.mousseau@ecp.fr, Olivier Cailloux, Patrick Meyer

Multicriteria sorting assigns alternatives to predefined ordered categories. We consider the Electre Tri method, which involves 3 types of parameters: 1) category limits defining the frontiers between consecutive categories, 2) weights and majority level specifying which coalitions form a majority, 3) veto thresholds characterizing discordance effects. We propose an elicitation procedure to infer category limits from assignment examples provided by multiple DMs. The procedure computes a set of category limits common to all decision makers, with variable weights and vetoes for each DM.

3 - Investigating mcda approaches for the national institute for health and clinical excellence

Brian Reddy, ScHARR, University of Sheffield, 30 Regent Court, S1 4DA, Sheffield, United Kingdom, b.reddy@sheffield.ac.uk

NICE uses evidence-based, health economic approaches to prioritise interventions, reduce variation in levels of treatment between regions and encourage best practice across the NHS. For various reasons it is challenging to quantify, model and describe the multiple effects of public health interventions. As a result there is uncertainty around cost effectiveness, complicating decision processes. This presentation will describe some common problems in this area, explain why MCDA techniques may help and explain where these approaches are currently being further investigated for future use.

■ TD-40

Tuesday, 14:30-16:00

HH-Livingstone

Preference Learning 3

Stream: Preference Learning

Invited session

Chair: Krzysztof Dembczynski, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, kdembczynski@cs.put.poznan.pl

1 - Improving ranking performance with cost-sensitive ordinal classification via regression

Hsuan-Tien Lin, Computer Science and Information Engineering, National Taiwan University, Taiwan, htlin@csie.ntu.edu.tw, Yu-Xun Ruan, Ming-Feng Tsai

This paper proposes a novel ranking approach, cost-sensitive ordinal classification via regression (COCR). The approach applies a theoretically sound method for reducing an ordinal classification task to binary ones and solves them with regression. In addition, COCR allows specifying mis-ranking costs to improve the ranking performance. The opportunity is exploited by deriving a corresponding cost for the popular ERR criterion. Evaluations on several large-scale data sets verify the significant superiority of the ERR-tuned COCR over commonly used simple regression approaches.

2 - A new rule-based method for label ranking

Massimo Gurrieri, University of Mons, Rue du Houdain 9, 7000, Mons, Belgium, Massimo.Gurrieri@umons.ac.be, Xavier Siebert, Philippe Fortemps

This work focuses on an application of preference ranking, where the problem is to learn a mapping from instances to rankings over a finite set of labels. Our approach is based on a learning reduction technique and provides such a mapping in the form of logical rules: if [antecedent] then [consequent], where [antecedent] contains a set of conditions (connected by a logical conjunction operator (AND)) while [consequent] consists in a ranking among labels. This approach comprises five phases: preprocessing, rules generation, post-processing, classification and ranking generation.

3 - Learning preference relations with Kronecker kernels: Some theoretical and algorithmic results

Tapio Pahikkala, Turku Centre for Computer Science, 20014, Turku, Finland, aatapa@utu.fi

In this talk, we consider a framework for learning various types of preference relations that is based on Kronecker product kernels and their modifications. As case studies, we consider tasks of inferring rankings of objects and learning to predict nonlinear preferences, as well as extensions to more complex preference learning problems. Next, we present theorems about the universal approximation properties of the considered kernel functions. Finally, we present computationally efficient learning algorithms for the considered problems and practical results on several application domains.

4 - Efficient information retrieval in bioinformatics with conditional ranking algorithms

Willem Waegeman, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure links 653, 9000, Ghent, Belgium, willem.waegeman@ugent.be

In domains like multimedia retrieval, bioinformatics, social network analysis and game playing, one can find retrieval tasks where the goal consists of inferring a ranking of objects, conditioned on a target object query. We recently presented a general machine learning framework for learning conditional rankings from various types of relational and structured data. In this talk we focus on three specific bioinformatics applications: retrieval of enzymes w.r.t. functionality, ranking of ligands for computational drug design and modelling interactions between bacterial species.

■ TD-41

Tuesday, 14:30-16:00

HH-Heyerdahl

Dynamical Systems and Mathematical Modelling in OR

Stream: Dynamical Systems and Mathematical Modelling in OR

Invited session

Chair: Selma Belen, Mathematics and Computer, CAG University, Adana-Mersin Karayolu Uzeri, Yenice-Tarsus, 33800, TARSUS / Mersin, Turkey, selmabelen@cag.edu.tr

Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Fractional partial differential equations driven by fractional Gaussian noise

Mahmoud El-Borai, Mathematics, Faculty of science Alexandria University, Dep. of Mathematics Faculty of science, Alexandria University Alexandria Egypt, 21511, Alexandria Egypt, m_m_elborai@yahoo.com, Khairia El-Said El-Nadi

Some fraction parabolic partial differential equations driven by fraction Gaussian noise are considered. Initial-value problems for these equations are studied. Some properties of the solutions are given under suitable conditions and with Hurst parameter less than half.

2 - A discrete system simulating an e-shop built bottom up from customer behavior

Peter Vojtas, Software Engineering, Charles University, Faculty of Mathematics and Physics, Malostranske nam. 25, 118 00, Prague, Czech Republic, vojtas@ksi.mff.cuni.cz, Ladislav Peska

Our motivation is modeling a web based e-shop from manager's perspective. One of problems of such modeling is to find analytical description. We combine database preference querying and our model of learning user preferences for explicit/implicit users' behavior. We propose a simulation system with stochastic generated artificial users and manager's decision. In our experiments, distribution of user behavior was collected in a real travel agency and system response contained items based partly on advertisement, partly on popularity and partly on top-k object of each user in person.

3 - Taxonomy of concepts and terms in administration

Erwin Reizes, O.R., Fac.Ing./UdelaR,Uruguay, Luis A.de Herrera 1042,ap.1701 (home), ap.1701, 11300, Montevideo, Uruguay, bereizes@adinet.com.uy

A taxonomy of concepts and terms seems necessary to cope with the Babel of synonyms and homonyms which plagues present System and Administration Theory and Practice. Therefore, based on these ideas, on OR and on ideas of Linguistic, Logic and Information, a bijective mapping between concepts and terms is given.

4 - A Hybrid Modelling Approach for Physical Network Design under Demand Uncertainty

Sutthipong Meeyai, Cranfield University, United Kingdom, sutthipong.meeyai@cranfield.ac.uk

We consider a modelling approach for physical network design when it is managed in a decentralised way. An optimization approach generally determines an optimum or near-optimum solution from a 'top-down perspective.' Instead of designing only from the standard approach, we examine the results from a 'bottom-up perspective' by an agent-based simulation. With the agent properties we can investigate operations by a local objective with a set of degree of freedom. We provide a modelling approach for network design with a numerical result from a real-world example.

2 - A survey analysis on the investment attitudes of individual investors

Belma Ozturkkal, International Trade and Finance, Kadir Has University, Cibali, İstanbul, Turkey, belma.ozturkkal@khas.edu.tr

This study aims to analyze determinants of trading behavior of local investors, where a survey of 55 questions on 85 people is used. The survey is composed of four parts: demographic properties, perceived characters, investment preferences, portfolio diversification. The findings show that investors are subject to home bias and the surveyed investors prefer to invest in local equity market.

3 - Stochastic interventions: Methods to model uncertainty

Shweta Agarwal, Management Science, London School of Economics, New Academic Fields, Lincoln's Inn Fields, WC2A 2AE, London, Great Britain, United Kingdom, shweta1963@gmail.com, Gilberto Montibeller

Managers frequently associate controlling risk with managing the uncertainty that generates them. One way to represent this in decision models is by not treating uncertainties as exogenous but by allowing the probability distributions of state variables to be altered by stochastic interventions. We define such an intervention using principles of causal reasoning and propose modelling it with generalized conditioning. The ability to model the effects of probability alteration can enhance the prescriptive scope of decision analytic tools in risk management.

4 - Records Properties of Nonstationary Time Series

Ana Elizabeth García Sipols, Estadística e investigación operativa, Universidad Rey Juan Carlos, c/ Tulipan s/n, 28933, Madrid, Spain, anaelizabeth.garcia@urjc.es, Clara Simon de Blas, M. Teresa Santos Martin

This paper compares the statistical properties of the records from independent and identically distributed time series with those of time series containing a single unit root. It is shown that there are important differences in both the limiting distributions and the convergence rates of the associated record counting processes. We prove some properties for the test statistic in the context of the renewal theory and we suggest two new candidates to test the hypothesis of random walk with positive and negative drift.

■ TD-42

Tuesday, 14:30-16:00

BW-Amber

Advances in Stochastic Modeling and Simulation

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science

Invited session

Chair: Basak Tanyeri, Bilkent University, Turkey, basak@bilkent.edu.tr

1 - A Comparison of Artificial Neural Network and Multinomial Logit Models in Predicting Mergers

Nilgun Fescioglu-Unver, Industrial Engineering, TOBB University of Economics and Technology, Sogutozu Cad. No:43, Sogutozu, 06560, Ankara, Turkey, nfunver@etu.edu.tr, Basak Tanyeri

Predicting who will propose merger bids and who will receive merger bids is important to measure the price impact of mergers. This study investigates the performance of artificial neural networks and multinomial logit models in predicting bidder and target candidacy. We use a comprehensive dataset that covers the years 1979 to 2004 and includes all deals with publicly listed bidders and targets. We find that both models perform similarly while predicting target and non-merger firms. The multinomial logit model performs slightly better in predicting bidder firms.

■ TD-43

Tuesday, 14:30-16:00

BW-Granite

Stochastic and robust optimization

Stream: Stochastic Programming

Invited session

Chair: Abdel Lisser, LRI, Université de Paris Sud, Bat. 650, 91405, Orsay, France, lisser@lri.fr

1 - Solving SCOPF problems by a new structure-exploiting method

Naiyuan Chiang, School of Mathematics School of Mathematics School of Mathematics School of Mathematics, University of Edinburgh, Room 5620, JCMB, The King's Buildings, EH9 3JZ, Edinburgh, State, United Kingdom, sorakid507@gmail.com

The aim of this paper is to demonstrate some new approaches to solve the linearized security constrained optimal power flow (SCOPF) problem by OOPS, which is a modern structure-exploiting primal-dual interior-point implementation. Firstly, we present a reformulation of the SCOPF model, in which most matrices only need to be factorized once throughout the IPM iterations. Moreover, we use a preconditioned iterative method to solve the corresponding linear system and suggest several schemes to pick a good and robust preconditioner based on combining different 'active' contingency scenarios.

2 - A Second-Order Cone Programming approach for Linear programs with joint probabilistic constraints

Abdel Lisser, LRI, Universite de Paris Sud, Bat. 650, 91405, Orsay, France, lisser@lri.fr

In this this talk, we consider a special case of Linear programming problems with joint probabilistic constraints (LPPC). We assume that the constraint matrix is random with normally distributed coefficients and independent rows. To solve this hard problem, we use the piecewise linear approximation and the piecewise tangent approximation to come up with upper and lower bounds respectively. For this purpose, we solve two different second-order cone programming (SOCP) problems. Numerical results on randomly generated data are given.

3 - Robust portfolio optimization - impact of copula and estimation choice

Justyna Majewska, Department of Demography and Business Statistics, University of Economics in Katowice, 1 Maja 50, 40-287, Katowice, Katowice, Poland, justyna.majewska@ue.katowice.pl, *Grażyna Trzpiot*

The paper deals with estimating risk-minimizing portfolios when departures from standard assumption of Gaussianity are present. Its aim is to investigate the impact of different copula on optimal portfolios, when different robust alternatives to the classical variance portfolio optimization problem are used. Specifically, we examine some aspects of the relationship of dependence structure and robust estimation. We present applications using a data set based on a global portfolio of an emerging market investors located in Central and Eastern Europe.

4 - On reduction of quantile optimization problems with discrete distributions to mixed integer programming problems

Vladimir Norkin, Operations Research, Institute of Cybernetics, Glushkov avenue, 40, 03187, Kiev, Ukraine, norkin@i.com.ua, *Andrey Kibzun*, *Andrey Naumov*

In the report we suggest a method of equivalent reduction of a general quantile optimization problem with discrete distribution of random data to large scale mixed integer programming problems. The latter are supposed to be solved by standard discrete optimization software. As a particular case a two-stage quantile stochastic optimization problem is considered. Our main contribution consists in establishing new conditions of equivalence between two formulations. Some generalizations can be found in http://www.optimization-online.org/DB_HTML/2010/05/2619.html

2 - Nonlinear regression model generation and graph transformations

Roman Sologub, Innovations and High Technology, Moscow Institute of Physics and Technology, 508, 86, Altufievskoe sh., Moscow, 127349, Moscow, alucardische@gmail.com

We investigate a problem of non-linear regression model generation. The practical application is to define regression of strike and maturity of a European option towards its volatility. To derive the volatility surface we use symbolic regression. The competitive models are generated as superpositions of expert-given functions. The main problem of the model generation process is to filter the isomorphic models with different structure. The methods of graph transformation are used as solution. The result is a set of models of unique structures. The optimal model is selected from this set.

3 - Multiclass classification of cardio-vascular disease patients with sample size estimation

Anastasia Motrenko, Applied mathematics and management, MIPT, Moscow, Russian Federation, pastt.petrovna@gmail.com

We discuss an algorithm that classifies four groups of patients, divided by their health condition. Concentrations of proteins in blood cells are used as features. Our first objective is to select a set of features that will classify the patients making minimum amount of errors. This selection is implemented by means of exhaustive search. Two classification strategies are investigated, "one versus all" and "all versus all". The second objective is the sample size. Amount of data is small, so we evaluate minimum sample size, necessary for statistical significance of classification.

4 - Mixture models in the financial time series forecasting

Vadim Strijov, Russian Academy of Sciences, Computing Center, Vavilova 42-268, 119333, Moscow, Russia, Russian Federation, strijov@ccas.ru

To forecast financial time series one needs a set of models of optimal structure and complexity. The mixture model selection procedures are based on the coherent Bayesian inference. To estimate the model parameters and covariance matrix, Laplace approximations methods are introduced. Using the covariance matrix one could split up the data set to form mixture of models and select a model with minimum description length.

■ TD-44

Tuesday, 14:30-16:00

BW-Marble

Model Generation and Model Selection

Stream: Machine Learning and its Applications
Invited session

Chair: *Michael Khachay*, Ural Branch of RAS, Institute of Mathematics and Mechanics, S.Kovalevskoy, 16, 620990, Ekaterinburg, Russian Federation, mkhachay@imm.uran.ru
Chair: *Vadim Strijov*, Russian Academy of Sciences, Computing Center, Vavilova 42-268, 119333, Moscow, Russia, Russian Federation, strijov@ccas.ru

1 - Search for Optimal Composite Indicators

Miroslav Klucik, Faculty of Economics, VSB-Technical University of Ostrava, Havlickovo nabrezi 38, 701 21, Ostrava, Czech Republic, miroslav.klucik.st@vsb.cz

Contemporary approaches to construct composite leading indicators using economic theory and statistical analysis rely mostly on subjective decisions of researchers and analysts. An artificial intelligence tool — genetic programming — can mine all the information available in large data sets and help to construct models best fitted to the reference data. The composition of indicators and the lead of time series are being searched for by symbolic regression. The structure of associated information between reference series and large data sets is shown.

■ TD-45

Tuesday, 14:30-16:00

BW-Water

Quantitative Approaches in Managerial and Financial Accounting

Stream: Quantitative Approaches in Managerial and Financial Accounting
Invited session

Chair: *Matthias Amen*, Chair for Quantitative Accounting & Financial Reporting, University of Bielefeld, Universitaetsstrasse 25, 33615, Bielefeld, Germany, Matthias.Amen@web.de

1 - Optimizing continuous inventory

Matthias Amen, Chair for Quantitative Accounting & Financial Reporting, University of Bielefeld, Universitaetsstrasse 25, 33615, Bielefeld, Germany, Matthias.Amen@web.de

Physical inventory exists explicitly or implicitly (IFRS, ISA 501) in all accounting systems. The German Commercial Code (Handelsgesetzbuch, HGB) requires an annual physical inventory for each item of the balance sheet. Traditional physical inventory requires a stop of operations of the production plant for a certain period around the balance sheet date. To ensure continuous production continuous inventory is also allowed. We present an optimization approach to determine the schedule of stocktaking in a continuous inventory system during the accounting period.

2 - Meta Managerial Accounting — quantitative approaches for designing managerial accounting systems

Markus Puetz, Chair, Department of Managerial Accounting and Control, WHL Graduate School of Business and Economics, Hohbergweg 15 - 17, D-77933, Lahr, Baden-Wuerttemberg, Germany, markus.puetz@whl-lahr.de

Meta Managerial Accounting (MMA) is used to design effective managerial accounting systems for practical applications. In this presentation 3 MMA approaches will be discussed: 1. Analytical and graph theoretical approach for representation of business and control processes with open decision networks. 2. First order predicate logic approach for specification of business and control processes and potentials, including handling of verification and validation tasks which refer to control methods. 3. Approach for implementation of simulation based open decision networks for MMA purposes.

3 - Corporate taxes, capital structure and valuation: Combining Modigliani/ Miller and Miles/ Ezzell

Ulrich Schäfer, Professur für Finanzen und Controlling, Georg-August-Universität Göttingen, Platz der Göttinger Sieben 3, 37073, Göttingen, Germany, ulrich.schaefer@wiwi.uni-goettingen.de, Stefan Dierkes

Valuing a company with Discounted Cash Flow (DCF) approaches requires assumptions about the financing strategy. In general, pure strategies are considered thus far: Either, according to Modigliani and Miller, debt levels or, following Miles and Ezzell, capital structure targets are pre-determined for all periods. In this paper, it is shown how to value a company for an arbitrary combination of these strategies. The familiar approaches are embedded into a common framework. For practical application, a combined financing allows for a more realistic modeling of a company's financing strategy.

4 - Electronic transfer of financial data to banks - reasons for refusal and possible improvements

Karina Sopp, University of Vienna, Bruenner Straße 72, 1210, Vienna, Austria, karina.sopp@univie.ac.at

Electronic transfer of financial data based on a reporting language like XML or XBRL gets more and more common in multiple areas. However in the communication between banks and their business customers the distribution of financial information in alternative formats still remains dominant and therefore shows potential for further development. To detect the reasons for the lack of acceptance a survey was carried out among approximately 2000 Austrian accountants. The results of the survey show next to the reasons for the low acceptance the conditions which have to be met for a higher acceptance.

Tuesday, 16:30-17:30

■ TE-01

Tuesday, 16:30-17:30

Opera

Celebration of EURO and its Presidents

Stream: Keynote, Tutorial and Plenary Lectures

Plenary session

Chair: *M. Grazia Speranza*, President of EURO, EURO Office, ULB CP210/01, 1050, Bruxelles, Belgium, president@euro-online.org

Chair: *Gerhard Wäscher*, President-Elect of EURO, EURO Office, ULB CP210/01, 1050, Bruxelles, Belgium, pe@euro-online.org

1 - 40 Years of EURO: History, Applications, Future Potentials

Hans-Jürgen Zimmermann, Operations Research, Aachen Institute of Technology, Korneliusstr.5, 52076, Aachen, Germany, zi@or.rwth-aachen.de

40 years ago, i.e. in 1972, the world looked quite different from today: Logistics were slower and more complicated: The best way to travel from Europe to the USA was by ship, which took between 5 and 13 days. Alternatively one could take a "Super Constellation" and go via Island in 24 hours. There were no electronic booking systems, customs-and passport control at each European Border, but no security systems at airports, no terrorism and no hijacking of planes. Communication was as clumsy: No fax, no email, no courier services, a letter between Europe and overseas took two to three weeks, each single letter had to be typed, and there were neither social nets nor a www. Professionally there existed three large OR-journals (and a number of small national ones), East and West was separated by the Iron Curtain. "Large" OR-Societies existed in the USA, Japan and Great Britain and in Europe there were a dozen of smaller national OR Societies. There was hardly any communication between these European societies and if one wanted to know what was going on in OR in another European country, the best way was, to ask a colleague in the USA. In the USA Ackoff had stated (in 1979) "American Operations Research is dead though not yet buried". Under these circumstances the presidents of the European OR societies met at the IFORS conference 1972 in Dublin and came to the conclusion, that this situation of OR in Europe was sub-optimal and should be improved. They met again in 1973 and 1974 and decided to organize the first European OR conference at the end of January 1975 in Brussels. There were 500 participants and the representatives of 10 European countries. In the framework of this conference EURO was founded, 7 European working groups were started, the EURO-bulletins was started and it was decided to prepare the publication of a European OR journal (EJOR). In the meantime EURO has 30 member countries, several professional journals, about 30 working groups, several very successful types of events, several prizes and awards, a very impressive web-page, and has had 25 successful EURO conferences. Hence: EURO has turned out to be a very successful organization. The success of OR can, however, not only be measured by the manifold growth of EURO ! As an applied discipline the situation of OR in Europe should also be considered from the point of view of available OR-tools, from its public visibility, the areas of applications, the education in this area, and its relationship to other disciplines that have emerged in the meantime and are relevant for OR. In some of these dimensions OR can certainly also be considered to be very successful. In others there are still or again big challenges that have to be met, if OR is also to be successful in the future. In this presentation some of these challenges will be considered in more detail and some ways suggested, how they can possibly be met.

2 - Celebration of the EURO Presidents

M. Grazia Speranza, President of EURO, EURO Office, ULB CP210/01, 1050, Bruxelles, Belgium, president@euro-online.org, *Gerhard Wäscher*

EURO is especially pleased and proud to recognise the 17 former EURO presidents with a special celebration as part of this plenary session. To celebrate the 25th EURO conference we look back on the development of the Association and its continued growth and success. This is a perfect time to reflect on our history and thank former presidents for their strong guidance and leadership.

Wednesday, 8:30-10:00

■ WA-01

Wednesday, 8:30-10:00

RB-Alfa

Keynote Lecture: Professor Boris Polyak

Stream: Keynote, Tutorial and Plenary Lectures
Keynote session

Chair: *Leonidas Sakalauskas*, Operational Research, Institute of Mathematics & Informatics, Akademijos 4, LT-08663, Vilnius, Lithuania, sakal@ktl.mii.lt

1 - Robust eigenvector problem and its application to PageRank

Boris Polyak, Laboratory of adaptive and robust systems, Institute for Control Science, Profsojuznaya 65, 117997, Moscow, Russian Federation, boris@ipu.ru

There are novel approaches to Robust Linear Programming and Robust Least Squares which convert them into nonsmooth convex optimization problems. We provide similar technique for robust eigenvector problem for stochastic matrices. Such robust formulations are natural for numerous ranking problems. The approach is compared with standard ones, such as PageRank. Numerical optimization algorithms for nonsmooth problems arising are addressed.

■ WA-02

Wednesday, 8:30-10:00

RB-Beta

New Models for Project Scheduling

Stream: Project Management and Scheduling
Invited session

Chair: *Christian Artigues*, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, France, artigues@laas.fr

1 - An integrated solution procedure for project staffing

Broos Maenhout, Business Informatics and Operations Management, Ghent University, Tweeckerkenstraat 2, 9000, Gent, Belgium, Broos.Maenhout@Ugent.be, *Mario Vanhoucke*

We study a strategic scheduling problem that integrates project scheduling and personnel staffing in order to determine how to staff and schedule single projects as best as possible. A decision is made on the best mix of resource types (regular workers, overtime and temporal workers) to carry out a single project. In this perspective, we want to determine the project schedule and deadline and the usage of the different resources in order to minimize the total cost.

2 - Variable resource consumption and dynamic activity duration in the resource-constrained project scheduling problem

Torben Schramme, DS&OR Lab Paderborn, University of Paderborn, Warburger Straße 100, 33098, Paderborn, Germany, schramme@dsor.de, *Leena Suhl*, *Stefan Bunte*

The resource-constrained project scheduling problem (RCPSP) has been discussed in literature for decades, although there was only little focus on handling dynamic resource consumption for activities. We will present an extension of this problem considering dynamic resource allocation for every execution period of an activity which leads to activities with a fixed workload but variable duration. We will show some related practical problems with such requirements, discuss the difficulties of this extension for current solving methods and show some ideas how to deal with them.

3 - Integer programming and constraint propagation for scheduling under energy constraints

Christian Artigues, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, France, artigues@laas.fr, *Pierre Lopez*, *David Rivreau*

We consider a scheduling problem where activities are subject to time windows and "energy" resource constraints. The amount required by each activity on the energy resource at each time has to be decided such that it lies between a minimum and a maximum once the activity is started and before the activity is finished. The total amount of energy required instantaneously cannot exceed a maximal limit and, for each activity, the total energy brought must fulfill its demand. To solve this NP hard problem we propose integer programming and constraint propagation techniques.

4 - A preprocessing procedure to improve recent exact algorithms for the resource-constrained project scheduling problem

Alexander Schnell, Dept of Management, University of Vienna, Austria, alexander.schnell@univie.ac.at, *Richard Hartl*

This talk deals with exact algorithms for the standard version of the resource-constrained project scheduling problem assuming a single mode, non-preemption and renewable resources. Thereby, we analyse and enhance Branch and Bound algorithms from the literature combining principles from Constraint Programming, Boolean Satisfiability Solving and Mixed-Integer Programming. In this context, we propose a preprocessing step to two state-of-the-art algorithms to improve their computational performance. The results on instances with 60 (120) jobs show the efficiency of our preprocessing procedure.

■ WA-03

Wednesday, 8:30-10:00

RB-L1

EURO/ROADEF Challenge Session 2

Stream: EURO/ROADEF Challenge
Invited session

Chair: *H. Murat Afsar*, Industrial Systems, University of Technology of Troyes, 12 rue Marie Curie, BP 2060, 10010, Troyes, France, murat.afsar@utt.fr

Chair: *Christian Artigues*, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, France, artigues@laas.fr

Chair: *Ender Özcan*, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, exo@cs.nott.ac.uk

Chair: *Eric Bourreau*, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr

Chair: *Emmanuel Guere*, Google, 38 Avenue de l'Opera, 75002, Paris, France, guere@google.com

Chair: *Kedad-Sidhoum Safia*, LIP6 - UPMC, 4 Place Jussieu, 75005, Paris, France, safia.kedad-sidhoum@lip6.fr

Chair: *Marc Sevaux*, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - Constraint-based large neighborhood search for machine reassignment

Jochen Speck, Institute of Theoretical Informatics, Karlsruhe Institute of Technology, 76131, Karlsruhe, Germany, speck@kit.edu, *Felix Brandt*, *Markus Völker*

The presented approach is basically a large neighbourhood search that iteratively improves the given solution. In each iteration a subset of processes is released, while all other processes stay on their current machine. Released processes are then reassigned to the machines by a constraint program and the first improving solution is selected. We evaluate different neighbourhood selection strategies, branching techniques and optimization to improve performance on big instances. Furthermore, we present a network flow formulation that allows to compute lower bounds on the necessary costs.

2 - Constraint-based large neighborhood search approach based on constraint programming for the machine reassignment problem

Deepak Mehta, Cork Constraint Computation Center, University College Cork, Ireland, d.mehta@4c.ucc.ie, Barry OSullivan, Helmut Simonis

We use a large neighborhood search approach based on constraint programming (CP) to solve the machine reassignment problem. We repeatedly select a subset of processes and re-optimize the resulting subproblem by reassigning machines to these processes using CP. The algorithm often finds a solution that is significantly better than the initial one. One advantage of our approach is that we can restore the domains of the variables efficiently when a subset of processes are removed from a subset of machines. Therefore, there is no need to create new variables or domains for a subproblem.

3 - Combining VNS, Simulated Annealing, and a Greedy Heuristic for the ROADEF/EURO 2012 Challenge

Frederic Roupin, LIPN, CNRS-UMR 7030, Université Paris 13, 99 avenue, Jean-Baptiste Clément, 93430, Villetaneuse, France, frederic.roupin@lipn.univ-paris13.fr, Laurent Alfandari, Franck Butelle, Camille Coti, Lucian Finta, Gérard Plateau, Antoine Rozenknop

We describe the resolution method of Senior Team S26 for the ROADEF/EURO 2012 Challenge. There are two main algorithms that are used: Variable Neighborhood Search (VNS) and Simulated Annealing (SA). Both algorithms explore neighborhoods generated via three types of moves: Swap, Shift and Ejection Chain. Initial solution used is either the one provided by Google with the data set, or an alternative initial solution that we produce with a specific greedy heuristic.

4 - A GRASP approach for the machine reassignment problem

Michaël Gabay, Laboratoire G-SCOP, 46 avenue Félix Viallet, 38031, Grenoble, France, michael.gabay@g-scop.grenoble-inp.fr, Sofia Zaourar

We describe our approach to solve the machine reassignment problem. The main idea is to combine different heuristics to find good quality solutions. We apply a GRASP metaheuristic scheme: first, a constructive heuristic inspired by vector bin packing problem builds various solutions. Then we use local search to improve these solutions. We take advantage of problem constraints structure to design moves that keep the solution feasible and are very fast to apply.

■ WA-04

Wednesday, 8:30-10:00

RB-L2

Combinatorial Optimization: Applications

Stream: Combinatorial Optimization

Invited session

Chair: Stephan Visagie, Department of Logistics, University of Stellenbosch, Posbus 3404, Matieland, 7602, Stellenbosch, South Africa, svisagie@sun.ac.za

1 - Selecting subsets of foods to measure nutrient exposure: the max_r method

Hannelie Nel, Department of Logistics, Stellenbosch University, Private Bag X1, Matieland, 7602, Stellenbosch, Western Province, South Africa, jhnel@sun.ac.za, Martin Kidd

In human nutrition, the max_r method measures specific nutrient exposure. This method calculates the optimal subset of foods that maximizes the Pearson correlation of a given nutrient intake, for example iron, based on the chosen subset of foods with the total nutrient intake (iron, for example) based on all the foods. This paper illustrates the use of metaheuristics to solve this combinatorial optimization problem.

2 - A pallet arrangement algorithm for legal loads

Neil Jacobs, Logistics, Stellenbosch University, 7600, Stellenbosch, Western Cape, South Africa, neil@sun.ac.za

In road transport it is frequently found that a load of pallets in certain arrangements, contravenes legal axle mass and wheel mass restrictions on a given vehicle. The need thus exists to find legal arrangements. It is possible to determine an optimal position for the centroid of any load for a given vehicle and let that position be the target point in arrangement processes. Arrangement for a pallet load centroid to a target point presents a combinatorial problem, which could be very hard to solve to optimality. A method which finds a feasible area (as opposed to a target point) for the load centroid is presented. An algorithm is presented which finds legal arrangements for pallet loads.

3 - An algorithm for the bi-objective integer minimum cost flow problem

Salima Nait Belkacem, Economy and Commercialisation des Hydrocarbures, University of M'hamed Bougara, 1 avenue de l'indépendance, 35000, Boumerdès, Algeria, naitnali@yahoo.fr

In this paper, we propose an algorithm that finds more efficient integer non-extreme points in the objective space. This algorithm is based on the well known method. Our alternative method improved the second phase of Sedeno-Noda and Gonzalez-Martin's algorithm published on 2001. We show that our method gives more efficient points in the objective space and we give a didactic example.

4 - On the optimization of a unidirectional picking line in a DC.

Jason Matthews, Department of Logistics, University of Stellenbosch, South Africa, 14855054@sun.ac.za, Stephan Visagie

A real life order pick operation making use of cyclical picking lines used by Pep stores Ltd, South Africa, is considered. Multiple pickers walk in a clockwise direction around a conveyor belt past bin locations while picking orders. The problem of assigning SKUs to bin locations and the sequencing of the resulting orders for the pickers is discussed. A strong lower bound on the number of cycles needed for a fixed assignment of SKUs is established and heuristics for assigning SKUs to bin locations presented.

■ WA-05

Wednesday, 8:30-10:00

RB-L3

Topics in combinatorial optimization I

Stream: Discrete Optimization, Geometry & Graphs (contributed)

Contributed session

Chair: Eric Bourreau, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr

1 - A column generation model for Eternity 2

Eric Bourreau, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr

Eternity II is a combinatorial problem: a 2D edge matching puzzle. The goal is to place 256 square tiles on a 16x16 square such that all adjacent tiles have matching colors along their common edge. Despite 2 million dollars proposed by Tomy, nobody, between 2007 and 2010 was able to find a solution. We will show an innovative way to describe the problem: a polyomino packing problem with additional cardinality constraints. We propose a column generation model. We validate it, on smaller instances generated with the same parameter as the original (inaccessible!) instance.

2 - Optimization of a Nonlinear Workload Balancing Problem

Stefan Emet, Dept of Mathematics and Statistics, University of Turku, Vesilinnantie 5, FI-20014, Turku, Finland, semet@utu.fi

We consider the optimization of a printed circuit board (PCB) assembly unit. The production unit consists of a number of lines of different machines in series for inserting electronic components on bare PCBs. The objective is to optimize the usage of the lines by optimally allocating the jobs to the machines of each line. The balancing problem is modeled and solved using Mixed Integer Nonlinear Programming (MINLP) techniques. It is shown that the presented model can be convexified in an equivalent linear form. A set of test problems is successfully solved.

3 - Efficient Parallel Algorithm for Solving UNSAT 3-SAT and Similar Instances Via Static Decomposition

Emir Demirović, Mathematics, Faculty of Natural Sciences, Bosnia And Herzegovina, emir.demirovic@gmail.com, *Haris Gavranovic*

We rework our SAT solver, D-Sat, to work in a parallel environment. As with D-Sat, the solution space is decomposed into simpler pieces, i.e., the original problem is decomposed into smaller problems, which are solved in parallel and combined to obtain the solution of the original problem. Any existing solver may be used to process the newly decomposed pieces, as long as it outputs sufficient information about the solution process. Our experimental results show that significantly lower execution times can be achieved for UNSAT 3-Sat and similar instances.

4 - Clique-Forest partitions of P-4-tidy graphs

Sulamita Klein, COPPE-PESC, Universidade Federal do Rio de Janeiro, Caixa Postal 68511, Cidade Universitária, 21941-972, Rio de Janeiro, RJ, Brazil, sula@cos.ufrj.br, *Loana Nogueira*, *Raquel Bravo*, *Fabio Protti*

A graph G is a P4-tidy graph if, for any induced subgraph H of G isomorphic to a P4, there exists at most one vertex outside H forming an induced P4 along with three vertices of H . This work considers the problem of (C,F)-partitions of P4-tidy graphs, that is, the problem of determining if the set of vertices of a P4-tidy graph can be partitioned into 2 subsets C and F such that C induces a complete graph and F induces a forest (acyclic graph). We characterize the P4-tidy-(C,F) graphs by forbidden subgraphs and we present a linear-time algorithm to recognize this class.

■ WA-06

Wednesday, 8:30-10:00

RB-Gamma

Variable Neighborhood Search and hybrid metaheuristics

Stream: Variable Neighborhood Search
Invited session

Chair: *Dauwe Vercamer*, Marketing, Ghent University, Tweekerkenstraat 2, 9000, Gent, Belgium, Dauwe.Vercamer@ugent.be

1 - Variable neighborhood search for Unit commitment problem

Raca Todosijevic, Mathematical Institute of the Serbian Academy of Sciences and Arts, 11000, Belgrade, Serbia, racatodosijevic@gmail.com, *Igor Crevits*, *Said Hanafi*, *Marko Mladenovic*, *Nenad Mladenovic*

Unit commitment (UC) problem for thermal units consists of finding optimal electricity production plan in long time period of T hours. For the first time Variable neighborhood search based heuristic is suggested in this paper as a mean for solving it. In each hour, economic dispatch (ED) problem which is the problem of convex programming is solved by lambda iteration method. Neighborhood structure N_k is defined by opening or closing k thermal units. Extensive computational results are performed on well-known test instances from literature.

2 - A VNS for the Real-Life Asymmetric Large-Scale MTSP with Stochastic Customers

Dauwe Vercamer, Marketing, Ghent University, Tweekerkenstraat 2, 9000, Gent, Belgium, Dauwe.Vercamer@ugent.be, *Dirk Van den Poel*, *Birger Raa*

When working in B2C environments, distribution logistics often deal with customers who are not at home. If a customer's service time is substantial compared to the travel times, it is clear this impacts the number of customers one vehicle can serve in its tour. Taking this into account, we developed in collaboration with a home vending company a VNS meta-heuristic that creates least-cost routes for a fleet of identical trucks. Given the impact of real-world constraints on the solution, we used real travel times. Our method solved instances of up to 30.000 customers within reasonable time.

3 - Environmental unit commitment problem with CO2 taxes

Marko Mladenovic, Numerical Mathematics and Optimization, University of Belgrade Faculty of Mathematics, Serbia, mladja87@gmail.com, *Igor Crevits*, *Said Hanafi*, *Nenad Mladenovic*, *Raca Todosijevic*

The unit commitment problem (UC) consists of optimally scheduling electrical power plants to produce sufficient power each hour with minimal fuel expenses. Depending on the fuel used by the plants a certain amount of carbon dioxide (CO2) will be emitted to the atmosphere. Ecological taxes that follow this emission vary from country to country and can be more expensive than the fuel itself. In this paper we offer a new and more realistic model for solving the UC problem including CO2 environmental taxes. To solve this new model we used the VNS methaheuristic.

4 - A system based on ontologies, agents and metaheuristics applied to the multimedia service of the brazilian digital television system

Toni Wickert, Informatic, Unisinos - Universidade do Vale do Rio dos Sinos, Av. Unisinos - 950, São Leopoldo, RS, Brazil, toniwickert@gmail.com, *Arthur Gomez*

With the advent of the Brazilian Digital Television System the users will be able to have an interactive channel. Thus, will be possible to access the multimedia application server, i.e., to send or to receive emails, to access interactive applications, among others. This paper proposes the development and the implementation of an architecture that includes a module that suggests the content to the user according to his profile and another module to optimize the content that will be transmitted. The implementation was developed using ontologies, software agents and metaheuristics.

■ WA-07

Wednesday, 8:30-10:00

RB-Eta

Logistics and Vehicle Routing

Stream: Vehicle Routing and Logistics Optimization
Invited session

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, Facultad de Matemáticas, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es
Chair: *Hipólito Hernández-Pérez*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), C/ Astrofísico Francisco Sánchez s/n, 38271, La Laguna, Canarias, Spain, hhperez@ull.edu.es

1 - One stage approximation algorithm to solve the 2LCVRP

Javier Faulin, Department of Statistics and OR, Public University of Navarre, Los Magnolios Building. First floor, Campus Arrosadia, 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, *Angel*, *A. Juan*, *Alba Agustín*, *Oscar Domínguez*

We propose a parameter-less algorithm (MultiRound-2LCVRP metaheuristic) to solve the two-dimensional loading capacitated vehicle problem (2LCVRP). From the biased randomization of the Clarke and Wright saving matrix, the algorithm merges routes that minimize distance costs and ensure loading feasibility. Our remarkable contributions are the next ones: (1) an optimal solution is reached from each

round, (2) the algorithm combine implicitly two completely different heuristics in only one and (3) for the loading part, any considered heuristic can be hold.

2 - Large Neighborhood Search for solving the Newspaper Delivery Problem

Belma Turan, Department of Business Administration, University of Vienna, Chair for Production and Operations Management, Brünner Straße 72, 1210, Vienna, Austria, belma.turan@univie.ac.at, *Karl Doerner*, *Richard Hartl*, *Verena Schmid*

We consider a real-world problem of delivering daily and weekly newspapers. The goal is to find a minimal number of vehicles that serve the stores at minimum travel costs. Fairness regarding the number of stops per driver is obtained by minimizing the number of stops per route. The objective is represented as a weighted sum of these three terms. The problem is formulated as a Multi Depot Multi Period Vehicle Routing Problem with Time Windows. A method inspired by ideas of Large Neighborhood Search is developed to solve the problem. We present results on data based on benchmark instances.

3 - A multi-commodity Pickup-and-Delivery Problem

Hipólito Hernández-Pérez, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), C/ Astrofísico Francisco Sánchez s/n, 38271, La Laguna, Canarias, Spain, hhpez@ull.edu.es, *Juan José Salazar González*

The "multi-commodity Pickup-and-Delivery Traveling Salesman Problem" is a generalization of the well-known TSP in which cities correspond to customers providing or requiring known amounts of m different products, and the vehicle has a given capacity. It is assumed that a specified product collected from a customer can be supplied to any other customer that requires a quantity of this product. We introduce a Mixed Integer Linear Programming model for the m -PDTSP, discuss a decomposition technique and describe some strategies to solve the problem. Computational results are presented also.

4 - The Robust Vehicle Routing Problem with Stochastic Demand

Remy Spliet, Econometric Institute, Erasmus University Rotterdam, Burgemeester Oudlaan 50, 3000DR, Rotterdam, Netherlands, Spliet@ese.eur.nl, *Adriana F. Gabor*, *Rommert Dekker*

We consider a vehicle routing problem where a schedule has to be designed before demand is known. Next, demand is revealed and we are allowed to adjust the original schedule to ensure capacity constraints are satisfied. However, it is not allowed to differ too much from the original schedule. Difference is measured by counting arcs that are used in the original schedule, but not in the adjusted schedule. We encountered this problem at Dutch retail chains. Too many adjustments, distorts operations beyond what managers think is acceptable. We develop a heuristic based on the classical Cluster-First Route-Second principle for the (Capacitated) Vehicle Routing Problem.

■ WA-08

Wednesday, 8:30-10:00
RB-Epsilon

Satisfiability and Hypergraphs

Stream: Boolean and Pseudo-Boolean Optimization
Invited session

Chair: *Stefan Porschen*, Fachgruppe Mathematik, Fachbereich 4, HTW Berlin, Fachbereich 4, Treskowallee 8, 10318, Berlin, Berlin, Germany, porschen@htw-berlin.de

1 - Euler walks in uniform hypergraphs

Zbigniew Lonc, Faculty of Mathematics and Information Sciences, Warsaw University of Technology, pl. Politechniki 1, 00-661, Warsaw, Poland, zblonc@mini.pw.edu.pl, *Pawel Naroski*

We generalize the concept of an Euler walk to uniform hypergraphs. The problem of deciding if a k -uniform hypergraph has an Euler walk is NP-complete, for k larger than 2. We prove that for a broad class of uniform hypergraphs an obvious necessary condition for existence of an Euler walk is sufficient as well. We also give a linear time algorithm for constructing an Euler walk and an Euler tour (if they exist) in this case. Motivations of studying Euler walks in hypergraphs come from the areas of geographic information systems, computer graphics and integer programming.

2 - Generalized Complexity of Subsumption

Arne Meier, Institut für Theoretische Informatik, Fakultät für Elektrotechnik und Informatik, Universität Hannover, Appelstrasse 4, 30167, Hannover, Germany, meier@thi.uni-hannover.de

Description Logics are a well known concept not only in the area of databases but also in the semantic web in terms of the web ontology language OWL 2. We turn towards the subsumption problem which has been referred to as the key inference problem by Nardi and Brachman. Given two formulae A, B and a terminology T , this problem asks if A implies B in every satisfying model for T . We restrict the allowed quantifiers as well as the Boolean functions and classify the computational complexity of these fragments. The Boolean restrictions are defined through Post's lattice using the term of clones.

3 - A satisfiability-based approach for generalized tanglegrams on level graphs

Andreas Wotzlaw, Institut für Informatik, Universität zu Köln, Köln, Germany, wotzlaw@informatik.uni-koeln.de, *Ewald Speckenmeyer*, *Stefan Porschen*

A tanglegram is a pair of trees on the same leaf set with matching leaves in the two trees joined by an edge. They are used in computational biology to compare evolutionary histories of species. We present a propositional logic based formulation of two combinatorial problems: the planar embedding and the crossing minimization problem. We show that our approach can handle cases with more than two, not necessarily binary, trees defined on arbitrary leaf sets. We conclude with an experimental comparison of our technique and several known heuristics for solving generalized binary tanglegrams.

4 - Satisfiability thresholds beyond k -XORSAT

Andreas Goerdt, Fakultät für Informatik, Technische Universität Chemnitz, 09107, Chemnitz, Germany, goerdt@informatik.tu-chemnitz.de, *Lutz Falke*

We consider random systems of constraint equations of length k which are interpreted as equations modulo 3: We show for k greater 15 that the satisfiability threshold of such systems occurs where the 2-core has density 1: The density is the number of equations divided by the number of variables. We show a similar result for random uniquely extendible constraints over 4 elements. Our results extend previous results of Dubois/Mandler for equations mod 2 and $k = 3$ and Connacher/Molloy for uniquely extendible constraints over a domain of 4 elements with $k = 3$ arguments.

■ WA-09

Wednesday, 8:30-10:00
RB-Zeta

Graphs and networks I

Stream: Graphs and Networks
Invited session

Chair: *Nicolas Bourgeois*, ESSEC Business School, 95000, Cergy, France, bourgeois@essec.fr

1 - On tightness in the analysis of Branch and Bound algorithms.

Nicolas Bourgeois, ESSEC Business School, 95000, Cergy, France, bourgeois@essec.fr

The running time of Branch-and-Bound algorithm is classically bounded by the size of the recursion tree. Still, this analysis fails to capture the fact that instances do not meet worst case at every step. Measure and Conquer was a first answer, showing how this upper

bound could be improved for several problems and algorithms. We display some classes of problems and algorithms where we prove that 'Measure and Conquer' analysis cannot be tight as well, and propose a new strategy to decrease the bound again. This includes, for example, the most straightforward algorithms for maximum clique.

2 - Moderately exponential approximation for Feedback Vertex Set.

Emeric Tourniaire, Lamsade, Paris Dauphine University, 75000, Paris, France, emeric.tourniaire@dauphine.fr

A feedback vertex set of a graph is a set that hits every cycle. Finding a minimal vertex set is one of the original Karp's problems, it is also APX-complete. On the other hand, some exponential algorithms faster than $2n$ have recently been issued [Fomin et al., 2009], but the upper bound they found in $O(1.74n)$ remains quite intractable for large instance. Following the paradigm defined by [Bourgeois, Escoffier and Paschos, 2010], we design a branching algorithm which can solve this problem with $(1+\epsilon)$ approximation ratio with smaller exponential time.

3 - Fast algorithms for finding specific subgraphs in Biology

Marc Bailly-Bechet, Biology, LBBE - Université Lyon 1, Lyon, France, marc.bailly-bechet@univ-lyon1.fr

Modern biology generates huge volumes of data that can be integrated using a network framework. One frequent question is to isolate in these graphs structures of interest. Finding appropriate connected subgraphs turns out to be a prize-collecting Steiner tree problem, computationally intractable. We develop a message-passing, probabilistic and distributed formalism, inspired from statistical physics, and apply our algorithm to various datasets combination in the baker's yeast. Our algorithm can deal with large data sets, run in parallel and be adapted to other problems in systems biology.

4 - Bipartite finite Toeplitz Graphs

Sara Nicoloso, IASI-CNR, Viale Manzoni 30, 00185, Roma, Italy, nicoloso@disp.uniroma2.it, *Ugo Pietropaoli*

Let n, a_1, \dots, a_k be distinct positive integers: a finite Toeplitz graph is a graph with n vertices, two of which are connected by an edge iff the absolute value of the difference of their indices is a_1, a_2, \dots, a_k . We characterize the whole family of bipartite finite Toeplitz graphs with $k=3$: the proved result completes the characterization of their chromatic number, and is based on a simple characterization of bipartite finite Toeplitz graphs with $k=2$. In addition, we characterize some classes of bipartite Toeplitz graphs with $k=4$.

■ WA-10

Wednesday, 8:30-10:00

RB-Theta

Non-deterministic models 3

Stream: Production Management & Supply Chain Management (contributed)

Contributed session

Chair: *Ernest Benedito*, Organitzacio d'Empreses, Universitat Politècnica de Catalunya, C/ Mare de Deu de Nuria, 41-43, 08017 Barcelona, Spain, ernest.benedito@upc.edu

Chair: *Frédéric Dugardin*, LOSI, University of Technology of Troyes, 12, rue Marie Curie, 10010, Troyes, France, frederic.dugardin@utt.fr

1 - Performance analysis through stochastic OEE simulation

Werner Schroeder, Economics and Business Management, Montanuniversität Leoben, Franz-Josef-Strasse 18, 8700, Leoben, Styria, Austria, werner.schroeder@wbw.unileoben.ac.at, *Markus Gram*

To reduce hidden losses is an important aim of manufacturing companies. The OEE is a well known and widely used operating metric to measure losses. Due to the deterministic nature of the calculation

model, the OEE only is reflecting a static image of the process efficiency. Since the influential variables can also be of stochastic nature our approach attempts to simulate these stochastic behaviors. It is examined, in particular, whether it makes more sense reducing the OEE variability than reducing its average value. The validation of the model will be confirmed by industrial application.

2 - A Two Stage Solution Procedure of Stochastic Programming Problem for Production Planning with Advance Demand Information

Nobuyuki Ueno, Dept. of Management Information Systems, Prefectural University of Hiroshima, 1-1-71 Ujina-Higashi, Minami-Ku Hiroshima-City, 734-8558, Hiroshima, Japan, ueno@pu-hiroshima.ac.jp, *Koji Okuhara, Takashi Hasuie*

Under demand uncertainty, the production planning problem with in advance demand information is formulated as a nonlinear stochastic programming problem. Feasible direction and cutting plane methods have been proposed, but they need the gradient of the probability function. We propose a two stage solution procedure. First, an approximate solution is obtained by solving iteratively a linear programming problem. Then, a near-optimal solution is looked for close to the solution, using problem convexity and meta-heuristics. The proposed procedure obtains near-optimal solutions efficiently.

3 - Stochastic bi-level programming of production planning in a reconfigurable aircraft fuselage assembly

Yohanes Kristianto, production, university of vaasa, yliopistonranta 10, 65101, vaasa, vaasa, Finland, ykristiantonugroho@gmail.com

Our research is motivated by a real life aircraft manufacturing. While the assembly sequence is not flexible due to the size of the aircraft parts and space constraint of the assembly plant. We solve the problem as a two-stage stochastic program where the production routing and scheduling have to be established in advance by anticipating the future variations about manufacturing lead times and the demands. We observe that the reformulation of the problem into a shortest path problem reduces the iteration time of the solution by implementing a column generation.

4 - Strategic capacity planning in a single-site production system considering renewal, maintenance, inventory and cash-flow management under uncertainty

Ernest Benedito, Organitzacio d'Empreses, Universitat Politècnica de Catalunya, C/ Mare de Deu de Nuria, 41-43, 08017 Barcelona, Spain, ernest.benedito@upc.edu

We propose a mixed-integer linear program for strategic capacity planning of a single-site production system, under uncertainty. The model takes into account the production planning, the inventory and cash-flow management, and tax payments. A computational experience is described and the results are explained. We propose a robust strategy to reduce the resolution time, by reducing the periods in which a capacity decision can be taken.

■ WA-11

Wednesday, 8:30-10:00

RB-Iota

Scheduling problems with additional constraints

Stream: Realistic Production Scheduling

Invited session

Chair: *Roman Capek*, Department of Control Engineering, Czech Technical University in Prague, Technicka 2, 12135, Prague, Czech Republic, capekrom@fel.cvut.cz

1 - New heuristics for the permutation flowshop problem with flowtime minimization

Ruben Ruiz, Departamento de Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Camino de Vera S/N, 46021, Valencia, Spain, rruiz@eio.upv.es, *Quan-Ke Pan*

In recent years a large number of heuristics have been proposed for the minimization of the flowtime in the permutation flowshop scheduling problem. This paper presents a comprehensive review and computational evaluation as well as a statistical assessment of 22 existing heuristics has been carried out. Five new heuristics are presented. The comparison results identify the best existing methods and show that the five newly presented heuristics are competitive or better than the best performing ones in the literature for the permutation flowshop problem with the total completion time criterion.

2 - A soft computing based approach to integrated process planning and scheduling with setup and machine capacity considerations

Filiz Şenyüzülür, Industrial Engineering, Zirve University, Zirve Üniversitesi Mühendislik Fakültesi, Kızıllıhisar Kampüsü 27260 Gaziantep, 27260, Gaziantep, Turkey, filissen@gmail.com, *Adil Baykasoğlu*, *Turkey Dereli*

The benefits gained from integrated process planning and scheduling in manufacturing industry motivated researchers to pay great effort on this subject. The present work investigates a new approach which makes use of Baykasoğlu's grammatical representation of generic process plans and clonal selection algorithm in order to integrate process planning and scheduling. In this approach Giffler&Thompson Algorithm and VIKOR method is employed by considering setup times and machine capacity constraints. Proposed approach is applied to some literature problems in order to analyze its performance.

3 - Blocking hybrid flow shop robotic cell scheduling problem with unrelated parallel machines, machine eligibility constraints and multiple part types

Seyda Topaloglu, Industrial Engineering, Dokuz Eylül University, 35160, Izmir, Turkey, seyda.topaloglu@deu.edu.tr, *Atabak Elmi*

This paper addresses the robotic scheduling problem in blocking hybrid flow shop cells with unrelated parallel machines, machine eligibility constraints, multiple part types, and a single robot to convey parts between stages. Initially, a mixed-integer programming model is proposed to minimize the makespan. Due to the complexity of the model, a simulated annealing based solution approach is developed using a new neighborhood structure based on block properties. The computational results demonstrate that the developed SA algorithm is efficient for this problem.

4 - Resource constrained project scheduling problem with alternative process plans and total changeover cost minimization

Roman Capek, Department of Control Engineering, Czech Technical University in Prague, Technická 2, 12135, Prague, Czech Republic, capekrom@fel.cvut.cz

We study the RCPSP problem with alternative process plans where the goal is to minimize the total changeover cost given by all performed changeovers. A special attention is paid to the model that includes deadlines and covers a possibility to define more alternative ways how to complete the project. A selection of activities present in the schedule influences both decision (finding a feasible schedule) and optimization problem. We propose a heuristic based on local search that is performed in a shifting time window. The heuristic is able to handle large scale instances in an efficient manner.

1 - A decomposition approach to real-time train rescheduling

Leonardo Lamorgese, SINTEF, Forskningsveien 1, 0314, Oslo, Norway, leonardo.lamorgese@gmail.com

Train rescheduling consists in the definition of new schedules and possibly new routes for trains when a deviation from the official timetable occurs. This must be done quickly and the new solution should minimize (a measure of) the total deviation. In contrast with the classic "holistic" approach, we show how to decompose the problem into a station problem and a line problem. This decomposition allows the use of different models which can take advantage of the features of specific railway infrastructure. We solve to optimality a number of real-life instances from single-track lines in Italy.

2 - Opportunities and challenges with new railway planning approach in Sweden

Malin Forsgren, SICS, Box 1263, 16429, KISTA, Sweden, malin@sics.se, *Martin Aronsson*, *Sara Gestrelus*, *Hans Dahlberg*

Long lead times in railway planning can give rise to a significant discrepancy between the original plan and the traffic eventually operated, resulting in inefficient utilization of capacity. Research shows that the railway sector in Sweden would benefit from a different planning approach in which capacity consuming decisions are pushed forward in time whenever possible. This approach is currently being implemented at Trafikverket, the Swedish Transport Administration. With it follows a number of mathematical opportunities and challenges, some of which will be presented in this talk.

3 - A Rapid Branching method for the Vehicle Rotation Planning Problem

Markus Reuther, Optimization, Zuse-Institut Berlin, Takustrasse 7, 14195, Berlin, Germany, reuther@zib.de, *Ralf Borndörfer*, *Thomas Schlechte*, *Steffen Weider*

The Vehicle Rotation Planning Problem is to schedule rail vehicles, i.e., the rolling stock, in order to cover the trips of a given timetable by a cost optimal set of vehicle rotations. The Problem integrates several facets of railway optimization, i.e., vehicle composition, fleet management, maintenance constraints, and regularity aspects. We propose an Rapid Branching algorithm that we are using to solve very large scale instances given by our industrial partner DB Fernverkehr AG, which is the largest intercity railway operator in Germany.

4 - Railway transportation planning optimization

Jean Damay, Innovation & Research, SNCF, 40, avenue des terroirs de France, 75611, Paris, France, jean.damay@sncf.fr, *Francis Sourd*

Our contribution consists in the optimization of the passenger railway transportation supply in a specific area. Given on this area the possible train routings and the passenger traffic forecasts on a regular day, the model provides to the carrier a transportation plan that respects structural hard constraints, minimizes the violation of specific soft constraints, and optimizes the customer conveyance and the inherent investment costs. The resolution is based on a decomposition of this large problem and embeds OR technics such as mixed integer programming, meta-heuristic, or list algorithms.

■ WA-12

Wednesday, 8:30-10:00

RB-Omicron

Railway Optimization I

Stream: Optimization in Public Transport
Invited session

Chair: *Gabrio Curzio Caimi*, Netzentwicklung, BLS Netz AG, Genfergasse 11, 3001, Bern, Bern, Switzerland, gabrio.caimi@bls.ch

Chair: *Marco Laumanns*, IBM Research - Zurich, 8803, Rueschlikon, Switzerland, mml@zurich.ibm.com

■ WA-13

Wednesday, 8:30-10:00

RB-Tau

Uncertainty in Inventory Management

Stream: Inventory Management
Invited session

Chair: *Mario Guajardo*, Finance and Management Science, NHH Norwegian School of Economics, NHH, Institutt for Foretaksøkonomi, Helleveien 30, 5045, Bergen, Norway, Mario.Guajardo@nhh.no

1 - Forest biomass planning under uncertainty

Mikael Rönnqvist, Département de génie mécanique, Université Laval, G1V 0A6, Québec, Canada, mikael.ronnqvist@nhh.no, *Patrik Flisberg, Mikael Frisk*

The interest in forest biomass has increased dramatic. Compared to traditional forest logistics, an additional transformation, chipping, must be planned. The demand at heating plants is uncertain with seasonal variations. This makes it difficult to coordinate the best use of resources for harvesting, chipping, inventory and transportation. The inventory management to secure supply is critical. Hence there is a need for OR based decision support dealing with large scale operations under uncertainty. We report on industrial case studies from the Swedish forest industry.

2 - Safety Stock Placement in Multi-Echelon Inventory Systems - A Comparison of the Stochastic-Service and Guaranteed-Service Approaches

Thomas Wensing, INFORM GmbH, Pascalstr. 23, 52076, Aachen, NRW, Germany, wensingt@web.de

When demand is stochastic, one can think of two basic fulfillment-policies for an inventory system. First, the system may fully capture demand uncertainty and thus provide a constant (guaranteed) service time to the following levels. Second, uncertainty may only partially be captured, meaning that the system's supply process will be stochastic, too. We analytically compare these two strategies based on a linear multi-echelon inventory system and indicate practical implications.

3 - Inventory management and pooling of spare parts in an energy company

Mario Guajardo, Finance and Management Science, NHH Norwegian School of Economics, NHH, Institutt for Foretaksøkonomi, Helleveien 30, 5045, Bergen, Norway, Mario.Guajardo@nhh.no, *Mikael Rönnqvist*

We study the inventory of spare parts problem in an energy company, producer of oil and gas. Spare parts are stored in several plants, which control their inventory per separate based on a min-max system. We apply methods to decide control parameters for this system under the fill rate constraint. We distinguish unit-size and lot-size demand cases, based on several distribution models. After the control parameters are found, we use them to analyze the impact of two main sources of savings: risk pooling among the plants and correcting inventory inaccuracy coming from duplicate item codes.

■ WA-14

Wednesday, 8:30-10:00

RB-Omega

Workforce scheduling II

Stream: Timetabling and Rostering

Invited session

Chair: *Lakhdar Djeflal*, Universit Hadj-lakhdar, 05000, Batna, Algeria, lakdar_djeffal@yahoo.fr

1 - Solving the Integrated Physician and Surgery Scheduling Problem Under Stochastic Demand

Christophe Van Huelde, Faculty of Economics and Business Administration, Ghent University, Tweekerkenstraat 2, 9000, Gent, Belgium, christophe.vanhuele@ugent.be, *Mario Vanhoucke*

We present a stochastic program to solve both the operating theatre scheduling problem as the physician rostering problem. Both problems have received a huge amount of attention in literature, but the combination remains untackled, largely due to complexity. The stochastic integer programming formulation is created based on the most important objectives and restrictions of both problems. We analyze schedules after applying variation on the surgeries. Our experiments show some interesting insights for physician roster schedulers as well as operating theatre scheduling managers.

2 - An Optimisation Model for Staff Planning in a Home Care Organisation

Pablo Andrés Maya Duque, Environment, technology and technology management, University of Antwerp, Stadscampus, S.B.513, Prinsstraat 13, 2000, Antwerp, Antwerp, Belgium, pmayaduque@gmail.com, *Marco Castro, Kenneth Sörensen, Peter Goos*

In this talk, we present the core optimisation component of a decision support system that Landelijke Thuiszorg, a non-profit organisation that provides home care services for several provinces in Belgium, will implement in order to assist the regional service planning. The optimisation model takes into account assignment, scheduling and routing decisions simultaneously, while considering two objectives, namely the service level and the travelled distance. A solution strategy based on a set partition formulation and a randomised local search is described and its performance is evaluated.

3 - A Branch and Bound Algorithm for Pharmacy Duty Scheduling Problem

Ozgur Ozpeynirci, Department of Logistics Management, Izmir University of Economics, Sakarya Cad. No:156, Balçova, 35330, Izmir, Turkey, ozgur.ozpeynirci@ieu.edu.tr

In Turkey, the pharmacies provide service during the daytime of weekdays. At the nights of weekdays and at the weekends, only on duty pharmacies provide service. The pharmacy duty scheduling (PDS) problem aims to assign duties to the pharmacies in the least costly way over a planning horizon. The PDS is multi-period facility location problem with special side constraints and it is NP-Hard. We propose a branch and bound algorithm and test the performance of the algorithm on randomly generated instances. The study is supported by the Scientific and Technological Council of Turkey (TUBITAK).

4 - A Mixed Integer Linear Program for Scheduling Problem

Lakhdar Djeflal, Universit Hadj-lakhdar, 05000, Batna, Algeria, lakdar_djeffal@yahoo.fr

Our work deals with a personal scheduling problem where the staff wishes and degrees of quality regarding their timetable are taken into account. This optimization problem is modelled as a mixed integer linear programming program. A solution algorithm based in branch and price procedure is then presented. Computational results are presented showing the ability of our algorithm to solve realistic instances and comparison with other solution approaches.

■ WA-15

Wednesday, 8:30-10:00

RB-2101

Vector and Set-Valued Optimization III

Stream: Vector and Set-Valued Optimization

Invited session

Chair: *Vicente Novo*, Matematica Aplicada, Universidad Nacional de Educacion a Distancia, Juan del Rosal no. 12, 28040, Madrid, Spain, vnov@ind.uned.es

Chair: *Elena Molho*, Dipartimento di Scienze Economiche e Aziendali, Università di Pavia, Via San Felice 5, 27100, Pavia, Italy, molhoe@eco.unipv.it

1 - Accuracy functions and robustness tolerances in vector discrete optimization

Yury Nikulin, Department of Mathematics and Statistics, University of Turku, Matematiikan laitos, Turun yliopisto, Vesilinnantie 5, Luonnontieteiden talo, 20014, Turku, Finland, yurnik@utu.fi, *Marko M. Mäkelä, Olga Karelkina*

A general vector combinatorial optimization problem is considered where individual linear cost functions are subject to small independent perturbations. For the Pareto optimality principle appropriate definitions of the worst-case relative regret and robust solution are specified. It is shown that these definitions are closely related to the concept of accuracy function. We also present formulae allowing the calculation of robustness tolerances of a single cost vector.

2 - On generalized well-posedness for vector optimization

Ruben Lopez, Departamento de Matematica y Fisica Aplicadas (DMFA), Universidad Catolica de la Santisima Concepcion, Alonso Ribera 2850, 409-0541, Concepcion, VIII Region, Chile, rlopez@ucsc.cl

The aim of this work is to study notions of generalized well-posedness for vector optimization problems. To do this, we employ a recent notion of approximate solution for vector optimization problems coupled with a notion of variational convergence for vector-valued functions.

3 - A notion of well-posedness in set-valued optimization

Elena Molho, Dipartimento di Scienze Economiche e Aziendali, Università di Pavia, Via San Felice 5, 27100, Pavia, Italy, molhoe@eco.unipv.it, César Gutiérrez, Enrico Miglierina, Vicente Novo

We study a notion of pointwise well-posedness in the setting of set optimization. We study the properties of a scalarization of the set optimization problem in the sense of Gerstewitz that allows us to characterize the strict minimizers on a collection of cone-proper sets. We characterize the well-posedness of the set optimization problem through the well-posedness, in the Tykhonov sense, of an associate family of scalar optimization problems. Finally, we use a notion of quasiconvexity for set-valued maps in order to individuate a class of well-posed problems.

■ WA-16

Wednesday, 8:30-10:00
RB-2103

Conic Optimization: Algorithms and Applications

Stream: Linear and Conic Programming
Invited session

Chair: Knut Haase, Institut f. Verkehrswirtschaft, Lehrstuhl BWL, insb. Verkehr, Universität Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, knut.haase@wiso.uni-hamburg.de

1 - Speeding up the spectral bundle method by solving the quadratic semidefinite subproblems with a PSQMR approach

Christoph Helmberg, Fakultät für Mathematik, Technische Universität Chemnitz, D-09107, Chemnitz, Germany, helmberg@mathematik.tu-chemnitz.de, Kim-Chuan Toh

The spectral bundle method is tuned to solving semidefinite programs (SDP) with large semidefinite matrix variables having constant or bounded trace. For efficient bundle sizes, solving a quadratic semidefinite subproblem by interior point methods formed the bottleneck so far. We report on our experience with a preconditioned symmetric quasi minimal residual (PSQMR) approach for computing the Newton step in this interior point method like in the package QSDP. On our test instances this results in significant savings. However, results are not yet satisfactory for cutting plane approaches.

2 - New results in copositive optimization

Mirjam Duer, Mathematics, University of Trier, 54286, Trier, Germany, duer@uni-trier.de

Copositive programming (i.e., minimization of a linear function over the cone of copositive matrices) is a highly useful tool to model non-convex quadratic problems, possibly even including binary variables. In this talk, we discuss some recent developments, such as copositivity tests, cutting plane algorithms and the relationship to Parrilo's approximation hierarchy.

3 - A Semidefinite Optimization Approach to Multi-Row Facility Layout

Philipp Hungerländer, University of Klagenfurt, Austria, philipp.hungerlaender@uni-klu.ac.at, Miguel Anjos

The multi-row facility layout problem is concerned with placing departments along one or several rows so as to optimize objectives such as material handling and space usage. Significant progress has been made in recent years on solving single-row problems to global optimality using semidefinite optimization. In our talk we present the extension of the semidefinite programming approach to multi-row layout. Our computational results show that the proposed semidefinite optimization approach provides high-quality global bounds in reasonable time for double-row instances with up to 16 departments.

4 - A Branch-and-Price Approach for Sales Force Deployment

Knut Haase, Institut f. Verkehrswirtschaft, Lehrstuhl BWL, insb. Verkehr, Universität Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, knut.haase@wiso.uni-hamburg.de, Sven Müller

The objective of sales force deployment is to maximize the total profit. In literature valid upper bounds are not provided. We propose a semi-infinite binary model. The LP-relaxation is solved by column generation. For the optimal objective function value of the LP-relaxation an upper bound is provided. Branch-and-Price is used to obtain a tight gap for the objective function value of the optimal integer solution. We propose contiguity constraints ensuring contiguous territories. The largest instance comprises 50 potential locations and 550 sales coverage units: 1273 sec., gap < 0.01.

■ WA-17

Wednesday, 8:30-10:00
RB-2105

Global Optimization 2

Stream: Global Optimization
Invited session

Chair: Herman Mawengkang, Mathematics, The University of Sumatera Utara, FMIPA USU, KAMPUS USU, 20155, Medan, Indonesia, mawengkang@usu.ac.id

Chair: Dmitry Krushinsky, Department of Operations, University of Groningen, Nettelbosje 2, 9747 AE, Groningen, Netherlands, d.krushinsky@rug.nl

Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Modeling Super-flexibility Sustainable Distribution Centre of a Supply Chain

Rosen Purba, Mathematics Dept., STMIK Mikroskil Medan/Graduate School of Mathematics, University of Sumatera Utara, Jalan Thamrin No. 140 Medan North Sumatera, Medan, Indonesia, purbaronsen17@yahoo.com

A supply chain is a network that performs the procurement of raw material, the transportation of raw material to intermediate and end products, and the distribution of end products to retailers or customers. Super-flexibility is defined as the capacity to transform by adapting to new realities. So far, superflexibility has not been included in the model of sustainable supply chain. In this paper we address a new optimization model to decide distribution centres based on super-flexibility and environmental consideration.

2 - Fish Processed Production Planning Under Uncertainty Considering Quality

Tutiarny Naibaho, Mathematics, Quality University, FMIPA USU, 20155, Medan, North Sumatera Province, Indonesia, tutiarny.naibaho@yahoo.com

The goal in production planning is to meet customer demand. The major decisions are production and inventory levels for each product and the number of workforce in each planning period. This paper considers the management of small traditional business at North Sumatera Province which performs processing fish into several local seafood products. The inherent uncertainty of quality to be met, leads the production planning problem to a chance constraint programming model. We use scenario generation based approach for solving the model.

3 - On multi-objective black box optimization of expensive objectives

Vytautas Jancauskas, Vilnius University, LT-01513, Vilnius, Lithuania, vytautas.jancauskas@mif.vu.lt, *Antanas Zilinskas, Panos Pardalos*

The problems are supposed non-convex, gradients not available; possible number of computations of objectives is relatively small. Therefore metrics used to evaluate algorithms should be defined correspondingly. The selection of test functions representing real world expensive multi-objective problems is discussed. Prospective of generalization of the algorithms, supposed to the single-objective global optimization of expensive problems, to the multi-objective optimization is analyzed including Lipschitz approach, algorithms based on statistical models, radial basis functions based algorithms.

4 - Optimality and multiobjectiveness of cell formation in group technology

Dmitry Krushinsky, Department of Operations, University of Groningen, Nettelbosje 2, 9747 AE, Groningen, Netherlands, d.krushinsky@rug.nl, *Boris Goldengorin, Jannes Slomp*

In this talk we present an exact model for cell formation based on the minimum multicut problem. We show that minimisation of intercell movement may not be appropriate as a sole goal. Several alternative objectives are proposed together with the ways of inserting them into the considered model. An industrial example is used for illustrative purposes.

■ WA-20

Wednesday, 8:30-10:00

RB-2113

Portfolio Decision Analysis

Stream: Decision Making Modeling and Risk Assessment in the Financial Sector

Invited session

Chair: *Marius Radulescu*, Institute of Mathematical Statistics and Applied Mathematics, Casa Academiei Române, Calea 13 Septembrie nr.13, Bucharest 5, RO-76100, 050711, Bucharest, Romania, mradulescu@csm.ro

1 - Absolutely optimal portfolios

Gheorghita Zbaganu, Faculty of Mathematics and Informatics, University of Bucharest, Academiei 14., Bucharest, Romania, gheorghitazbaganu@yahoo.com, *Marius Radulescu*

Consider n risky assets. A portfolio is a n -dimensional vector whose components represent the proportions of the sum owned by the investor that are invested in assets. A portfolio x is called absolutely optimal if it realizes the maximum of the expected utility of its return for every concave utility function. The aim of the paper is to give characterizations of those financial markets for which a given portfolio is absolutely optimal. Here by a financial market we understand a random vector whose components are the random variables associated with the rate of return of assets.

2 - Structured Portfolio Management under Ambiguity

Jean-luc Prigent, ThEMA, University of Cergy-Pontoise, 33, Bd du Port, 95011, CERGY-PONTOISE, France, jean-luc.prigent@u-cergy.fr, *Hachmi Ben Ameur*

In this paper, using results about martingale theory and convex analysis, we determine the general optimal portfolio payoff within ambiguity. We extend results of Leland (1980), Pflug and Wozabal (2007) and generalize the robust optimization of Ben-Tal and Nemirovski (1998,1999) by introducing the ambiguity index based on relative entropy. Our findings have important applications in financial engineering for the optimal design of financial structured portfolios.

3 - Determination of the Optimal Weights in a Currency Portfolio with Sharpe Ratio Maximizing Approach

Celal Barkan Güran, Management Engineering, İstanbul Technical University, Ulus Sok. 11/8 Sezer Apt, Suadiye, 34740, İstanbul, Turkey, barkan_guran@hotmail.com, *Oktay Taş*

In this paper we design a portfolio whose components are all currencies that are officially traded in Turkey. Based on the last five years daily data, the currencies lying outside the efficient frontier is excluded from the analysis and then Sharpe Ratio function, whose independent variables are the weights of the corresponding currencies, is constituted. Finally, the optimal weights maximizing this Sharpe Ratio function is found by using numerical optimization methods. This study can be considered as one of the leading portfolio optimization works about the currencies traded in Turkey.

4 - Applications of portfolio theory to production planning for fish farms

Marius Radulescu, Mathematical Statistics, Institute of Mathematical Statistics and Applied Mathematics, Casa Academiei, Calea 13 Septembrie, nr. 13, 050711, Bucharest, Romania, mradulescu.csmro@yahoo.com, *Constanta Zoie Radulescu, Sorin Radulescu*

The paper presents several single period portfolio selection models for production planning in fish farms. The aim of the models is to find optimal fish production plans. A fish production plan is a couple (x,y) formed by a binary matrix (denoted by x) that describes the allocation of fish species to pools and a vector y that describes the money allocations to pools. The objective functions and the constraints of the models are the financial risk and the expected return of the fish production plans. In order to solve the models heuristic algorithms and computer simulation is used.

■ WA-21

Wednesday, 8:30-10:00

RB-2115

Financial Service Management

Stream: Long Term Financial Decisions

Invited session

Chair: *Heinz Eckart Klingelhöfer*, Managerial Accounting and Finance, Tshwane University of Technology, Building 12, Room 117, Private Bag X680, 0001, Pretoria, Gauteng, South Africa, KlingelhoefHE@TUT.ac.za

1 - Long-term Simulation of Investment Strategies

Geraldine Tchegho, Faculty 7: Business Studies & Economics; Department of Finance, University of Bremen, Hochschulring 4, 28359, Bremen, Germany, tchegho@uni-bremen.de, *Thorsten Poddig*

Pension funds and life insurance companies face the problem of long-term return guarantees, either as a promised return rate or any kind of capital guarantee. Investors need to know how the return-risk-profiles behave in the long run. We investigate vector autoregressive and Markov switching models as well as a simple random walk model as benchmark to simulate asset returns using US macro economic data from 1871-2011. We use a rolling estimation window to assess performance and show that the different asset return simulation models lead to considerably varying results.

2 - Investments into Services

Heinz Eckart Klingelhöfer, Managerial Accounting and Finance, Tshwane University of Technology, Building 12, Room 117, Private Bag X680, 0001, Pretoria, Gauteng, South Africa, KlingelhoefHE@TUT.ac.za

The paper investigates the characteristics of services and develops a two-step approach for their valuation. The first step delivers the individually optimal service programme. The second step allows for valuating investments into new services and for identification of the determinants of the investments price ceiling. The may be interpreted as (corrected) net present values of the payments and the interdependencies arising from changes in the optimal programs. We use sensitivity analysis and example to support these findings and to get more information on the effects of these determinants.

3 - When to cut a tree

Fritz Helmedag, Economics, Technical University of Chemnitz, Chair VWL II, Thueringer Weg 7, 09107, Chemnitz, Germany, f.helmedag@wirtschaft.tu-chemnitz.de

For about two centuries, the optimal rotation period in forestry has been debated intensively. According to the meanwhile prevalent opinion, the so-called Faustmann condition solves the problem because it maximizes the present value of woodland. The result, however, contradicts the 'principle of maximum yield', i.e. it is productively inefficient. The article develops Faustmann's approach further and provides an objective function suited to reconcile available cutting rules.

4 - When to cut a tree given sustainability constraints

Thomas Burkhardt, Campus Koblenz, IfM, Universitaet Koblenz-Landau, Universitätsstr. 1, 56070, Koblenz, Germany, tburkha@uni-koblenz.de

In a remarkable paper Helmedag analyzes the problem when to cut a tree and derives an optimality condition which is independent of the interest rate, as opposed to the well known Faustmann approach. We discuss this approach and claim that a proper inclusion of sustainability constraints resolves the contradiction.

■ WA-23

Wednesday, 8:30-10:00

RB-Delta

Optimization in Machine Learning

Stream: Convex Optimization

Invited session

Chair: *Ronny Luss*, Sierra Project Team, INRIA, France, ronnyluss@gmail.com

Chair: *Vadim Strijov*, Russian Academy of Sciences, Computing Center, Vavilova 42-268, 119333, Moscow, Russia, Russian Federation, strijov@ccas.ru

1 - Application of cutting plane methods in machine learning

Vojtech Franc, Department of Cybernetics, Czech Technical University in Prague, FEE, Technicka 2, 16627, Prague, Czech Republic, xfrancev@cmp.felk.cvut.cz

Cutting plane methods are optimization techniques that incrementally construct an approximation of a feasible set or an objective function by linear inequalities called cutting planes. Numerous variants of this basic idea are among standard tools used in convex nonsmooth optimization. Recently, cutting plane methods have seen growing interest in the field of machine learning. We describe basic theory behind these methods and show several of their applications to solving machine learning problems. We concentrate on learning structured output classifiers and their applications in computer vision.

2 - Sparse Rank-One Matrix Approximations: Convex Relaxations, Direct Approaches, and Applications to Text Data

Ronny Luss, Sierra Project Team, INRIA, France, ronnyluss@gmail.com, *Marc Teboulle*

The sparsity constrained rank-one matrix approximation problem is a difficult mathematical optimization problem arising in a wide array of useful applications. We survey a variety of approaches including convex relaxations and direct approaches to the original nonconvex formulation. Convex relaxations are solved by applying fast first-order methods, while the direct approach builds on the conditional gradient method. Numerical experiments and applications with text data will be given.

3 - Optimizing support vector regression parameters by using global search algorithm

Alexey Polovinkin, Computational Mathematics and Cybernetics, Nizhny Novgorod State University, Nizhny Novgorod, Russian Federation, alexey.polovinkin@gmail.com, *Konstantin Barkalov*, *Nikolai Zolotykh*, *Iosif Meyerov*, *Sergey Sidorov*

The performance of Support Vector Regression (SVR) significantly depends on insensitive zone thickness, a penalty factor and kernel function parameters. The most popular algorithms for finding optimal parameters of SVR use optimization of cross-validation error function that is multiextremal in general case. We use global search algorithm (based on information-statistical approach for global optimization) to solve multiextremal optimization problem. The algorithm reduces multidimensional problem to equivalent one-dimensional problem by applying Peano-type space-filling curves.

■ WA-24

Wednesday, 8:30-10:00

CC-A11

Data Mining and Decision Making

Stream: Data Mining and Decision Making

Invited session

Chair: *Benjamin Gotthardt*, Department of Mathematics and Scientific Computing, Uni Graz, 8010, Graz, Styria, Austria, bennogotthardt@yahoo.de

1 - Development of Traffic Accidents Prediction Model with Neural Networks

Muhammed Yasin Çodur, Engineering/civil, Ataturk University, Ataturk University Engineering Faculty Civil Engineering department no :224, 25240, Erzurum, Turkey, mycodur@atauni.edu.tr, *Ahmet Tortum*

Road traffic accidents continue to be a major problem in Turkey. It is important to clarify the relationship between traffic accidents and various influencing factors in order to reduce the number of traffic accidents. The data was collected on the Turkey/Erzurum Highways. In order to minimize the uncertainty of the data, neural network theory were applied. The neural network theory can provide fair learning performance by modeling the human neural system mathematically. In conclusion, this study focused on the practicability of the neural network theory for traffic safety analysis.

2 - Multi product Newsvendor-problem - solution with NCP and a non-trivial effect

Benjamin Gotthardt, Department of Mathematics and Scientific Computing, Uni Graz, 8010, Graz, Styria, Austria, bennogotthardt@yahoo.de, *Marc Reimann*

This talk investigates a multi product Newsvendor-problem with two limited capacity sources. Under uncertain demand the solution contains the production strategies (speculative, reactive, dual or no production) and the produced quantities for each product. Until now only models governed by one limited capacity are known in literature. In the solution process a non-trivial effect was found: With decreasing level of one capacity (other one kept constant), a back-and-forth switch between production strategies occurs. Due to the special structure of the Newsvendor an NCP is used to solve it.

3 - A cash flow and profitability monitoring system for retailers in the greek pharmaceutical industry

George Marinakos, Engineering Sciences, University of Patras, 26500, Patras, Greece, george.marinakos@yahoo.com, *Sophia Daskalaki*, *Theodor Drinias*, *Kostas Tsekouras*

We present a cash flow and profitability monitoring solution designed for Greek pharmacies. It relates accounting entries with credit time and so reflects the times of cash flows for a business unit. The equations take into account attributes that affect liquidity. Monthly inflows and outflows are represented by equations that eventually build the liquidity curve and the cash flow balance overtime. The model has an ambitious and useful purpose, to inform and consult the owners of the business units and the other members of the pharmaceutical chain and thus reduce financial risk for the chain.

4 - Preference Modelling and Market Price Forecasting with Causal-Retro-Causal Neural Networks

Hans Georg Zimmermann, Corporate Technology CT T, Siemens AG, Otto-Hahn-Ring 6, 81730, München, Germany, Hans_Georg.Zimmermann@siemens.com, Ralph Grothmann, Christoph Tietz

Forecasting of market prices is a basis of rational decision making. Recurrent neural networks offer a framework for modelling temporal developments. Causality explains the present state of a system by features, which are prior to the current state. Looking for alternatives, we remember that markets are human made dynamical systems. In microeconomics we describe human behaviour with utility functions. If we know the human reward function, we could describe the behaviour of the market participants and thus the market by retro causal equations. This approach improves the forecasting accuracy.

■ WA-25

Wednesday, 8:30-10:00

CC-A23

Future role of nuclear

Stream: Long Term Planning in Energy, Environment and Climate

Invited session

Chair: Nicklas Forsell, CMA, CMA, France, nicklas.forsell@cma.ensmp.fr

1 - Future challenges for the French power generation paradigm

Edi Assoumou, Centre de Mathematiques Appliquees, Mines ParisTech, Sophia Antipolis, France, edi.assoumou@cma.ensmp.fr, Vincent Mazauric, Nadia Maïzi

In the late 80's France shifted from fossil fuel consumption to electricity due to its nuclear power plants electricity producing capacity. We propose to examine the consequences of this shift in terms of long term energy policy in France. We apply an updated TIMES-FR model that optimizes energy systems with explicit descriptions of the technologies used. Through scenarios that reflect different nuclear policies, we illustrate the impact of future energy choices on the evolution of French electricity generating system for the 2050 horizon and assess the question of reliability of the system

2 - Looking Japan energy future after the 11th March 2011's earthquake

Adrien Wacziarg, EPI, EDF, 75, Paris, France, adrien.wacziarg@gmail.com, Nadia Maïzi, Prabodh Pourouchottamin

The scope of the study is to investigate the consequences of the Great East Japan Earthquake on the energy future of Japan and elsewhere, while conducting prospective studies. One important focus will be Japan's possible long term evolution, beyond the current post-crisis climate. This will lead to a better understanding of how other countries, most notably western will change and the parameters that comes into play.

3 - Critical Analysis of "Energy 2050" report: An overview of the French electricity mix

Renaud Dudouit, MINES ParisTech, 06904, Sophia Antipolis Cedex, France, renaud.dudouit@mines-paristech.fr

In wake of the Fukushima accident and national targets to reduce the greenhouse gases emissions, Questions are being raised concerning how the French electricity mix will evolve. "Energy 2050" report tries to answer these questions by studying 4 scenarios of nuclear production: extension of the operation of today's nuclear power plants, acceleration of 3rd generation (European Pressurized Reactor) deployment, reduction of nuclear power capacity, and exit of the nuclear power. This study will analyze these different scenarios and evaluate their impact on the future French electricity mix.

4 - An evaluation of the European CCS potential

Olivia Ricci, Orleans Economic Laboratory, University of Orleans, 45067, Orleans, France, olivia.ricci@univ-orleans.fr, Sandrine Selosse

Carbon negative biofuels could be obtained if a carbon capture and geological storage (CCS) chain is applied to their production. This study evaluates the potential of biofuels-CCS in the transport sector in order to limit temperature increase as far below 2C as possible. This analysis is conducted with the multiregional TIAM-FR optimization model.

■ WA-26

Wednesday, 8:30-10:00

CC-A24

OR and Environmental Management

Stream: OR and Environmental Management

Invited session

Chair: Ralf Gössinger, Business Administration, Production and Logistics, University of Dortmund, Otto-Hahn-Str. 6, 44227, Dortmund, Germany, ralf.goessinger@udo.edu

Chair: Michael Kaluzny, Business Administration, Production and Logistics, University of Dortmund, Germany, michael.kaluzny@tu-dortmund.de

1 - A Modified Cross Entropy Method for the Optimization of an Environmentally Sustainable Supply Chain

Ali Eshragh Jahromi, School of Mathematical Sciences, The University of Adelaide, North Terrace Campus, 5005, Adelaide, South Australia, Australia, ali.eshraghjahromi@adelaide.edu.au, Behnam Fahimnia

We develop an optimization model that minimizes the overall supply chain costs while explicitly incorporating multiple environmental performance measures including carbon emission, energy consumption and waste generation. A modified Cross-Entropy solution approach is designed to determine the optimal production and distribution strategies for the proposed environmentally sustainable supply chain. Lastly, numerical results from the model implementation in a real world case study are analyzed and interesting practical and managerial implications are discussed.

2 - Resilience of the smart meter-enabled electricity supply chains

Behzad Samii, Operations and Technology Management Center, Vlerick Research, Reep 1, 9000, Gent, Belgium, behzad.samii@vlerick.be, Hakan Ümit

Controlling demand is one of the most effective —yet hard to reach— ways to achieve resilience in any supply chain. In electricity supply chains, fortunately, the real-time consumption data provided by the smart meters can be instrumental in designing mechanisms to flatten demand (i.e. resilience by variability reduction) during the peak hours. In this study, we use actual consumption data (recorded by the smart meters in two Belgian towns during the summer of 2011) to propose and compare subscribers' segmentation mechanisms based on the 15-minute and 24-hour meter reading frequencies.

3 - Value co-creation system for B2B service: A case study on after-sales service of electric power industry

Nobuhiko Nishimura, Faculty of Economics, Nagasaki University, 4-2-1, Katafuchi, 850-8506, Nagasaki, Japan, nishimura@nagasaki-u.ac.jp

The service proposal process in B2B sector still has been carried out mainly by experienced service engineers. The objective of this research is to establish efficient value co-creation process of the B2B service for the after-sales service of electric power plants. A number of service proposal documents were disassembled into elemental service components using the text mining. Each service proposal was characterized as the integration of each elemental service component. Then the causal relation of the criteria to the business circumstances was modeled with Bayesian network approach.

4 - Energy price models: Regime switching with clustering techniques

Baptiste Salasc, R&D, Air Liquide, Centre de recherche Claude & Delorme, 1, chemin de la porte des Loges B.P 126, 78354, Jouy-en-Josas, France, baptiste.salasc@airliquide.com, Steven Gabriel, Yohan Shim

Energy prices present different commonly known smooth features, like mean reversion, troubled by highly volatile periods in the occurrence of unexpected jumps, spikes or structural breaks. The purpose of this work is to investigate the possibility to apply clustering methods used in data mining (k-mean, k-median) to the detection and reproduction of one of the specific features of energy prices: the regime switching. The application of clustering techniques to energy price regime switching models improved significantly the robustness of the underlying mean reversion model parameters estimation

■ WA-27

Wednesday, 8:30-10:00

CC-A25

Decision Support Systems

Stream: Decision Support Systems

Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, Toulouse University, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

1 - Decisions, processes, and decision processes for enabling risk sharing and performance creation at the buyer-supplier interface

Kristian Rotaru, Accounting and Finance, Monash University, Australia, 900 Dandenong Rd, 3145, Caulfield East, Victoria, Australia, Kristian.Rotaru@buseco.monash.edu.au, *Carla Wilkin, Leonid Churilov*

We investigate how, through alignment of risk-performance objective trade-offs and underlying business processes, risk sharing and performance creation can be enabled at the buyer-supplier interface in collaborative supply chain processes. This is achieved by extending the Risk-Aware Value-Focused Process Engineering modeling methodology to formally represent value creation mechanisms that are driven by both performance improvement and risk minimization objectives of buyers and suppliers and align these mechanisms with process components at the buyer-supplier interface.

2 - Modelling to generate alternatives using biologically-inspired algorithms

Julian Scott Yeomans, OMIS, Schulich School of Business, York University, 4700 Keele Street, SSB S338, M3J 1P3, Toronto, Ontario, Canada, syeomans@schulich.yorku.ca, *Raha Imanirad*

In solving real-world programming applications, it is preferable to generate numerous alternatives providing disparate perspectives. They should possess near-optimal measures to all known modelled objective(s), but be different in their system structures. Biologically-inspired modelling-to-generate-alternative algorithms are particularly efficient at creating multiple solution alternatives that both satisfy required system performance criteria and yet remain maximally different in their decision spaces. Efficacy of some bio-inspired methods is demonstrated on some applications.

3 - The Role of product factors, sellers' factors and attitude toward risk on e-store purchasing

Arik Sadeh, Management of Technology, Holon Institute of Technology, 52 Golomb Street, P.O. Box 305, 58102, Holon, Israel, sadeh@hit.ac.il

The willingness to purchase products in e-stores is examined. Three aspects of purchasing are explored: (1) the role of product factors, (2) sellers' factors and (3) the attitude of buyers toward risk. The product factors are quality and price of a given product while accurate product description, on-line seller accountability, and privacy and security

are sellers' factors. Portfolios of these five factors are examined with respect to motivation to purchase in e-stores using an experimental design scheme. The attitude of buyers toward risk is examined using Zukerman's sensation questionnaire.

4 - A multicriteria decision scheme for water pipe replacement prioritization

Youssef Tlili, GESTE, ENGEES, 1 Rue Quai Koch, 67000, Strasbourg, France, youssef.tlili@engees.unistra.fr, *Amir Nafi*

The goal of this study is to identify a reliable replacement policy for pipes of a water distribution system. The paper deals with two topics: 1) Asset management of water networks which is based on the prioritization of pipes that require an urgent intervention for the rehabilitation or replacement. 2) Decision-making concerning the classification of pipe candidates for renewal through the comparison between two kinds of aggregation methods: a) sophisticated methods or models, b) simple understandable schemes.

■ WA-28

Wednesday, 8:30-10:00

CC-A27

OR Military Applications

Stream: OR in Military, Safety and Security Applications

Invited session

Chair: *Ana Isabel Barros*, Military Operations, TNO, POBox 96864, 2509 JG, The Hague, Netherlands, ana.barros@tno.nl

Chair: *Herman Monsuur*, Faculty of Military Sciences, Netherlands Defence Academy, P.O. Box 10.000, 1780 CA, Den Helder, Netherlands, h.monsuur@nlda.nl

1 - Taking uncertainty into account in Unmanned Aerial Vehicle tour planning

Lanah Evers, Defence, Security and Safety, TNO, P.O. Box 96864, 2509 JG, The Hague, Netherlands, lanah.evers@tno.nl, *Kristiaan Glorie, Suzanne van der Ster, Ana Isabel Barros, Herman Monsuur*

Unmanned Aerial Vehicles (UAVs) are used to gather information for both civilian and military purposes by capturing imagery of specific locations in the area of interest. We model this problem as the orienteering problem. To cope with environmental dynamics, we introduce the Two Stage Orienteering Problem (TSOP), which accounts for the effect of fuel uncertainty on the tour information gain. Using stochastic programming we formulate and solve the TSOP and show that the resulting tours have a higher expected tour information gain than tours resulting from a robust optimization approach.

2 - Multi objective decision analysis for fighter squadrons flight scheduling problem

Mehmet Durkan, Turkish Staff College, Turkey, mehmet_durkan@hotmail.com

Flight scheduling in fighter squadrons is a hard and complicated problem which comes with a dynamic environment and multiple decision makers. Using pilots as machines and missions to be flown as jobs, it can be solved like an assignment problem. In this research, the Value Focused Thinking method is applied to build a decision analysis model to help decision makers in fighter squadrons evaluate the mission-pilot matches. The model is used not only for evaluating matches but also for ordering assignments to see priorities and proved to be helpful and accelerated the assignment matching process.

3 - Determining maintenance manpower requirements for aircraft units

Nicole van Elst, TNO - Defense, Security and Safety, POBox 96864, 2509 JG, The Hague, Netherlands, nicole.vanelst@tno.nl, *Wouter Noordkamp*

When introducing a new weapon system the required maintenance manpower levels is an important issue. This paper describes how the Dutch manpower that is required to guarantee future F-35 operations

has been calculated using simulation. Due to the nature of defense operations it is nearly impossible to compensate for shortages. Thus Measures of Effectiveness (MOEs) to determine whether the manpower levels are adequate may not be based on averages. We describe which MOEs are used and how the required number of replications has been determined, since confidence intervals could not be used.

4 - Lifetime management of defence fleet capability

Patrick Tobin, Arts and Sciences, Australian Catholic University, St Patricks Campus, Victoria Pde Fitzroy, 3065, Melbourne, Victoria, Australia, patrick.tobin@acu.edu.au

Efficient management of defense fleet capability and effective maintenance and replacement of assets over a variety of time horizons is an important operational issue affecting various types of platform. Many common features exist in studying all of these assets (platforms) including efficient maintenance on a scheduled basis, dealing effectively with unscheduled maintenance and addressing long term sustainability of capability which meet budget targets and use constraints. We look at various approaches to the problem. Difficulties arise in each type of approach which tackles this aspect.

■ WA-29

Wednesday, 8:30-10:00

CC-A29

Data Mining

Stream: Optimization and Data Mining

Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

1 - Exact and heuristic algorithms based on Support Vector Machine for Feature Selection with application to Financial Problems

Renato De Leone, School of Science and Technologies, Università di Camerino, via Madonna delle Carceri 9, 62032, Camerino, MC, Italy, renato.deleone@unicam.it, *Sonia De Cosmis*

SVMs are tool belonging to the class of supervised learning methods that can solve Regression and Feature Selection Problems. Robustness can be incorporated to address the issue of uncertainties and bounded variability in the data. In this talk we will present new heuristic algorithms for Robust Support Vector Regression and Feature Selection. We will show that, the use of Simulated Annealing allows to efficiently select a subset of features, moreover, the use of robustness slightly decreases the quality of the solution in the training set while improving the quality for the test set.

2 - Arrhythmia Classification via Mathematical Programming

Emre Çimen, Industrial Engineering, Anadolu University, Anadolu Üniversitesi İki Eylül Kampüsü Endüstri Mühendisliği no:106, 26000, Eskişehir, Turkey, ecimen@anadolu.edu.tr, *Gurkan Ozturk*

Heart diseases are killing millions every year. A lot of people lose their lives due to failure of diagnose heart disease earlier. Therefore, early detection of arrhythmia which is significant portion of heart diseases can be defined as a classification problem. The aim of this study is to develop an arrhythmia classifier based on mathematical programming which consists of k-means clustering algorithm and polyhedral conic functions. Proposed classifier is tested on MIT — Bih and UCI Arrhythmia databases.

3 - Proposal for generation of the three-way Perceptual Map using non-metric Multidimensional Scaling with clusters

Moacyr Machado Cardoso Junior, Production Department, Aeronautics Institute of Technology - ITA, R Licinio Rodrigues Alves 114, Chácara Jafet, 08730661, Mogi das Cruzes, São Paulo, Brazil, moacyr@ita.br, *Rodrigo Scarpel*

The proposal for improvement of the Three-Way perceptual map using MDS involves the separation of the judges in homogeneous clusters, so that more than one perceptual map of the group of judges will be generated. The validation of clusters was performed with an Ex-ante indicator of quality. The Final configurations obtained for each cluster were tested for effective separation of centroids within objects. The separation ratio generated an Ex-post indicator of quality of the separation of clusters. The results showed that the use of two or three clusters were optimal in most cases.

■ WA-30

Wednesday, 8:30-10:00

CC-A31

Scheduling Applications

Stream: Emerging Aspects of Production Planning in Continuous Process Industries: Theory, Optimization, and Practice

Invited session

Chair: *Krystina Bakhrankova*, Applied economics, SINTEF - Technology and society, Box 4760 Sluppen, S. P. Andersens veg 5, 7465, Trondheim, Norway, krystina.bakhrankova@sintef.no

1 - Single machine scheduling with due dates and perishable raw materials

Jean-Charles Billaut, University of Tours, 37200, Tours, France, jean-charles.billaut@univ-tours.fr, *Federico Della Croce*, *Patrick Esquirol*, *Jean-François Tournamille*

We consider a single-machine scheduling problem. Each job is characterized by duration, a due date and a quantity, corresponding to a raw material. All jobs require the same product, which is characterized by a volume per vial and life duration after opening. We search for a schedule, minimizing the quantity of lost product and satisfying a given value of the maximum lateness. This NP-hard problem comes from a chemotherapy production, where perishable active agents are required for the realization of medical drugs. Efficient solution methods based on integer linear programming are proposed.

2 - Optimum cost blending application in flour mills

Mehmet Akif Sahman, Selcuk University, Turkey, asahman@selcuk.edu.tr, *Abdullah Oktay Dundar*, *Adem Alpaslan Altun*

The quality and trade-off optimization of the product produced at flour mills is a significant problem. In this study, the most appropriate cost blending decision in producing flour suitable to the quality sought by customers from among various varieties and qualities of wheat was realized by using linear programming (the Big M method). The application was coded from among the object-oriented programming languages, Visual C#. Based on the results obtained, it was observed that the linear program produced optimal value solutions that were rapid and decisive.

3 - Production Scheduling in Batch Process Industries Using Timed Automata Models

Subanatarajan Subbiah, Dept. of Biochemical and chemical engineering, Technische Universität Dortmund, Emil-Figge strasse 70, 44227, Dortmund, NRW, Germany, subanatarajan.subbiah@bci.tu-dortmund.de, *Christian Schoppmeyer*, *Sebastian Engell*

The approach to model complex scheduling problems in the process industries by timed automata (TA) and to solve them using reachability analysis is presented. The machines and the jobs are modeled as sets of TA in a modular fashion and are composed to form a global automaton (GA) - directed graph. The GA has an initial node where no task has been started and at least one target node where all tasks to produce the products have been finished. Each path from the initial node to a target represents a schedule and a cost optimal reachability analysis is performed to compute the optimal schedule.

■ WA-32

Wednesday, 8:30-10:00

CC-A34

DEA and Performance Measurement: Methodology 4

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Cecilio Mar-molinero*, Kent Business School, University of Kent, KBS, University of Kent, CT2 7PE, Canterbury, Kent, cm235@kent.ac.uk

1 - On the properties of a linear transformation of variables in Data Envelopment Analysis

Abolfazl Keshvari, Aalto University School of Economics, Finland, abolfazl.keshvari@aalto.fi, *Pekka Korhonen*

We consider the problem of making a linear transformation of variables in DEA. When a linear transformation is nonsingular, no problems arise provided the efficient frontier is re-defined. Instead, problems ensue, if a linear transformation is singular. This is the case, when we reduce the number of variables. Using the geometrical structure of DEA, we show how different sets of variables can change the dominance cones and affect the efficient frontier. We will consider various dimension reduction methods applied in DEA and point out that a user has to be very careful in choosing the method.

2 - Classifying Inputs and Outputs Based on TOPSIS Method Using Modified DEA Model

Sahand Daneshvar, Industrial Engineering, Eastern Mediterranean University, North Cyprus (via Mersin 10 Turkey), 5555, Gazimagusa, Famagusta, Turkey, sahand.daneshvar@emu.edu.tr, *Gokhan Izbirak*

In conventional data envelopment analysis, it is assumed that the input versus output status of any particular performance measure is known. In some situations, finding the status of some variables from the input or output point of view is very difficult; these variables are treated as both inputs and outputs and are called flexible measures. In this paper the CCR Model, modified by facet analysis, and TOPSIS Method are used for classifying inputs and outputs based on Cook and Zhu (2007), for specifying the input versus output status of flexible measures.

3 - Weights in the multi-activity DEA model

Cecilio Mar-molinero, Kent Business School, University of Kent, KBS, University of Kent, CT2 7PE, Canterbury, Kent, cm235@kent.ac.uk, *Fabiola Portillo*, *Diego Prior*

The standard DEA model assumes that the units to be assessed perform a single activity by using inputs to generate outputs. The multi-activity DEA model allocates efficiency scores to each one of the activities that are jointly performed, but there is a cost: the formulation becomes non-linear. We discuss the difference between the standard and linearized model within a micro-economic theoretical framework, and use Karush-Kuhn-Tucker theory to demonstrate that the linearized and the standard model only produce the same results if the units being assessed are 100% efficient at all activities.

■ WA-33

Wednesday, 8:30-10:00

CC-A37

Sustainable Development in Civil Engineering and Multi-attribute Decision Making

Stream: OR for Sustainable Development
Invited session

Chair: *Tatjana Vilutiene*, Department of Construction Technology and Management, Vilnius Gediminas Technical University, Sauletekio ave. 11, LT01001, Vilnius, Lithuania, tatjana.vilutiene@vgtu.lt

1 - Logistics significance of wood product manufacturing on competitiveness based management

Kristine Fedotova, Civil construction and real estate economics, Riga Technical University, Meza 1/7-212, LV-1048, Riga, Latvia, kristine.fedotova@inbox.lv, *Ineta Geipele*, *Sanda Geipele*

Topicality is associated with the important contribution of wood products manufacturing in Latvian economy. Important role in development of wood products manufacturing has improvement of wood products manufacturing that includes acceptance of strategic management decisions and solutions for wood resource flow optimization throughout wood products added value chain, as well as an interference with related industries. Solutions of logistics issues play leading role in increasing manufacturing management by providing options of product manufacturing cost optimization.

2 - Structural Reliability Analysis and Decision Support Applying Probabilistic Methods

Robertas Alzbutas, Lithuanian Energy Institute, Kaunas University of Technology, LT-44403, Kaunas, Lithuania, robertas@mail.lei.lt, *Gintautas Dundulis*

A probability-based modelling approach was developed to analyze reliability of critical structures and to support decisions for managing of uncertainty. If parameters of structural model are uncertain, then this randomness is taken into account. As example the parameters important for structural integrity are analysed. The finite element method is used for the deterministic analysis of strength and then applying probabilistic methods the parameters under uncertainty were taken into consideration and probabilities of structural failure were estimated.

3 - Model of structure solution selection for the sustainable building's design

Klaus Holschemacher, Faculty of Civil Engineering and Architecture, HTWK Leipzig, Karl-Liebknecht-Strasse 132, 04277, Leipzig, Germany, klaus.holschemacher@fb.htwk-leipzig.de, *Ernestas Gaudutis*, *Jolanta Tamosaitiene*

The aim of sustainable development is to minimize the ecological damage resulting from infrastructure creation, operation and maintenance, reduce the ecological footprint of human activities. Many concepts of sustainable design aren't properly estimated in high rise buildings design process. The objective of this research is to demonstrate how simulation can be used to reflect fuzzy inputs, which allows more complete interpretation of model results. Authors discuss on advantages and disadvantages of presented sustainable high rise building structural system selection model.

4 - Selection of the rational modernization measures: Case of art school modernization in Birstonas city

Tatjana Vilutiene, Department of Construction Technology and Management, Vilnius Gediminas Technical University, Sauletekio ave. 11, LT01001, Vilnius, Lithuania, tatjana.vilutiene@vgtu.lt, *Česlovas Ignatavičius*

Significant reduction of energy costs, improvement of building indoor comfort conditions, reduction of pollution of the environment, improvement of aesthetic appearance of the building and extending the lifetime of the building are important issues of modernization. This article presents the analysis of energy saving measures for art school in Birstonas, Lithuania. Objective of the study is to select appropriate energy saving measures by comparison of packages of energy saving measures.

■ WA-34

Wednesday, 8:30-10:00

CC-A39

Solution concepts for TU-games

Stream: Cooperative Game Theory
Invited session

Chair: *Ilya Katsev*, St. Petersburg Institute for Economics and Mathematics, Russian Academy of Sciences, Tchaikovsky st. 1, 191187 St. Petersburg, Russia, 195067, Saint-Petersburg, Russian Federation, katsev@yandex.ru

1 - The [0,1]-nucleolus in 3-person cooperative TU-games

Nadezhda Smirnova, International Banking Institute, Russian Federation, nadezhda.v.smirnova@gmail.com, *Svetlana Tarashnina*

We investigate a new solution concept of a cooperative TU-game called the [0,1]-nucleolus in a class of 3-person TU-games. We construct analytical formulas for calculation of the solution. Early it has been proved that the [0,1]-nucleolus contains the prenucleolus, the SM-nucleolus for arbitrary 3-person TU-games and the modiclus for balanced games. So, the obtained formulas are hold for them as well.

2 - The lexicographic prekernel

Elena Yanovskaya, Game Theory and Decision Making, St.Petersburg Institute for Economics and Mathematics, RAS, Tchaikovsky st. 1, 191187, Saint-Petersburg, Russian Federation, eyanov@emi.nw.ru

The lexicographic prekernel of a cooperative game with transferable utilities lexicographically minimizes the maximal surpluses of one player over another. It is a non-empty efficient solution contained in both the least core and the prekernel, and it may not contain the prenucleolus (Yarom, 1981). In the presentation a combinatorial characterization of vectors belonging to the lexicographic prekernel is given. The characterization is a weak analog of the known Kohlberg's (Kohlberg 1971) characterization of the prenucleolus with the help of balanced collections of coalitions.

3 - The SD-prenucleolus for TU games

Ilya Katsev, St. Petersburg Institute for Economics and Mathematics, Russian Academy of Sciences, Tchaikovsky st. 1, 191187 St. Petersburg, Russia, 195067, Saint-Petersburg, Russian Federation, katsev@yandex.ru

We introduce and characterize a new solution concept for TU games. The new solution is called SD-prenucleolus and is a lexicographic value although is not a weighted prenucleolus. The SD-prenucleolus satisfies several desirable properties and is the only known solution that satisfies core stability, strong aggregate monotonicity and null player out property in the class of balanced games. The SD-prenucleolus is the only known solution that satisfies core stability, continuity and is monotonic in the class of veto balanced games

4 - Cooperative games on accessible union stable systems

Rene van den Brink, Econometrics, VU University Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, Netherlands, jrbrink@feweb.vu.nl, *Encarnación Algaba*, *Chris Dietz*

We consider restricted cooperation in cooperative games where the set of feasible coalitions (i) contains the emptyset, (ii) is union stable (i.e. the union of every two non-disjoint feasible coalitions is feasible), and (iii) satisfies accessibility (i.e. every feasible coalition has at least one player such that without this player the coalition is feasible). This generalizes several known set systems such as the sets of connected coalitions in an undirected graph and antimatroids. We provide results on these structures, their dual structures, their supports and an associated restricted game.

■ WA-35

Wednesday, 8:30-10:00

CC-A41

Sports and OR

Stream: OR in Sports
Invited session

Chair: *Luciano Mercadante*, School of Applied Science, University of Campinas, Pedro Zaccaria St, 1300, Jd Santa Luzia, Limeira, SP, Brazil, 13484350, Limeira, São Paulo, Brazil, lucianomerc@yahoo.com.br

1 - A proposal for redesign of the FedEx Cup playoff series on the PGA TOUR

Chris Potts, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, C.N.Potts@soton.ac.uk, *Nicholas Hall*

We propose a new design for The TOUR Championship, the final event of the FedEx Cup playoff series on the PGA TOUR, whereby the tournament is a strongly seeded match play event. We validate our design by estimating the probability that a player with a particular rank entering The TOUR Championship finishes in various positions in the FedEx Cup standings. A match play format is chosen because it is closer to the spirit of a playoff event than stroke play. We discuss how our proposal achieves the various objectives outlined by PGA TOUR Commissioner Tim Finchem about a possible redesign.

2 - The pooling of sports teams in parallel competitions

Dennis Van den Broeck, MOSI, VUB, P.P. Rubensstraat 9, 1880, Kapelle-op-den-Bos, Belgium, devdbroe@vub.ac.be

Although the organization of sports competitions is widely discussed in literature, less attention was devoted to the phenomenon of parallel competitions at some fixed hierarchical level. This is often the case in countries covering huge geographical areas or in the organization of regional sports. The term pooling is used for the process of grouping teams together in separate (parallel) competitions. In this contribution models based on mathematical optimization are given to achieve fair results. Applications in Belgian football are discussed and recommendations are given.

3 - Forecasting in-play match outcome in One-day international Cricket

Muhammad Asif, Center of Operational Research and Applied Statistics, University of Salford, 86 Ayres Road, M16 7GP, Manchester, United Kingdom, m.asif@edu.salford.ac.uk, *Ian McHale*

We present a model to forecast in-play match outcome in One-day international cricket. We use the modified Duckworth/Lewis method to estimate the remaining wickets resources at each given stage of the innings. These resources can further be used as an important covariate for logistic model.

4 - Patient transportation and mountain running: looking for optimal solutions

Martin Bracke, Department of Mathematics, University of Kaiserslautern, Gottlieb-Daimler-Str. 48, 67663, Kaiserslautern, Rheinland-Pfalz, Germany, bracke@mathematik.uni-kl.de

Mathematical Modelling with students at high school and undergraduate/graduate level has long been our focus. This paper introduces two real-world problems, namely the planning of efficient patient transportation in large hospitals and the design of optimal strategies in mountain running. We are going to outline some important findings from different student groups. Moreover, we shortly discuss similarities and differences of the various approaches as well as common challenges of the modelling teams.

■ WA-36

Wednesday, 8:30-10:00

CC-A43

Societal Complexity, Healthcare and Sustainable Development

Stream: Methodology of Societal Complexity
Invited session

Chair: *Dorien DeTombe*, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB, Amsterdam, Netherlands, detombe@nosmo.nl

Chair: *Eizo Kinoshita*, Urban Science Department, Meijo University, 4-3-3 Nijigaoka, 509-0261, Kani, Gifu, Japan, kinoshit@urban.meijo-u.ac.jp

1 - How to handle societal complexity

Dorien DeTombe, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB, Amsterdam, Netherlands, detombe@nosmo.nl

In the world of today there are many complex societal problems such as climate change and credit crisis, traffic and pollution. Policy makers handle these problems globally or locally depending on the problem. When policy makers are not trained during their academic education they should ask for scientific support on handling complex societal problems. A scientific methodology for handling complex societal problems is developed in the field of Methodology of Societal Complexity. Applying this methodology leads to a more stable and sustainable changes of complex societal problems.

2 - A framework for asking questions about the state of the art: the Methodology of Societal Complexity

Stephen Taylor, Champlain Regional College, Retired, 5320 Avenue MacDonald, Apt 207, H3X 2W2, Cote Saint-Luc, Quebec, Canada, steveta@alumni.concordia.ca

Predicting the future of humankind is difficult and complex. The immediate future continues the past, but, while many scenarios provide possible futures, the dominant theme is change. Mediating change will be the predominant occupation of future societal leaders, and many changes are rooted in complex societal problems. This session provides a framework for discussion of the current state and future of the study of complex societal problems, focusing attention on aspects of the COMPRAM Methodology. The participants' contributions will guide leaders of the field find pathways to its future.

3 - Globalization or isolation?-Ricardo's Model

Eizo Kinoshita, Urban Science Department, Meijo University, 4-3-3 Nijigaoka, 509-0261, Kani, Gifu, Japan, kinoshit@urban.meijo-u.ac.jp

Through the attempt to clarify justifiable economic circumstances where a policy of globalization and/or a policy of national isolation is proven valid, the author revealed in this thesis that there are two such economic phases: An economy where the theory of comparative advantage, proposed by David Ricardo, is applicable and an economy where the theory is not applicable. The author applied his original approach to prove the validity of Ricardo's comparative advantage theory, and found that the theory can be justified only when a macro economy is in the primal problem phase.

4 - Critical systems practice in generating creative knowledge

Slavica P. Petrovic, Faculty of Economics, University of Kragujevac, D. Pucara 3, 34 000, Kragujevac, Serbia, pslavica@kg.ac.rs

Critical Systems Practice (CSP), as a met methodology, is based on critical systems thinking. CSP consists of four phases: creativity (to identify key dimensions of the problem situation), choice (to select a systems methodology/ies, methods for tackling the problem situation), implementation (to make and implement proposals for change) and reflection (to assess the intervention and learn about the problem situation and the methodology/ies, methods). Through paradigm diversity protection, CSP seeks to provide creative knowledge for managing complex organizational and societal problems.

Jelena Hadzi-Purić, Department for Computer Science, Faculty of Mathematics, Studentski trg 16, 11000, Beograd, Serbia, Serbia, jelenagr@matf.bg.ac.rs, *Jeca Grmusa*

Pediatric drug dosing should be based on knowledge of the physiological characteristics of drugs and pharmacokinetic parameters obtained during clinical trials. Evidence of safety and efficiency cannot be extrapolated from adults to children (especially for antibiotics therapy). The objectives of this paper are to review the quantitative features of chosen antibiotics, to introduce appropriate mathematical model and solver. We have also designed an extensible Web application that regularly updates the database with dosing changes, adverse reactions of drugs and biochemical parameters.

2 - An accurate model of Critical Care Unit through queueing theory

Izabela Komenda, Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, United Kingdom, komendai@cardiff.ac.uk, *Jeff Griffiths*, *Vincent Knight*

The random behaviour of arrivals and lengths of stay within a Critical Care Unit (CCU) make for a complex system. As such dealing with the growing constraints on the healthcare system at the acute level is difficult. In this study queueing theory is used to develop a new mathematical model of patients' flow. Predictions from the model are compared to the observed performance of the Units in the real world, and the sensitivity of the model to changes in Unit size is explored.

3 - Providing healthcare for elderly in smart homes

Radu Prodan, Automation, Technical University Cluj-Napoca, Gheorghe Baritiu Street, no.26-28, room 350, 400027, Cluj-Napoca, Cluj, Romania, prodan.radu@gmail.com, *Ioan Nascu*

The main objective of this paper is that of proposing a smart environment which monitors the elderly people continuously in their daily living at home and in case of happening of an accident or a major health problem sends an emergency call for help. The paper concentrates on implementation details and practical considerations of merging the various technologies into a functional system. (Acknowledgment: TUCN, paper supported by contract no. POSDRU/107/1.5/S/78534, project co-funded by the European Social Fund through the Sectorial Operational Program Human Resources 2007-2013)

4 - A compact formulation for the Kidney Exchange Problem

Xenia Klimentova, INESC TEC, 4000, Porto, Portugal, xenia.klimentova@inescporto.pt, *Miguel Constantino*, *Ana Viana*, *Joao Pedro Pedroso*, *Abdur Rais*, *Filipe Alvelos*

In recent years several countries set programs that allow exchange of kidneys between two or more incompatible patient-donor pairs. These programs are commonly referred to as Kidney Exchange Programs (KEPs) and can be modeled as integer programs (IPs). Previously proposed IP formulations are exponential either in the number of constraints or of variables. In this talk, a new compact IP formulation for the KEP will be presented. The new description and computational results will be compared to other known formulations.

WA-37

Wednesday, 8:30-10:00

CC-Act

OR in Health & Life Sciences 5

Stream: OR in Health & Life Sciences (contributed)
Contributed session

Chair: *Ana Viana*, INESC TEC/ISEP, Campus da FEUP, Rua Dr. Roberto Frias, 4220-465, Porto, Portugal, aviana@inescporto.pt

1 - Operations Research for pediatric care systems: an opportunity for the personal medical advisor in antibiotic treatment**WA-38**

Wednesday, 8:30-10:00

HH-Colombus

Multiobjective Optimization in Location Problems

Stream: Multiobjective Optimization
Invited session

Chair: *José Rui Figueira*, Instituto Superior Tecnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, figueira@ist.utl.pt
Chair: *Christiane Tammer*, Mathematics and Computer Science, Martin-Luther-University Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06120, Halle, Germany, christiane.tammer@mathematik.uni-halle.de

1 - Robust multicriteria optimization problems

Elisabeth Köbis, Faculty of Natural Sciences II, Martin-Luther-Universität Halle-Wittenberg, Institute of Mathematics, 06099, Halle (Saale), Saxony-Anhalt, Germany, elisabeth.koebis@student.uni-halle.de

In this talk, we propose a class of robust multicriteria optimization problems. We show that well-known robust optimization problems correspond to certain scalarizations of robust multicriteria optimization problems by proving that solutions of the corresponding scalar problem are weakly and, under uniqueness conditions, strictly Pareto optimal for the robust multicriteria problem. Additionally, we show that we get well-known concepts of robustness by using the Tammer-Weidner-functional. Furthermore, we propose applications for robust multicriteria optimization problems in location theory.

2 - Location Problems with Future Facilities

Andrea Wagner, Mathematics, Martin-Luther-Universität Halle, Theodor-Lieser-Straße 5, 06120, Halle/Saale, Germany, andrea.wagner@mathematik.uni-halle.de, *Kathrin Klamroth*, *Christiane Tammer*

The talk deals with median location problems where the goal is to establish one new facility with respect to a set of existing facilities as well as a set of future facilities. Future facilities are equivalent to the existing ones concerning their usage but they do not exist yet. In case of polyhedral distances the problem will be linearized. For the more general case of an arbitrary norm, duality statements will be given using a generalized Lagrange function. Further it will be shown that the dual of the linearized problem and the Lagrange dual problem coincide in case of polyhedral norms.

3 - An algorithm for solving multicriteria location-cost optimization problems

Shaghaf Alzorba, Mathematics, Martin-Luther-Universität, Richard-Paulick-Str.13, 1210, 06124, Halle, Sachsen-Anhalt, Germany, shaghaf7z@yahoo.com

We investigate a multicriteria location - cost optimization problem, where distances as well as cost functions are to be minimized. First, using a decomposition method we solve the vector-valued location part. A convex partition algorithm for the solution set of the location problem is derived in order to minimize the linear (cost vector-valued) part over this partition. Finally, we present the implementation of the algorithm in Matlab.

4 - Robustness in Multiobjective Optimization

Jonas Ide, Fakultät für Mathematik, Georg-August-Universität Göttingen, Germany, j.ide@math.uni-goettingen.de, *Anita Schöbel*, *Matthias Ehrgott*

Robust Optimization considers problems with uncertain objective function or feasible set. Due to various applications, many different interpretations of robustness exist. These various concepts so far only apply to single objective functions. Hence, the question arises how to extend these robustness concepts to multiobjective optimization. In this talk we present some robustness concepts for multiobjective problems. We will concentrate on strictly robust efficiency, discuss how to compute these robust solutions and show how this concept can be applied in portfolio optimization.

Lidija Zadnik Stirn, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, lidija.zadnik@bf.uni-lj.si

Management of protected areas which calls for an equilibrium of economic, ecological, technological and social objectives is based on long-term, sustainable and multiple use (agriculture, forestry, water, CO₂, etc.) principles. Several stakeholders with conflicting interests are included through participatory planning of development possibilities. The model established on new developed group AHP methods and dynamic programming will be used to solve the treated management problem. The acceptable consistency of the aggregated group interval judgments is ascertained on individual crisp judgments.

2 - A dynamic programming approach to analyze the development of non conventional oil supply under uncertainty: application to the Canadian oil sands

Frederic Lantz, IFP-School, 228, avenue Napoleon Bonaparte, 92852, Rueil-Malmaison, France, frederic.lantz@ifpen.fr

The aim of this paper is to model the development of the non conventional Canadian crude oil under uncertainty and increasing environmental cost. First, a LP model has been set-up in a deterministic approach. Second, a dynamic programming model has been developed with several crude oil prices and CO₂ taxes level. The simulation for 2030 with the LP model point out that the Canadian tar sands could represent a significant crude oil supply. However, the results of the dynamic programming model point out the negative impact of uncertainties on the development of the resource.

3 - A Parallel Procedure for Dynamic Multi-objective TSP

Weiqi Li, School of Management, University of Michigan-Flint, 303 East Kearsley Street, 48502, Flint, Michigan, United States, weli@umflint.edu

This paper proposes a parallel procedure for dynamic multi-objective TSP. For each of the objectives, a multi-start local search algorithm runs on several processors for the dynamic TSP. A solution attractor drives the local search trajectories to converge into a small region in the solution space. This procedure identifies the solutions from the solution attractor. This procedure not only generates a set of Pareto-optimal solutions, but also provides the structural information about each of the solutions, which can aid a decision-maker in choosing the best compromise solution in real-time.

4 - Bi-criteria optimization problem of binary objects flow servicing by stationary service processor with storage container

Anastasia Kuimova, Department of Computer Sciences, Control Systems and Telecommunications, Volga State Academy of Water Transport, 5a Nesterova St., 603950, Nizhni Novgorod, Russian Federation, anastasia.kuimova@gmail.com

The mathematical model of binary objects flow servicing in one servicing processor system with storage container is considered. The problem of synthesizing effective service policies subject to two independent criteria is formulated. This problem is proved to be NP-hard. It is solved based on Pareto optimization concept. Total set of Pareto-optimal service policies is synthesized using the bi-criteria dynamic programming based algorithm. The model gives a description of mass water-transport control processes such as diesel fuel deliveries to the Northern Territories of the Yamal Peninsula.

WA-39

Wednesday, 8:30-10:00

HH-Cousteau

Dynamic Programming 1

Stream: Dynamic Programming
Invited session

Chair: *Lidija Zadnik Stirn*, Biotechnical Faculty, University of Ljubljana, Vecna pot 83, 1000, Ljubljana, Slovenia, lidija.zadnik@bf.uni-lj.si

1 - Decision support model based on group AHP and dynamic programming for optimal regulation of protected areas**WA-40**

Wednesday, 8:30-10:00

HH-Livingstone

Preference Learning 4

Stream: Preference Learning
Invited session

Chair: *Willem Waegeman*, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure links 653, 9000, Ghent, Belgium, willem.waegeman@ugent.be

1 - Preference elicitation for interactive learning of Optimization Modulo Theory problems

Andrea Passerini, disi, University of Trento, via sommarive 5, 38100, Povo di Trento, Italy, passerini@disi.unitn.it, Paolo Campigotto, Roberto Battiti

We consider unknown decision maker preferences as weighted combinations of predicates in a certain theory of interest. We developed an iterative approach alternating a search and a learning stage: (i) the current approximation of the preference function is optimized (Optimization Modulo Theory), providing a set of candidate solutions; (ii) the preference function is refined according to the DM feedback on these candidates. The learning stage relies on a sparse ranking algorithm aimed at automatically selecting the relevant predicates and their combination, among a catalogue of candidate ones.

2 - On the characterization of a ranking procedure based on a natural monotonicity constraint

Michael Rademaker, Departement of Mathematical Modelling, Statistics and Bioinformatics, Ghent University, Coupure links 653, 9000, Gent, Belgium, michael.rademaker@ugent.be, Bernard De Baets

In previous work, we formulated a new ranking procedure in the traditional context where each voter has expressed a linear order relation or ranking over the candidates. The final ranking of the candidates is taken to be the one which best adheres to a natural monotonicity constraint. For a ranking $a > b > c$, monotonicity implies that the strength with which $a > c$ is supported should not be less than the strength with which either one of $a > b$ or $b > c$ is supported. Though some properties of the ranking procedure have been determined, a formal characterization is still ongoing.

3 - Preference learning for automated reasoning

Evgeni Tsivtsivadze, Radboud University, Heyendaalseweg 135, 6525 AJ, Nijmegen, Netherlands, evgeni@science.ru.nl, Daniel Kuehlwein, Tom de Ruijter, Twan van Laarhoven, Josef Urban, Tom Heskes

Learning reasoning techniques from previous knowledge is a largely underdeveloped area of automated reasoning. As large bodies of formal mathematical libraries are becoming available, the state-of-the-art preference learning and ranking methods can help us to address a cornerstone task for automated theorem provers, namely premise selection and ranking. In this talk I will briefly describe our recent results on development and application of the preference learning and ranking algorithms to the automated reasoning domain.

4 - Learning from preferences in the context of Case-Based Reasoning (CBR)

Patrice Schlegel, Mathematics and Computer Science, Philipps-Universität Marburg, Hans-Meerwein-Straße 6, 35032, Marburg, Hesse, Germany, pschlegel@mathematik.uni-marburg.de

Recent research has shown the potential of exploiting knowledge contained in preference data. Our goal is to apply this concept in the field of Case-Based Reasoning, where it complements the underlying reasoning paradigm of solving problems by considering the stored solutions of similar problems. We aim at liberating the method from the rigidity and limitations of the problem-solution tuple by replacing the solution with preferences over a space of candidate solutions. Thereby, it becomes more flexible while accommodating for the uncertain and approximate nature of case-based problem solving.

■ WA-41

Wednesday, 8:30-10:00

HH-Heyerdahl

Young scientists doing research in OR

Stream: Young People for System Theory, Optimization and Education

Invited session

Chair: Alexis Pasichny, Students' Science Association, National Technical University of Ukraine, 37, Peremohy av., 03056, Kiev, Ukraine, alexis.pasichny@gmail.com

1 - Heteroscedastic processes in finance modelling

Bohdan Pukalskyi, Students Science Association, National Technical University of Ukraine, Kovalskyi provulok 5, 03057, Kyiv, Ukraine, bogdanpukalsky@gmail.com

There exists a big amount of different models to explain financial processes. Heteroscedastic modeling has important place among them. This paper analyses different heteroscedastic models in application to modern stock price forecasting to find the most adequate models for better understanding of the market situation.

2 - Comparative analysis of methods for prediction of finance and economic processes.

Yaroslav Shevchenko, Institute of Applied System Analysis, National Technical University of Ukraine, Kovalsky lane 5, 03085, Kyiv, Ukraine, y.t.shevchenko@gmail.com

In prediction of nonlinear nonstationary processes a number of difficulties appears in selecting mathematical models relying on the quality of predictions. This paper makes a comparative analysis of several mathematical models for price formation on stock exchange, so we'll find the most appropriate model from proposed according to the quality of prediction.

3 - Mathematical methods for regional sustainable development modeling based on SD measurement metrics

Alexej Orlov, Students Science Association, Institute for applied system analysis of the National Technical University of Ukraine, Peremohy ave. 37, 03056, Kyiv, Ukraine, orlov.alexej@gmail.com

Usage of a system of factors (indices and indicators, based on expert and statistical data) for measuring the sustainable development allows turning the sustainability study to the practical tool which is used in strategic planning and decision-making. Sustainable development on a regional level is one of urgent issues in governmental policies in developed countries. There are different metrics used for sustainable regional development estimation and modeling in the focus of this talk; some cases of their application are considered and analyzed as well.

■ WA-42

Wednesday, 8:30-10:00

BW-Amber

Robust Optimization and Randomized Methods

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science

Invited session

Chair: Erik Kropat, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: Ayse Özmen, Scientific Computing, Institute of Applied Mathematics, Middle East Technical University, Kazimkarabekir Mah. 2048. Sok No:5/5, Etimesgut, 06790, Ankara, Turkey, ayseozmen19@gmail.com

1 - A robust optimization approach to production planning under non-compliance risks

Ban Kawas, IBM Research - Zurich, 8803, Rueschlikon, Zurich, Switzerland, kaw@zurich.ibm.com, Marco Laumanns, Eleni Pratsini

In various industries, production companies face compliance risks as governmental authorities enforce good manufacturing practices for the protection of consumers and the environment. As failing inspections can be costly, companies should measure and manage their exposure to non-compliance risks. We study an adversarial decision model that addresses these risks and aims to find a strategy reflecting a suitable risk-return trade-off. Within the model, data uncertainty is addressed using robust optimization techniques, and a compact formulation as a robust MIP is derived.

2 - Fast sample average approximation for minimizing Conditional-Value-at-Risk

Eduardo Moreno, Faculty of Engineering and Sciences, Universidad Adolfo Ibañez, Avda. Diagonal Las Torres 2640 Of:532C, Peñalolen, Santiago, Chile, eduardo.moreno@uai.cl, *Daniel Espinoza*

Sample Average Approximation approach allows to solve stochastic optimization problems, like minimizing CVaR, using linear programming. However, the number of samples required to get good approximated solutions tends to be very large. In this work we propose an automatic aggregation scheme to exactly solve linear programs with CVaR objective function using sample average approximations with a very large number of scenarios. Our results shows that this aggregation scheme is in average between 3-100 times faster than the standard LP-equivalent formulation.

3 - Stochastic optimization of nonlinear problems with constraints and differentiable functions: The wait and see method

Kherchi Hanya, ENSSEA, 16000, Alger, Algeria, hanya.kherchi@gmail.com

It's a matter to do a stochastic optimization of nonlinear problems with constraints and differentiable functions by using a passive method, namely, the method of wait and see based on the work established in stochastic linear programming. This technique consists in studying the behavior of the optimum as the random effect of parameters of the objective function. We will try to establish the existence of a general probabilistic law managing the behavior of the optimum, and then we can have the necessary information such as the mean and variance.

4 - Randomized Clustering: Weakening Necessary Conditions for the Confidence Interval of the True Number of Clusters

Mikhail Morozkov, Sankt-Petersburg State University, 198504, St. Petersburg, Russian Federation, mmorozkov@gmail.com, *Oleg Granichin*, *Zeev (Vladimir) Volkovich*

Finding the true number of clusters in a data set has proved to be one of the most challenging problems in cluster analysis. In this paper we describe approach where the true number of groups is picked as the slope discontinuity of the underlying index function. Randomized algorithm is proposed to find confidence interval for such point. We provide relaxed conditions for necessary conditions to find corresponding interval with a priori fixed level of confidence. The ideas of scenario approach are used to significantly reduce computational intensity. Several simulation examples are given.

and second-order SDC strategies. As a pilot case the optimization of the immunization strategy in fixed-income security portfolios is considered under some sources of uncertainty.

2 - Scenario cluster partitioning in the Lagrangian based procedures

Aitziber Unzueta, Applied Economy III, UPV/EHU, Lehendakari Aguirre 83, 48015, Bilbao, Spain, aitziber.unzueta@ehu.es, *Laureano Fernando Escudero*, *María Araceli Garín*, *Gloria Perez*

A scenario Cluster based Lagrangian Decomposition scheme for obtaining strong lower bounds to the optimal solution of two-stage stochastic mixed 0-1 problems is introduced. The aim consists of resolving the Lagrangian dual problem via solving scenario cluster submodels once the nonanticipativity constraints have been dualized. We report some computational experience to compare the performance of several Lagrange multiplier updating schemes for different number of scenario clusters. The results show that the cluster partitioning outperforms the traditional scenario partitioning.

3 - Parallel computing via break stage scenario clustering for multistage stochastic programming

Gloria Perez, Applied Mathematics and Statistics and Operational Research, Universidad del País Vasco, Science and Technology Faculty, Barrio Sarriena s/n, 48940, Leioa, Spain, Spain, gloria.perez@ehu.es, *María Merino*, *Laureano Fernando Escudero*, *María Araceli Garín*, *Unai Aldasoro*

Break Stage Scenario Clustering is introduced for decomposing mixed integer optimization problems, where nonanticipativity constraints are partially relaxed. We analyze the effect of using parallel programming in several strategies. Main results are based on our BFC-MS procedure. We have implemented a C++ code that uses the CPLEX optimizer within COIN-OR for solving the independent MIP submodels with MPI. The experience shows the speedup obtained in the computational cluster ARINA provided by the SGI/IZO-SGIker at the UPV/EHU.

4 - Vehicle Routing with Soft Time Windows and Stochastic Travel Times: A Column Generation and Branch-and-Price Solution Approach

Michel Gendreau, MAGI and CIRRELT, École Polytechnique, C.P. 6079, succ. Centre-ville, H3C 3A7, Montreal, Quebec, Canada, michel.gendreau@cirrelt.ca, *Duygu Tas*, *Nico Dellaert*, *Tom Van Woensel*, *Ton de Kok*

We study a vehicle routing problem with stochastic travel times. For each customer, a soft time window allows early and late servicing. The objective is to minimize the sum of transportation costs (total distance traveled, number of vehicles used and total expected overtime of drivers) and service costs (penalties for time-window violations). We apply a column generation procedure. The master problem is a classical set partitioning problem. The pricing subproblem corresponds to an elementary shortest path problem with resource constraints. Integer solutions are obtained by branch-and-price.

■ WA-43

Wednesday, 8:30-10:00

BW-Granite

Stochastic programming in industry I

Stream: Stochastic Programming

Invited session

Chair: *Laureano Fernando Escudero*, Dept. de Estadística e Investigación Operativa, Universidad Rey Juan Carlos, c/Tulipan, S/n, 28933, Mostoles (Madrid), Spain, laureano.escudero@urjc.es

1 - Risk averse measures in Stochastic mixed 0-1 Optimization

Larraitz Aranburu, Economía Aplicada III, UPV/EHU, San Bartolomé 28, 1.A, 48300, Gernika-Lumo, Bizkaia, Spain, larraitz.aranburu@ehu.es, *Laureano Fernando Escudero*, *María Araceli Garín*, *Gloria Perez*, *Gloria Perez*

We present several risk averse measures for stochastic mixed 0-1 optimization as alternatives to the objective function expected value optimization. Most of the proposed strategies are extensions of the two stage case studied in the literature to the multistage environment. Additionally, two innovative multistage strategies are proposed: a mixture of CVaR and first-order SDC strategies and a mixture of CVaR

■ WA-44

Wednesday, 8:30-10:00

BW-Marble

Data Analysis and Its Applications

Stream: Machine Learning and its Applications

Invited session

Chair: *Michael Khachay*, Ural Branch of RAS, Institute of Mathematics and Mechanics, S.Kovalevskoy, 16, 620990, Ekaterinburg, Russian Federation, mkhachay@imm.uran.ru

1 - Forecasting algorithm for short time series with preliminary classification

Irina Yatskiv, Computer Science, Transport and Telecommunication institute, Lomonosova 1, LV-1019, Riga, Latvia, ivl@tsi.lv

Algorithm for short time series forecasting on the basis of ARIMA model and classification are offered. A set of time series with lengths that is enough for forecast are grouped in homogeneous classes. The "time series-centroid" (TSC) for each class is determined and the estimation of parameters of ARIMA model has been performed for it. The short time series refer to one of the classes using the Mahalanobis distance. Then, a forecast on the basis a model for the TSC of determined class is built and then corrected by application the distance between TSC and short time series.

2 - A robust algorithm for sequential ANOVA with incomplete data

Carmen Anido, Economic Analysis: Quantitative Economy, Autonoma University of Madrid, Faculty of Economics, Cantoblanco., 28049, Madrid, Spain, carmen.anido@uam.es, *Teofilo Valdes*

We present an algorithm for ANOVA analysis of data under the following robust conditions: (a) the data is not received in batch but sequentially, (b) the data may be imprecise, (c) the error distributions may vary within the class of the strongly unimodal distributions and (d) the variance of the errors is unknown. The algorithm updates the analysis as soon as a new data is received. This updating is simple, needs little computational requirements, yields the estimates of the effect parameters and ends up estimating the asymptotic covariance matrix of the parameter estimates.

3 - A clustering method based on Independent Component Analysis

Takashi Onoda, System Engineering Lab., CRIEPI, 2-11-1, Iwado Kita, Komae-shi, 201-8511, Tokyo, Japan, onoda@criepi.denken.or.jp

The clustering result in k-means clustering method depends heavily on the chosen initial clustering centers. We propose a clustering method based on the independent component analysis. The proposed method does not need initial clustering centers. We evaluate the performance of our proposed method and compare it with some clustering methods by using artificial datasets and benchmark datasets. The experiments show that the normalized mutual information of our proposed method is better than the normalized mutual information of k-means clustering method, KKZ method and k-means++ clustering method.

4 - Dissimilarity Based on Cluster Discernibility on Attribute Subsets

Yoshifumi Kusunoki, Osaka University, Japan, kusunoki@eei.eng.osaka-u.ac.jp, *Tetsuzo Tanino*

Clustering is to classify given objects into clusters using their attributes. In this research, we focus on clustering for objects with nominal attributes. For such objects, logical expressions such as "attribute a_1 equals to v " are suitable to describe features of clusters. However, clustering methods using dissimilarity for object pairs do not necessarily output clusters having simple and compact logical expressions. So, we propose dissimilarity using cluster discernibility on attribute subsets. We apply the proposed dissimilarity to clustering, and examine them by numerical experiments.

Network capacity control (NCC) tools identify the most profitable proposals where the profitability is determined by incorporating a forecast about the expected remaining demand. Inaccurate demand forecasts compromise the transfer of NCC tools from the airline industry into the road haulage sector. However, road haulage product portfolios consist to a large part of flexible products with two or more execution modes. We investigate if the large number of flexible products contributes to the compensation of inaccurate demand forecasts and enable the re-use of NCC tools in road haulage.

2 - Operational capacity management in the car rental industry

Claudius Steinhardt, Department of Analytics & Optimization, University of Augsburg, Universitätsstraße 16, 86159, Augsburg, Germany, claudius.steinhardt@wiwi.uni-augsburg.de, *Jochen Gönsch*

Car rental companies are often able to spontaneously adjust their fleet size within a certain range in order to match market needs. We present an approach that integrates these fleet decisions with revenue management's capacity control. To decide on the fleet size, we propose an LP-formulation that is used in a hierarchical planning context with a rolling horizon, allowing for the combination with arbitrary approaches of standard capacity control. To reveal the potential of the approach, we conduct extensive simulation studies based on real-world data from a European car rental company.

3 - Dynamic pricing and efficient management of installation and maintenance resources

Rupal Rana, Business School, Loughborough University, Epinal Way, Loughborough, United Kingdom, r.rana@lboro.ac.uk

We consider a problem faced by many companies that use a fixed number of employees to provide two services an installation service and a maintenance service. We propose to join resources of employees and use dynamic prices for installations in accordance to the demand for maintenance, and we explore, e.g., how changes in various problem parameters affect the optimal policy structure. We investigate the economic benefits of a joint strategy and find that dynamic pricing and capacity flexibility works best.

4 - An EMSR approach for revenue management with planned upgrades

Jochen Gönsch, Department of Analytics & Optimization, University of Augsburg, Universitätsstraße 16, D-86159, Augsburg, Germany, jochen.goensch@wiwi.uni-augsburg.de, *Sebastian Koch*, *Claudius Steinhardt*

We consider the capacity control problem with integrated upgrading. The optimal dynamic program for this problem is hard to solve even in the single-leg case, as multiple hierarchical resource types must be considered simultaneously. Therefore, we propose a new heuristic approach that generalizes the well-known EMSR-a procedure. A simulation study compares the performance to other capacity control methods incorporating upgrades. The results show that our approach significantly outperforms existing methods including the successive planning approaches widely used in commercial RM systems.

■ WA-45

Wednesday, 8:30-10:00

BW-Water

Non-Airline Revenue Management Applications

Stream: Advanced Inventory Control and Pricing Strategies

Invited session

Chair: *Jochen Gönsch*, Department of Analytics & Optimization, University of Augsburg, Universitätsstraße 16, D-86159, Augsburg, Germany, jochen.goensch@wiwi.uni-augsburg.de

1 - Network capacity control and road-based freight transportation

Jörn Schönberger, University of Bremen, 28359, Bremen, Germany, jsb@uni-bremen.de

Wednesday, 10:30-12h00

■ WB-01

Wednesday, 10:30-12h00

RB-Alfa

Keynote Lecture: Professor Matteo Fischetti

Stream: Keynote, Tutorial and Plenary Lectures
Keynote session

Chair: *Elena Fernandez*, Universitat Politècnica de Catalunya, Barcelona, Spain, e.fernandez@upc.es

1 - On the role of randomness in exact tree search methods

Matteo Fischetti, DEI, University of Padua, via Gradenigo 6/a, 35100, Padova, Italy, Italy, fisch@dei.unipd.it, *Michele Monaci*

High-sensitivity to initial conditions is generally viewed as a drawback of tree search methods, as it leads to an erratic behavior to be mitigated somehow. In this talk we address the opposite viewpoint. Our working hypothesis is that erraticism is just a consequence of the exponential nature of tree search, that acts as a chaotic amplifier, so it is largely unavoidable. We discuss possible ways to actually take advantage of randomness, and present computational experiments on a testbed of difficult MILP instances.

■ WB-02

Wednesday, 10:30-12h00

RB-Beta

Preemption, Lower Bounds and Robustness in Project Scheduling

Stream: Project Management and Scheduling
Invited session

Chair: *Christoph Schwindt*, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de

1 - Incorporating costs in the RCPSP with pre-emption

Francisco Ballestin, Department of Statistics and OR, Public University of Navarra, Campus Arrosadia, S/N, 31006, Pamplona, Spain, Francisco.Ballestin@uv.es

The classical models of project scheduling problems suppose that activities are non-preemptable. However, some project environments allow this assumption to be relaxed. Almost all published papers presuppose that activities can be restarted at no additional cost, but this is not true in some practical situations. We define new models that incorporate costs in the RCPSP with preemption. The cost might be of different types; this paper focuses in what we think are the most plausible and interesting ones. We offer algorithms capable of offering quality solutions for each of the proposed models.

2 - Lower and upper bounds for preemptive project scheduling with generalized precedence relationships

Christoph Schwindt, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de, *Tobias Haselmann*

We study a project scheduling problem where the activities can be interrupted at any point in time and generalized precedence relationships between the activities have to be taken into account. After providing a formal problem statement, we introduce a novel MILP formulation and an optimization model combining a large-scale linear program with a

single machine scheduling problem. Moreover, we report on the results of an experimental performance analysis comparing upper bounds obtained with the MILP model and lower bounds that arise from solving the linear program by column generation.

3 - Lower bounds for a Fixed Job Scheduling Problem with an equity objective function

Damien Prot, Automatique et Productique, Ecole des Mines de Nantes, 4, rue Alfred Kastler, 44307, Nantes Cedex 3, France, damien.prot@mines-nantes.fr, *Tanguy Lapegue*, *Odile Bellenguez-Morineau*

We are interested in a problem that consists in assigning a set of tasks to a set of workers with specific skills. Given a targeted working load for each worker, we want to maximize the fairness between workers; more precisely, our objective is to minimize the difference between the highest and the lowest worker's gap value, which is defined as the difference between the targeted working load and the real working load. We present specific lower bounds for this problem and compare them with the one obtained by solving an integer linear program with an industrial software.

4 - Increasing schedule robustness by task grouping

Michel Wilson, Software Technology, Delft University of Technology, Mekelweg 4, 2628 CD, Delft, Netherlands, M.Wilson@tudelft.nl, *Cees Witteveen*

An important problem in scheduling is ensuring robustness of solutions in case of execution delays. We propose a new method, task grouping, and apply it to resource-constrained project scheduling. Using this method tasks that must be executed sequentially can be grouped, but their definitive order is determined at execution time such that delays can sometimes be mitigated. As a consequence, our method generates a set of execution options for a schedule. Using the well-known PSPLIB instances, we show that our method can reduce the impact of delays on the execution of the schedule significantly.

■ WB-03

Wednesday, 10:30-12h00

RB-L1

EURO/ROADEF Challenge Session 3

Stream: EURO/ROADEF Challenge
Invited session

Chair: *Christian Artigues*, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, France, artigues@laas.fr
Chair: *Ender Özcan*, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, exo@cs.nott.ac.uk
Chair: *Emmanuel Guere*, Google, 38 Avenue de l'Opera, 75002, Paris, France, guere@google.com
Chair: *Kedad-Sidhoum Safia*, LIP6 - UPMC, 4 Place Jussieu, 75005, Paris, France, safia.kedad-sidhoum@lip6.fr
Chair: *H. Murat Afsar*, Industrial Systems, University of Technology of Troyes, 12 rue Marie Curie, BP 2060, 10010, Troyes, France, murat.afsar@utt.fr
Chair: *Eric Bourreau*, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr
Chair: *Marc Sevaux*, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - Google/Roadef Challenge: a 100-line LocalSolver model qualifies for the final round

Romain Megel, e-lab, Bouygues SA, 75008, Paris, France, rmegel@bouygues.com, *Bertrand Estellon*, *Thierry Benoist*, *Julien Darlay*, *Frédéric Gardi*, *Karim Nouioua*

The machine reassignment problem proposed by Google is a very large-scale optimization problem. We solved it with LocalSolver, the first math programming software combining the simplicity of use of a model-and-run solver and the power of local-search techniques for combinatorial optimization (www.localsolver.com). In practice it

means that we merely translated the problem definition into a straightforward 0-1 model and then launched LocalSolver on this model. Ranked 25th among 82 teams from 33 countries, LocalSolver is the sole math programming solver qualified for the final round.

2 - Adaptive Local Search for Google Machine Reassignment problem

Emir Demirović, Mathematics, Faculty of Natural Sciences, Bosnia And Herzegovina, emir.demirovic@gmail.com, *Mirsad Buljubasic, Haris Gavranovic*

We present a hybrid method to efficiently solve Google Machine Reassignment problem. We study, implement, combine and empirically examine different local search neighborhoods to solve the set of available instances. We present results obtained with the solver respecting the given computational time of 5 minutes. The solutions obtained with longer runs and/or with relaxed constraints will also be reported. We also develop a decomposition method for the given problem improving overall numerical efficiency of the method. Some of the obtained results are proven to be optimal or near optimal.

3 - A Hybrid Large Neighborhood and Local Search for the Machine Reassignment Problem

Thibaut Vidal, CIRRELT - Université de Montréal & ICD-LOSI - Université de Technologie de Troyes, 12, rue Marie Curie, BP 2060, cedex, 10010, TROYES, France, thibaut.vidal@cirrelt.ca, *Hugues Dubedout, Renaud Masson, Julien Michallet, Puca Penna, Vinicius Petrucci, Anand Subramanian*

A hybrid metaheuristic combining Local Search (LS), Large Neighborhood Search (LNS) and integer programming is proposed for the machine reassignment problem. The LS performs relocations and exchanges of processes with similar resource consumptions and dependency requirements among machines in the cluster. The LNS iteratively and adaptively selects a subset of decision variables whose optimized values are given by a compact integer programming formulation. The method produces competitive results on the first set of instances provided by the ROADEF 2012 challenge organizers.

■ WB-04

Wednesday, 10:30-12h00

RB-L2

New Ideas in Integer Programming

Stream: Combinatorial Optimization

Invited session

Chair: *François Soumis*, GERAD, 3000 Cote Ste-Catherine, H3T 2A7, Montreal, Québec, Canada, francois.soumis@gerad.ca

1 - A fast and accurate algorithm for stochastic integer programming, applied to stochastic shift scheduling

Rémi Pacqueau, GERAD, 3000 chemin de la Cote Sainte Catherine, H3T 2A7, Montreal, Quebec, Canada, remi.pacqueau@polytechnique.edu, *François Soumis, Le Hoang*

Stochastic programming can yield significant savings over deterministic approaches. However, stochastic approaches always lead to very large problems, since recourse must be computed for every scenario. There is no fast and exact method for solving such problems. In this article, the L-shaped method is improved in two ways: a Benders cuts dynamic management algorithm for the master problem and a multithreaded implementation to solve the subproblems. Those two improvements yield a heuristic able to solve a 10 million variables IP problem in less than 5 minutes, with a very good accuracy, and enable the resolution of larger instances.

2 - Correction of an infeasible mixed integer linear programming problem towards feasibility

Dmitry Borodin, Optimization, OM partners, Belgium, dk.borodin@gmail.com, *Viktor Gorelik*

This research provides a practical method for solving infeasible mixed-integer programming models by correcting their constraints. The initial infeasible MILP is decomposed into two subproblems finally yielding to the correction problem which is deduced to an LP in case of using the uniform correction criterion. The solution of the corrected MILP shows how the constraints (e.g. resources) of the initial infeasible model can be changed in a minimal way to make the model feasible that can mean a technological update for the modeled production process (e.g. energy consumption reduction).

3 - Integral simplex using decomposition

François Soumis, GERAD, 3000 Cote Ste-Catherine, H3T 2A7, Montreal, Québec, Canada, francois.soumis@gerad.ca, *Issmail Elhallaoui, Zaghroui Abdelouahab*

Since the early '70s, several authors proposed, without much success, adaptations of the simplex algorithm to reach an optimal integer solution to the set-partitioning problem, with a sequence of basic integer solutions. We present an algorithm that iteratively finds improving integer solutions up to optimality by solving small subproblems. Theoretical background and experimental results on problems up to 1 600 constraints and 500 000 variables are presented. Larger problems are solved in time between 10 and 20 minutes.

4 - A hybrid solution to configurate H.264/AVC video CODEC for the Brazilian Digital TV

Iris Linck, University of the Sinos Valley, Av. Unisinos, 950, 93022000, Sao Leopoldo, Rio Grande do Sul, Brazil, linck.iris@gmail.com, *Arthur Gomez*

This article presents a study focused on finding good solutions to improve the H.264/AVC CODEC configuration for encoding video to the Brazilian Digital Television System (DBTS). A hybrid algorithm called Simulator of Metaheuristics applied to a CODEC (SMC) was developed and it utilizes the concepts of Tabu Search and Genetic Algorithm. SMC will search for the best CODEC configuration by using six parameters: bitrate, framerate, quantization parameters of the B, P and I slices; and the number of B slice in a Group Of Pictures. The goal is to get a compressed video with a good picture quality.

■ WB-05

Wednesday, 10:30-12h00

RB-L3

Topics in combinatorial optimization II

Stream: Discrete Optimization, Geometry & Graphs (contributed)

Contributed session

Chair: *Robert Manger*, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, manger@math.hr

1 - Fixing rules, Reduction and Optimal resolution for the Knapsack Problem with Setups

Abdelkader Sbihi, Axe Logistique-Terre-Mer-Risque, Ecole de Management de Normandie, Le Havre, France, 30, rue de Richelieu, 76087, Le Havre Cedex, France, a.sbihi@em-normandie.fr

The knapsack problem with setups (KPS) is a non standard hard variant of the knapsack problem with setups costs and constraints and with many real-life applications. We present a two-phase optimal approach for KPS: (i) the first one is a reduction based phase obtained by fixing the variables to their optimal values in the solution via upper/lower bounding rules and (ii) in the second phase, we apply an exact method for the reduced problem composed by the remaining free variables. We considered both B&B and DP and we give a comparison study of the two variants of the approach.

2 - Adding an Edge between Two Levels of a Complete K-ary Linking Pin Structure Minimizing Total Distance

Kiyoshi Sawada, Department of Policy Studies, University of Marketing and Distribution Sciences, 3-1, Gakuen-nishi-machi, Nishi-ku, 651-2188, Kobe, Japan, Kiyoshi_Sawada@red.umds.ac.jp

This study proposes a model of adding relation to an organization structure which is a complete K-ary linking pin structure where every pair of siblings in a complete K-ary tree of height H is adjacent such that the communication of information in the organization becomes the most efficient. When an edge between a node with a depth M and its descendant with a depth N is added, an optimal pair of depth $(M,N)^*$ is obtained by minimizing the total distance which is the sum of the number of edges in shortest paths between every pair of all nodes in the complete K-ary linking pin structure.

3 - Minimizing the costs of evacuation paths by decomposing network flows

Jan Peter Ohst, Mathematics, TU Kaiserslautern, Germany, ohst@mathematik.uni-kl.de, Stefan Ruzika

Many models and algorithms for large scale routing and flow optimization are known. The solution of such problems is naturally a flow on a network. However to implement this flow a decomposition into paths is required. While it is straight forward to find an arbitrary decomposition the choice of the decomposition can have a tremendous effect on the properties of the single paths. The problem of finding optimal decompositions is NP-hard but has not been investigated in detail. An integer program for such problems as well as an approximation algorithm on series-parallel graphs are presented.

4 - Implementing the work function algorithm by network flows and flow cost reduction

Robert Manger, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, manger@math.hr, Tomislav Rudec

This paper deals with the work function algorithm (WFA) for solving the on-line k-server problem. The WFA is usually implemented by network flow techniques including the flow augmentation method. In the paper we develop a new implementation of the WFA, which is again based on network flows, but uses simpler networks and the cost reduction method. We also present experiments showing that our implementation is considerably faster than the conventional one.

In e-commerce complex markets there are numerous limitations and other ties between market participants and objects of trade. Frequently occurring constraints arising from a structure of the problem, as well as preferences of participants, cause inability to reach a satisfactory outcome using bilateral negotiations. The solution is either the trade on centralized auctions or the multilaterally negotiated agreement. In the paper we consider two interaction protocols for the multilateral negotiation. One is based on the sequential message passing, the other assumes parallel communication.

3 - Symmetric rendezvous search on a hexagon

John Howard, Operational Research, London School of Economics, Houghton Street., London, WC2A 2AE, United Kingdom, j.v.howard@lse.ac.uk

In symmetric rendezvous search on a hexagon two players are initially placed at two different vertices two edges apart. Each period they must move to one of the adjacent vertices. They try to meet in the least possible expected time using the same (mixed) strategy.

This problem is unsolved, so we modify it by giving the players extra information. We are then able to solve the modified problem, thereby giving a lower bound to the original problem. The solution requires an interesting analysis of the behaviour of two intertwined discrete dynamical systems.

4 - Lorenz and lexicographic maximal allocations for bankruptcy problems

Javier Arin, Economic Theory, University of the Basque Country, L. Agirre 83, 48015, Bilbao, Spain, franciscojavier.arin@ehu.es

A bankruptcy problem consists of a set of claimants who must divide between them an infinitely divisible good, the endowment, that is not sufficient to satisfy their claims in full. We introduce egalitarian criteria to solve bankruptcy problems. We focus on two egalitarian criteria: the Lorenz and lexicographic criteria. Talmud Rule is one of the most important sharing rules. We prove that this rule is also a lexicographic maximizer. This analysis allows a new sharing rule: Lexmax Rule. We also characterize the sets of Lorenz maximal vectors of awards/losses.

■ WB-06

Wednesday, 10:30-12h00

RB-Gamma

Industrial Organization

Stream: Dynamical Systems and Game Theory
Invited session

Chair: Luis Ferreira, Matemática, Escola Superior de Estudos Industriais e de Gestão, IPP, ESEIG, Rua D Sancho I, número 981, 4480-876, Vila do Conde, Porto, Portugal, migferreira2@gmail.com

1 - Flexibility in a Stackelberg leadership

Luis Ferreira, Matemática, Escola Superior de Estudos Industriais e de Gestão, IPP, ESEIG, Rua D Sancho I, número 981, 4480-876, Vila do Conde, Porto, Portugal, migferreira2@gmail.com

We study the effects of product differentiation in a Stackelberg model with demand uncertainty, only for the first mover. We do an ex-ante and ex-post analysis, in terms of product differentiation and of the demand uncertainty, of the profits of the leader and of the follower firms. We show that even with small uncertainty about the demand, the follower firm can achieve greater profits than the leader, if their products are sufficiently differentiated.

2 - Parallel vs. Sequential Interaction Protocols for the Multilateral Negotiations in Distributed, Multi-agent Environment

Piotr Palka, The Faculty of Electronics and Information Technology, Warsaw University of Technology, ul. Nowowiejska 15/19, 00-665, Warsaw, mazowieckie, Poland, P.Palka@ia.pw.edu.pl

■ WB-08

Wednesday, 10:30-12h00

RB-Epsilon

Boolean Optimization in Graph Theory

Stream: Boolean and Pseudo-Boolean Optimization
Invited session

Chair: Martin Milanic, UP IAM and UP FAMNIT, University of Primorska, Muzejski trg 2, 6000, Koper, Slovenia, martin.milanic@upr.si

1 - Forbidden induced subgraph characterizations of graph classes

Guillermo Durán, University of Buenos Aires, Argentina, gduran@dm.uba.ar

In this talk we present several results about partial characterizations of different graph classes by forbidden induced subgraphs. First, we analyze three classes related to perfect graphs: clique-perfect, coordinated and balanced graphs. Furthermore, we study two important classes of intersection graphs: circular-arc and circle graphs. We will show the main results on these topics obtained for our group in the last 10 years. Joint works with F. Bonomo, M. Chudnovsky, L. Grippo, M. Groshaus, M.Lin, M. Safe, F. Soullignac, G. Sueiro, J. Szwarcfiter and A. Wagler.

2 - A generalization of the P4-free graph sandwich problem to multigraphs

Endre Boros, RUTCOR, Rutgers University, 08854, Piscataway, New Jersey, United States, Endre.Boros@rutcor.rutgers.edu, Vladimir Gurvich

An n-multigraph is an n-edge colored complete graph. D is a 3 edge colored triangle, and P is a 2 colored complete graph on 4 vertices, such that each color defines a P4. In this paper we show a polynomial time algorithm to decide if a given n-multigraph contains a P- and D-free

subgraph. This result generalizes the P4-free graph sandwich problem introduced by Golubic, Kaplan, and Shamir in 1995. As motivation and application, we consider n-person positional game forms. It is known that such game forms are in a one-to-one correspondence with P- and D-free n-graphs.

3 - The Price of Connectivity for Vertex Cover

Oliver Schaudt, Institut für Informatik, AFS, Universität zu Köln, Weyertal 80, 50931, Cologne, Germany, schaudto@uni-koeln.de

We study a graph parameter called the Price of Connectivity for Vertex Cover (PoC). It was recently introduced by Cardinal et al. and is defined as the ratio of the minimum size of a connected vertex cover and the minimum size of a vertex cover. We prove structural results for the PoC. These results concern PoC-critical, PoC-perfect and PoC-near-perfect graphs.

4 - Equistable graphs: conjectures, results, and connections with Boolean functions

Martin Milanic, UP IAM and UP FAMNIT, University of Primorska, Muzejski trg 2, 6000, Koper, Slovenia, martin.milanic@upr.si

Equistable graphs form a graph class generalizing the well known class of threshold graphs, and are closely related to general partition graphs and triangle graphs. No combinatorial characterization of equistable graphs is known, and the complexity status of recognizing equistable graphs is open. In this talk, we will present an overview of results and conjectures on equistable graphs and related classes. Whenever applicable, connections to corresponding notions from the theory of Boolean functions will be discussed. Joint works with V. Levit, S. Miklavic, J. Orlin, G. Rudolf and D. Tankus.

■ WB-09

Wednesday, 10:30-12h00

RB-Zeta

Optimization Problems on Graphs

Stream: Graphs and Networks

Invited session

Chair: *Mirjana Cangalovic*, Laboratory for Operational Research, Faculty of Organizational Sciences, University of Belgrade, Jove Ilica 154, Belgrade, Serbia, canga@fon.bg.ac.rs

1 - An algorithm for finding the most probable cut set

Mirko Vujosevic, Faculty of Organizational Sciences, University of Belgrade, ul. Jove Ilica 154, 11000, Belgrade, Serbia, mirkov@fon.bg.ac.rs, *Dragana Makajic-Nikolic*, *Nebojsa Nikolic*

A new approach for finding the most probable cut set is proposed. The structure of the system is firstly modeled as a fault tree with random primary events as leaves, intermediate events as logic functions of primary events, and the top event in the root. The top event is also a logic function of the primary events. A cut set is a set of primary events which cause the occurrence of the top event. Given probabilities of the primary events, the problem is to find the most probable cut set. An equivalent reverse Petri net is made and its properties are used for developing a new algorithm.

2 - Strong metric dimension of generalized Petersen graphs $GP(n,1)$

Mirjana Cangalovic, Laboratory for Operational Research, Faculty of Organizational Sciences, University of Belgrade, Jove Ilica 154, Belgrade, Serbia, canga@fon.bg.ac.rs, *Jozef Kratica*, *Vera Kovacevic Vujcic*

Generalized Petersen graphs $GP(n,k)$ were introduced by Coxeter in 1950. Recently, the metric dimension and the minimal doubly resolving set of $GP(n,k)$ have been investigated. In this paper we consider a related problem of determining the strong metric dimension for $GP(n,1)$ and prove that it is equal to n .

3 - A Set Covering Approach to Solving Heterogeneous Vehicle Routing Problem

Milan Stanojevic, Faculty of Organizational Sciences, University of Belgrade, Jove Ilica 154, 11000, Belgrade, Serbia, milans@fon.rs, *Bogdana Stanojevic*

We consider a vehicle routing problem with limited heterogeneous fleet of vehicles having various capacities, fixed costs and variable costs. Our approach provides approximate solution. It consists of two phases. In first phase we generate set of "good" routes for all types of vehicles from the fleet. For this step we use randomized enhanced savings algorithm. In second phase we solve to optimality set covering problem using routes from the first phase. Varying number of generated routes we can trade between solving time and solution quality. Computation results are presented.

4 - On the dominating tree problem

André Rossi, Lab-STICC - UMR 3192, Université de Bretagne-Sud, Centre de Recherche, BP 92116, 56321, Lorient, France, andre.rossi@univ-ubs.fr

The problem under consideration is called the dominating tree problem. Let G be an edge weighted, simple, connected and undirected graph. We want to build a tree of minimum cost on G such that each vertex is either covered by the tree, or is adjacent to a vertex that is covered by the tree. The cost of every edge is assumed to be strictly positive. We provide a simple proof of NP-hardness, and a series of cases where the problem can be solved in polynomial time. In addition, we present a cutting plane approach to this problem.

■ WB-10

Wednesday, 10:30-12h00

RB-Theta

Supply Chain Management 1

Stream: Production Management & Supply Chain Management (contributed)

Contributed session

Chair: *Rifat Gürçan Özdemir*, Industrial Engineering Department, Istanbul Kültür University, Atakoy Campus, Atakoy-Bakirkoy, 34156, Istanbul, Turkey, rg.ozdemir@iku.edu.tr

1 - Managing and Measuring Business Performance

Otilija Sedlak, Quantitative Methods in Economics, Faculty of Economics Subotica, Ivana Sarica 14., Segedinski put 9-11, 24000, Subotica, Vojvodina, Serbia, otilijas@ef.uns.ac.rs, *Zoran Ciric*

Project performance has become a significant issue, especially as poor performance in high profile information systems projects. The business management critical success factors: cost, quality, time, customer expectations. In this paper will be evaluated an integrative framework of performance for managing and measuring to bring together numerous and evolving strands. We believe it is important to investigate whether innovation theories can be generalized and empirical findings are applicable in different economic contexts.

2 - Optimization in supply chain decision making

Marija Cileg, Quantitative Methods in Economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, macileg@yahoo.com, *Tibor Kis*

Performance improvement of companies participating in supply chains is necessary to achieve harmonization, co-operation, coordination and efficiency. Partial optimization can be implemented in every stage of the chain, while general optimization deals with the whole of a given supply chain. In this paper one possible approach to optimization problems in a specific case is presented with creation of economic parameters necessary for realization of partial tasks. A modification of the goal programming model is presented as well.

3 - A Trade Credit Model for Supply Chain Coordination

Abhishek Chakraborty, Operations Management, Indian Institute of Management Calcutta, Diamond Harbour Road, Joka, 700104, Kolkata, West Bengal, India, abhishekc08@iimcal.ac.in, *Ashis Chatterjee*

This paper considers a single vendor and single buyer supply chain model where the vendor allows a trade credit to the buyer to synchronize his production cycle with the ordering cycle of the buyer. The vendor is being benefitted from the reduction in his set up costs while the buyer is being compensated for the extra inventory that he is carrying through the trade credit offered by the vendor. Trade credit is developed as a mechanism for achieving supply chain coordination in the weak form.

4 - An Analysis of Supply Chain Related Graduate Programs in Europe

Y. Ilker Topcu, Industrial Engineering, Istanbul Technical University, Istanbul Teknik Universitesi, Isletme Fakultesi, Macka, 34357, Istanbul, Turkey, ilker.topcu@itu.edu.tr, *Emel Aktas*, *Sezi Cevik Onar*, *Des Doran*

There is a continuous interest in analysing and designing SCM education. Parallel to increasing impact of globalisation, more and more companies operate in larger supply chains and there is an increasing need for skilled employees trained in SCM. Motivated by lack of studies on graduate level supply chain education, this research aims to determine the current status of supply chain related programs offered at graduate level in Europe. Our findings suggest that programs are clustered according to the weight of various knowledge and skill areas such as SCM, managerial or quantitative skills.

■ WB-11

Wednesday, 10:30-12h00

RB-Iota

Other realistic scheduling problems

Stream: Realistic Production Scheduling

Invited session

Chair: *Alper Gucumengil*, Foreign Relations Department, Turkish Statistical Institute, Yucetepe mah., Necatibey cad. No:114 Cankaya, Ankara, Turkey, alpergucumengil@hotmail.com

1 - Due-date assignment problems with common flow-allowance

Gur Mosheiov, Business School, The Hebrew University of Jerusalem, Mount Scopus, Jerusalem, 91905, Jerusalem, Israel, msomer@mscc.huji.ac.il, *Baruch Mor*

In due-date assignment problems with a common flow-allowance, the due-date of a given job is defined as the sum of its processing time and a job-independent constant. We study first the minsum version of the problem. In this case, the scheduler has the option to perform a maintenance activity which is rate modifying, i.e., improves the processing times of the following jobs. We consider a number of versions of this setting. We also study the minmax version of the problem, with extensions to position-dependent processing times, and to the (NP-hard) setting of parallel machines.

2 - Approximate algorithms for one-machine scheduling with interfering jobs

Paz Perez Gonzalez, Industrial Management, University of Seville, Camino de los descubrimientos s/n, 41092, Sevilla, Spain, pazperez@esi.us.es, *Jose M. Framinan*

In this paper, we analyze the problem of scheduling two sets of jobs on one machine with the objectives of total completion times for both sets. This problem is known to be NP-hard considering different approaches (Pareto, epsilon-constrained and linear convex), and several algorithms have been proposed in the literature. We analyze the approaches, compare the corresponding solution procedures, and present new heuristics for the problem.

3 - Flowshop scheduling with flexible operations: Throughput optimization

Hakan Gultekin, Industrial Engineering, TOBB-University of Economics and Technology, Endustri Muhendisligi Bolumu, TOBB Ekonomi ve Teknoloji Universitesi, Sogutozu Cad. No:43, 06560, Ankara, Turkey, hgultekin@etu.edu.tr

In classical flowshop scheduling, processing times of the parts are assumed to be fixed, predefined parameters. This assumption oversimplifies the problem for the systems consisting of flexible machines capable of performing different operations. In such systems, some of the operations that a part requires can be processed by alternative machines. In order to maximize the throughput rate the assignment of these operations to the machines must be determined. In this study we develop solution procedures for problems arising in 2 and 3-machine flowshops producing identical or multiple parts.

4 - Project Management Techniques: The Case of Agricultural Statistical Project

Alper Gucumengil, Foreign Relations Department, Turkish Statistical Institute, Yucetepe mah., Necatibey cad. No:114 Cankaya, Ankara, Turkey, alpergucumengil@hotmail.com, *Hüseyin Tatlıdil*

A general framework on Project Management(PM) approach is outlined and PM techniques, namely Gantt, CPM and PERT are scrutinized in this paper. The immediate focus of study, however, is on the assessment of an agricultural statistical project which is one of the projects carried out as part of preparatory work in the adaptation process of Turkey to European Statistical System with reference to PM techniques. By way of assessment of completed project, the aim is to improve current PM approach for international statistical projects and to offer suggestions in adopting PM techniques in future projects.

■ WB-12

Wednesday, 10:30-12h00

RB-Omicron

Railway Optimization II

Stream: Optimization in Public Transport

Invited session

Chair: *David Canca*, School of Engineers, University of Seville., Av. de los Descubrimientos s/n, Isla de la Cartuja, 41092, Seville, Spain, dco@us.es

1 - The management of rail system breakdowns for reducing travel demand impacts

Luca D'Acerno, Dipartimento di Ingegneria dei Trasporti, Università degli Studi di Napoli "Federico II", Via Claudio, 21, 80125, Napoli, Italy, dacierno@unina.it, *Mariano Gallo*, *Bruno Montella*, *Antonio Placido*

In urban context, the improvement of rail systems represents a useful tool to promote the use of public transport and reduce environmental impacts of private car use. However, in the event of breakdowns, since faulty trains cannot usually be overtaken and their removal could pose extreme difficulties, re-establishing the regular service could involve inconveniently long travel times. Therefore, in this framework, we analyse effects of management strategies for different levels of degraded services in order to define the best solution to adopt to minimise travel demand discomfort.

2 - New approaches for Wagon Routing in Railroad Freight Traffic

Robert Voll, Institute of Transport Logistics, TU Dortmund University, Leonhard-Euler-Strasse 2, 44227, Dortmund, Germany, voll@itl.tu-dortmund.de, *Uwe Clausen*

We consider a consolidation problem from railroad freight traffic. The problem is modeled as a fixed charge multicommodity flow problem. We present two new solution approaches based on a column generation formulation. The first one is a Branch-and-Price-algorithm. The second method is a heuristic algorithm. We present computational results for a couple of test instances we constructed in cooperation with our industrial partners. Results from our computations are compared to solutions provided by CPLEX.

3 - Analysis of the variability of travel conditions and flows along a transit line

Vincent Benezech, Ecole des Ponts ParisTech, ENPC - LVMT, 6-8 avenue Blaise Pascal, 77455, Marne-la-Vallée, France, vincent.benezech@enpc.fr, Fabien Leurent

One major issue in transit planning pertains to service reliability. The paper's objective is to provide a stochastic model of traffic variability and passenger exposure along a transit route. Headways are treated as random variables. Their distribution is estimated using data from the Transilien operator. Analytical formulas for the mean and variance of passenger loads on any section of the line, as well as average passenger exposure to crowding in the case of log-normal headways are derived. In the general case, a zip-unzip algorithm computing generalised travel times is described, for inclusion in a complete traffic assignment model.

4 - A methodology to analyze quality of railway timetables

David Canca, School of Engineers, University of Seville., Av. de los Descubrimientos s/n, Isla de la Cartuja, 41092, Seville, Spain, dco@us.es, Eva Barrena, Encarnación Algaba, Alejandro Zarzo

Railway scheduling and timetabling are two of the classical stages in the hierarchical railway planning process and they perhaps represent the step with major influence on user's quality of service perception. This paper considers the problem of timetable determination considering a dynamic behavior of passenger demand considering user and service provider points of view. Aspects like the influence of train capacity are discussed. To illustrate the methodology an application to the C5 line of Madrid rapid transit system is presented.

■ WB-13

Wednesday, 10:30-12h00

RB-Tau

Transportation and Logistics

Stream: OR Applications in the Automotive Industry
Invited session

Chair: Achim Koberstein, Business Administration, Goethe-University of Frankfurt, Gruenewaldplatz 1, 60323, Frankfurt am Main, Germany, koberstein@wiwi.uni-frankfurt.de
Chair: Martin Grunewald, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstraße 3, 38106, Braunschweig, Germany, m.grunewald@tu-bs.de

1 - Choosing charge carriers to guarantee the efficient material supply of production areas

Dominik Berbig, Institut für Fördertechnik und Logistiksysteme, KIT, Gotthard-Franz-Straße 8, 76131, Karlsruhe, Germany, berbig@kit.edu, Kai Furmans, Michaela Köker, Maximilian Altefrohn

To guarantee efficient material supply, it is crucial to choose adequate charge carriers for every part number: The larger the carrier, the larger is the required space, the number of contained pieces and, as a result, the fixed capital costs. The smaller it is, the higher the necessary transportation frequency. This trade-off shows that choosing a charge carrier is subject to many parameters. Currently, this choice is often based on the size only. This means wrong choices and wasted capital. Thus, we present an approach to solve this problem, a new model and possible benefits.

2 - The impact of decision making strategies in different network types on stock fluctuation

Meisam Nasrollahi, Industrial Engineering, University of Tehran, 32th - Masjed Jame St., Fasa - Fars - Iran, 7461833749, Fasa, Fars, Iran, Islamic Republic Of, m_nasrollahi@ut.ac.ir, Jafar Razmi, Reza Ghodsi

The knowledge about interdependency between decision making strategies and the stock fluctuation in a supply chain is important to identify those parts of a supply network which has the highest potential for improving total uncertainty. Two scenarios are suggested: each supply partner designs its own material handling system and network configuration organizes an integrated material handling policy for all supply partners. A multi-objective model is developed to compare these scenarios and identify under which situations lasting uncertainty reduction can be achieved.

3 - An integrated inventory-transportation system with periodic pick-ups and leveled replenishment

Martin Grunewald, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstraße 3, 38106, Braunschweig, Germany, m.grunewald@tu-bs.de, Thomas Volling, Thomas Spengler

In this paper we develop a combined inventory-transportation system. The principle idea is to integrate a simple replenishment policy with a routing component to derive operationally consistent standard routes as a basis for milk-run design. Therefore we combine stochastic vehicle routing with a replenishment policy which makes use of safety stock to level the variability propagated into transportation operations. To evaluate the approach, we compare its performance with stochastic vehicle routing as well as sequential vehicle routing and safety stock planning.

■ WB-14

Wednesday, 10:30-12h00

RB-Omega

Timetabling and Transport

Stream: Timetabling and Rostering
Invited session

Chair: Hagai Ilani, Industrial Eng. and management, Shamoon College of Engineering, 84 Jabotinsky st., 77245, Ashdod, Israel, Israel, hagai@sce.ac.il

1 - Algorithm for Solving Two-Stations Railway Scheduling Problem

Elena Musatova, Institute of Control Sciences V. A. Trapeznikov Academy of Sciences, Moscow, Russian Federation, nekolyap@mail.ru, Alexander Lazarev

There are two railway stations and a set of freight cars which are characterized by departures and destinations, weight and significance. Each car arrives to the departure in some release time and should be delivered to the destination before a due date. There are some restrictions on number of cars in a train. It is necessary to form trains and schedules that minimize a cost function. A polynomial algorithm is proposed for solving the described problem.

2 - An Integrated Optimization Model for Timetabling and Machinist Assignment in Light Rail Transit Systems

Selmin DanisOncul, Management Engineering, Istanbul Technical University, ITU İşletme Fakültesi, Macka-Istanbul, 34367, Istanbul, Turkey, selmindanis@gmail.com

This study proposed a novel model to solve the timetabling problem combining with resource allocation of a light rail transit system. Firstly, a detailed literature review is carried out, then extensive interviews have been realized with authorized experts. Mathematical models are built and solved by mixed-integer programming using CPLEX algorithm. Validation is made by comparing model results with real-life application. Sensitivity analysis is also performed by changing parameter values such as train capacity and also weights of objective function. Finally all the results are analyzed.

3 - Real-time Control Procedures for Transit

Alessandro Sales, Civil engineering, Università degli Studi Roma Tre, via vito volterra, 62, 00146, Roma, Italy, alessandrosales@libero.it, Stefano Carrese

In every high frequency transport system, the problem of regularity is critical. Randomness can increase passenger's travel time. We focus the attention on the real-time deadheading problem, because deadheading is the only way that allows to re-establish the correct headway without increase of the lap time. When a vehicle is deadheaded, it runs empty from a terminal skipping a number of stations, typically in order to reduce expected large headways at later stations. The objective is to determine the optimal number of stations to skip in order to minimize passenger's total travel time.

4 - A General Two-directional Two-campus Transport Problem

Hagai Ilani, Industrial Eng. and management, Shamoon College of Engineering, 84 Jabotinsky st., 77245, Ashdod, Israel, Israel, hagai@sce.ac.il, *Elad Shufan*, *Tal Grinshpoun*

In the present work we extend a reduction of a simple case of a transportation problem between two destinations to the shortest path problem. Our reduction is valid for a general two directional case where a set of n requests for a ride between two destinations has to be executed by a fleet of K vehicles of given capacities, in order to minimize the total waiting time of all the passengers. Our approach can be implemented to the case where passengers have different levels of importance.

■ WB-15

Wednesday, 10:30-12h00

RB-2101

Theory and algorithms of bilevel programming I

Stream: Variational Inequalities and Bi-Level Problems
Invited session

Chair: *Stephan Dempe*, Mathematics and Computer Sciences, Technische Universitaet Freiberg, 09596, Freiberg, Germany, dempes@math.tu-freiberg.de

1 - Fuzzy bilevel optimization problem

Alina Ruziyeva, Fakultät für Mathematik und Informatik, TU Bergakademie Freiberg, Akademiestr. 6, 09596, Freiberg, Germany, ruziyeva@student.tu-freiberg.de, *Stephan Dempe*

The optimal solution of a fuzzy optimization problem is described as the set of Pareto optimal solutions of a corresponding multiobjective optimization problem. The preferable fuzzy optimal solution is supposed to have a maximal membership function value, i.e. it has the highest potential being realized by the follower. In the talk fuzzy bilevel optimization problems are considered in which the preferable fuzzy optimal solution of the fuzzy lower level problem is used. Aim of the talk is to describe a solution algorithm for this problem using the stability region of this solution.

2 - Necessary optimality conditions in pessimistic bilevel programming

Alain B. Zemkoho, Mathematics and Computer Sciences, Technical University Bergakademie Freiberg, Akademiestr. 6, 09599, Freiberg, Saxonia, Germany, zemkoho@student.tu-freiberg.de

We consider the "pessimistic version" of bilevel programming programs. Employing advanced tools of variational analysis and generalized differentiation, we provide a general framework ensuring the Lipschitz continuity of the value functions. Several types of lower subdifferential necessary optimality conditions are derived. We also derive upper subdifferential necessary optimality conditions of a new type. Certain links are established between the obtained necessary optimality conditions for the pessimistic and optimistic versions in bilevel programming.

3 - Vanishing Stress Constraints in Topology Optimization of Mechanical Structures

Wolfgang Achtziger, Department of Mathematics, University of Erlangen-Nuremberg, Chair of Applied Mathematics 2, Cauerstrasse 11, 91058, Erlangen, Germany, achtziger@am.uni-erlangen.de

We consider the optimization of topology of mechanical structures in a discretized finite element setting. These problems express shape optimization through a problem of optimal material distribution on a given element grid. Local stress constraints are essential for a realistic modeling. The resulting problem is a large-scaled mathematical program with vanishing constraints (MPVC). In the recent past several numerical recipes have been proposed for the treatment of MPVCs. The talk presents some of these approaches and reports on their success in the numerical treatment of topology problems.

4 - Branch and bound method for the competitive facility location problem

Andrey Melnikov, Sobolev Institute of Mathematics, Russian Federation, a.a.melnikov@hotmail.com, *Vladimir Beresnev*

We deal with the competitive facility location problem, where two players, the leader and the follower, sequentially open their facilities in finite discrete space. Every consumer chooses one opened facility according to his own preferences. The problem consists in opening the leader's facilities so as to obtain the maximum profit, taking into account the follower's reaction. The problem is formulated in terms of the bilevel integer programming. An exact procedure based on the B&B method has been developed. Computational results for the randomly generated instances are discussed.

■ WB-16

Wednesday, 10:30-12h00

RB-2103

Linear and Quadratic Programming

Stream: Linear and Conic Programming
Invited session

Chair: *David Bartl*, Department of Mathematics, University of Ostrava, 30.dubna 22, 701 03, Ostrava, Czech Republic, bartl@osu.cz

1 - On the complexity of steepest descent algorithms for minimizing quadratic functions

Clovis Gonzaga, Dept. of Mathematics, Federal Univ. of Santa Catarina, Cx. postal 5210, Florianópolis, SC, Brazil, Florianópolis, SC, Brazil, clovis@mtm.ufsc.br

In this talk we examine patterns in the distribution of step lengths in steepest descent algorithms for minimizing a convex quadratic function. We show how a large number of short steps are needed, and how these relate to the much smaller number of large steps. We note that the order in which the step lengths is used is irrelevant, and show a worst case example with a small number of variables. We also conceive a brute force algorithm which is in a certain way optimal.

2 - Convex quadratic programming applied to the stability number of a graph

Maria F Pacheco, Instituto Politécnico de Bragança - ESTiG, Quinta de Santa Apolónia, Gab. 112, 5301-857, Bragança, Portugal, pacheco@ipb.pt, *Domingos Cardoso*, *Carlos J. Luz*

We deal with graphs whose stability number can be determined by a convex quadratic program and describe algorithmic techniques for the determination of maximum stable sets in such graphs (except there is an induced subgraph with least adjacency eigenvalue and optimal value of the convex quadratic program not changing if the neighborhood of any vertex is deleted). Such a graph is called adverse. Assuming that every adverse graph has convex-QP stability number, an algorithm for the recognition of graphs with convex-QP stability number is introduced and applied to determine maximum matchings.

3 - A discrete version of Farkas' Lemma and Duality Theorem for homogeneous linear programming

David Bartl, Department of Mathematics, University of Ostrava, 30.dubna 22, 701 03, Ostrava, Czech Republic, bartl@osu.cz

We report a discrete version of Farkas' Lemma, which is formulated in the setting of a module over a linearly ordered commutative ring (e.g.

the ring of the integer numbers). Inspired by the trick of the homogenization, used to prove Gale's Theorem of the alternative, which we also show, we introduce the concept of the primal and dual problem of homogeneous linear programming. We present the optimality condition for the primal and dual problem, respectively. In conclusion, we show that the Strong Duality Theorem holds for the problems.

4 - Optimization for switching control system

Shahlar Meherrem, Mathematics, Yasar University, Izmir, Turkey, Selcuk Yasar Camp, agaclı yol , No.35-37, Bornova, Izmir, Turkey, sahlar.meherrem@yasar.edu.tr, *Refet Polat*

A class of nonsmooth optimal switching control problems is considered (nonsmoothness posed on the minimizing functional). The cost functional is to be minimized. Necessary optimality conditions are derived by normal cone and Dubovitskii-Milyutin theory: a) treat local minima via the empty intersection of certain sets in the primal space; b) approximate the above sets by convex cones with no intersections; c) arrive at dual necessary optimality conditions in the form of an abstract Euler equation. The main result is a new optimality condition for the nonsmooth switching control system.

■ WB-17

Wednesday, 10:30-12h00

RB-2105

DC programming and DCA 1

Stream: Nonconvex Programming: Local and Global Approaches

Invited session

Chair: *Tao Pham Dinh*, INSA Rouen, 76131, Rouen, France, pham@insa-rouen.fr

1 - A Continuous Optimization Approach for the General Art Gallery Problem

Mahdi Moeini, Institute of Operating Systems and Computer Networks, Technical University of Braunschweig, IBR, Algorithms Group, Muhlenpfordtstr. 23, 38106, Braunschweig, Germany, moeini@ibr.cs.tu-bs.de, *Alexander Kroeller*, *Christiane Schmidt*

Suppose that an art gallery is in the shape of a polygon. The classical Art Gallery Problem (AGP) seeks for determining the minimum number of guards that are sufficient to oversee the entire art gallery. It has been proven that this problem is NP-hard even for very special cases. We present a continuous optimization approach based on DC (Difference of Convex functions) programming techniques to solve the AGP problem. The numerical experiments have been carried out on some benchmark data sets and the results will be presented.

2 - A DC Programming technique for sparse regularization in least-squares and logistic regressions

Mamadou Thiao, LITA, LITA- Université de Lorraine, 57000 Ile du saulcy, Metz, France, mamadou.thiao@gmail.com, *Hoai An Le Thi*, *Tao Pham Dinh*

This talk addresses a DC programming technique for solving $\ell_2 - \ell_0$ simultaneous regularization problem in least-squares and logistic regressions. We first consider the original $\ell_2 - \ell_0$ -regularized problems and we reformulate them as DC programs with the help of new exact penalty techniques. The resulting DC programs possess very nice DC structures and are quite adapted to convex DC relaxation techniques. Experiments in the context of feature selection are performed and the results on real-world data sets illustrate the potential and show the usefulness of this method.

3 - A DC programming approach for clustering massive data sets

Hoai An Le Thi, Computer Science, University of Lorraine, Ile du Saulcy,, 57 045, Metz, France, hoai-an.le-thi@univ-lorraine.fr, *Ta Minh Thuy*, *Lydia Boudjeloud-Assala*

In this paper, we present a robust nonconvex optimization method for clustering massive data using data streams. Our approach is based on DC (Difference of Convex functions) programming and DCA (DC Algorithms) that have been successfully applied in various fields of applied sciences. The method consists of two phases. Phase 1: the data is divided into subsets on which an efficient DCA for clustering is investigated. Phase 2: another DCA for weighted clustering on the set of centers obtained by phase 1 is studied. The numerical results on real data sets show the efficiency of our method.

4 - Solving Generalized Orienting Problem using DCA

Anh Son Ta, LMI, INSA de Rouen, LMI, INSA de Rouen, +33, Rouen, France, taanh_son@yahoo.com, *Hoai An Le Thi*, *Tao Pham Dinh*, *Djamel Khadraoui*

Orienteering problem is well-known as a NP-hard problem in transportation with many applications. This problem aims to find a path between a given set of control points, where the source and destination points are specified with respect to maximize the total score of collected points and satisfy the distance constraint. In this paper, we first analyze the structure of a generalized orienting problem and a new solution method, based on DC programming and DCA, is introduced. Preliminary numerical experiments are reported to show the efficiency of the proposed algorithm.

■ WB-18

Wednesday, 10:30-12h00

RB-2107

Discrete Location

Stream: Network and Discrete Location

Invited session

Chair: *Antonio Manuel Rodriguez-Chia*, Estadística e IO, Universidad de Cádiz, Facultad de Ciencias, Pol. Río San Pedro, 11510, Puerto Real (Cadiz), Cadiz, Spain, antonio.rodriguezchia@uca.es

1 - The p-center problem with capacities and failure ahead

Alfredo Marín, Departamento de Estadística e Investigación Operativa, University of Murcia, Facultad de Matemáticas, Campus de Espinardo, 30100, Murcia, Spain, amarín@um.es, *Inmaculada Espejo*, *Antonio Manuel Rodriguez-Chia*

This work deals with the p-center problem, where the aim is to minimize the maximum distance between any user and his reference center, considering that in case of failure of any center, the capacities of the remaining centers must suffice to satisfy the demand of all users, taking into account that the users will have as a reference the closest surviving center. The problem is of interest when locating emergency centers and, at the same time, taking precautions against emergencies which can cause failure of the center itself. We consider different formulations for the problem

2 - Assigning channels in cellular networks by neural networks

Enrique Dominguez, Dept. of Computer Science, E.T.S.I.Informatica - University of Malaga, Campus Teatinos s/n, 29071, Malaga, Spain, enriqued@lcc.uma.es, *Jose Muñoz*

Wireless communication constitutes one of the fastest growing industry segments in recent years, encompassing a number of application domains such as the cellular networks. Efficient allocation of channels for wireless communication in different network scenarios has become an extremely important topic of recent research. The main challenge lies in the fact that the channel allocation problem (CAP) is NP-complete. In many practical situations, sometimes we may need to be satisfied with a near-optimal solution because of a maximum allowable time limit is imposed for allocation of channels.

3 - A p-median model with distance selection

Stefano Benati, Department of Sociology, University of Trento, Via Verdi 26, 38100, Trento, Italy, stefano.benati@unitn.it, *Sergio García Quiles*

We are introducing an extension of the p-median model in which the units distance function, defined in an m-dimensional space, is the sum of elementary distances calculated on spaces of dimension 1 (this model originates from cluster analysis). We let the researcher select only q coordinates out of the m dimensional axes, so we are allowing different and possible distance definitions between the units. We propose many ILP formulations to the model and compare their properties.

4 - Single Allocation Capacitated Ordered Median Hub Location Models

Antonio Manuel Rodriguez-Chia, Estadística e IO, Universidad de Cádiz, Facultad de Ciencias, Pol. Rio San Pedro, 11510, Puerto Real (Cadiz), Cadiz, Spain, antonio.rodriguezchia@uca.es, *Justo Puerto*, *Ana Bel Ramos-Gallego*

In this paper we consider new formulations, based on the ordered median objective function, for capacitated hub location problems with new distribution patterns induced by the different user's roles within the supply chain network. This approach introduces some penalty factors associated with the position of an allocation cost with respect to the sorted sequence of these costs. First we present formulations for this problem, and then develop stronger formulations by exploiting properties of the model. The performance of all these formulations is compared by means of a computational analysis.

■ WB-19

Wednesday, 10:30-12h00

RB-2111

Predictive Modelling in Finance and Insurance

Stream: Simulation Methods in Finance
Invited session

Chair: *Aysegul Iscanoglu Cekic*, Statistics, Selcuk University, KONYA, Turkey, iaysegul@selcuk.edu.tr

1 - Simulation Study for Modified Maximum Likelihood Estimations in Poisson Regression

Muslu Kazım Körez, Statistic Department, Faculty of Science, Selcuk University, 42225, Konya, Turkey, kkorez@selcuk.edu.tr, *Evrin Oral*, *Yunus Akdoğan*, *Coskun Kus*

For most of the generalized linear models (GLM), the maximum likelihood (ML) equations involve nonlinear functions of the parameters and they are intractable. Solving these equations by iterations can be problematic for reasons of convergence to wrong values. In this study, we compare the ML and MML estimators with respect to their biases and mean square errors. Moreover, we provide the coverage probabilities of the confidence intervals (based on ML and MML estimators) of Poisson regression parameters by using a Monte Carlo simulation study. We also investigate the revised MML estimators proposed by Oral (2005) with respect to their initial values. We show that ordinary least squares estimators yield approximations as good as those proposed by Oral (2005).

2 - An Application of Wavelet Regression on Risk Analysis

Aşır Genç, Statistic, Selcuk University, Konya, Turkey, agenc@selcuk.edu.tr, *Tarik Yilmaz*

In this study we make a risk analysis for a software company which plans to develop and launch a new product. In the analysis we firstly model the financial statements of the company. The model includes both stochastic and deterministic variables. Therefore, we make a simulation study and we provide 10-year cash flow tables for the company. Then a risk analysis procedure is implemented. Moreover, we apply a wavelet regression smoothing procedure to the obtained values and we find new risk values. Finally, these new risk values are compared with Net Present Value and a decision plan is given.

3 - Predictive Power of Generalized Additive Models in Insurance

Aysegul Iscanoglu Cekic, Statistics, Selcuk University, KONYA, Turkey, iaysegul@selcuk.edu.tr

In insurance an event or a claim is usually related with various number of risk factors. The classification techniques are used to model the impact of such factors on occurrence of such events or claims. The generalized additive model is one of these techniques. In this study, we implement the generalized additive models with Conic quadratic programming approach (GAM-CQP) to the insurance framework. We also compare the predictive performance of GAM-CQP with the classical generalized additive models and some other techniques, e.g. generalized linear models and semi-parametric regression.

4 - An Application of Wavelet Regression in Exchange Rate Estimation

Tarik Yilmaz, Statistics, Science Institute, Selcuk Universitesi Alaaddin Keykubat Kampusu, Selcuklu, 42020, KONYA, Turkey, tyilmaz@selcuk.edu.tr, *Aşır Genç*

In this study, our main aim is to forecast exchange rate in an effective way. For this purpose we propose a new technique which is based on wavelet regression. In order to evaluate the effectiveness of the technique, the EURO(EUR) - U.S. Dollar (USD) parity data is used. Effectiveness of the new process is also shown by backtesting.

■ WB-20

Wednesday, 10:30-12h00

RB-2113

Financial Optimization 1

Stream: Financial Optimization
Invited session

Chair: *J. E. Beasley*, Mathematical Sciences, Brunel University & JB Consultants, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk

1 - A Risk-Return Approach to Enhanced Indexation

Francesco Cesarone, Economics, University of Rome 3, Faculty of Economics, Via Silvio D'Amico 77, 00145, Rome, Italy, fcesarone@uniroma3.it, *Renato Bruni*, *Andrea Scozzari*, *Fabio Tardella*

Enhanced Indexation is the problem of selecting a portfolio that generates excess return with respect to a benchmark index. We propose a linear bi-objective optimization model for enhanced indexation that maximizes average excess return and minimizes underperformance with respect to the index over a given observation period. The efficient frontier for this problem can be easily computed with standard LP solvers. We describe interesting theoretical features of the model and we present some experimental results for well-known financial data sets showing promising out-of-sample performance.

2 - Portfolio selection model based on technical, fundamental and market value analysis

Tea Poklepović, Faculty of Economics Split, Domovinskog rata 54, 21000, Split, Croatia, tpoklepovic@net.hr, *Branka Marasovic*, *Zdravka Aljinovic*

The aim of this paper is to develop decision-making model for selecting optimal portfolio in stock exchange based on technical and fundamental analysis. In the first step of the model the set of stocks are selected based on technical analysis. In the second step optimal portfolio will be formed from selected stocks using multi criteria method. The method is based on PROMETHEE II approach and different accounting criteria and those based on market values are used. The selected model has been applied in Zagreb Stock Exchange (ZSE) as a real case.

3 - Computing the Nondominated Surface in Tri-criterion Portfolio Selection

Ralph E. Steuer, Terry College of Business, University of Georgia, Department of Banking and Finance, Brooks Hall, 30602-6253, Athens, GA, United States, rsteuer@uga.edu

Motivated by the desire to extend Markowitz portfolio selection to an additional linear criterion (dividends, etc.), we demonstrate an exact method for computing the nondominated set of a tri-criterion program that is all linear except that one of its objectives is to minimize a convex quadratic function. With the nondominated set of the resulting program being a surface composed of curved platelets, a multi-parametric algorithm is devised for computing the platelets so that they can be graphed precisely. In this way, graphs can display all tri-criterion nondominated solutions at one time.

4 - Portfolio rebalancing with an investment horizon and transaction costs

J. E. Beasley, Mathematical Sciences, Brunel University & JB Consultants, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk

We consider the problem of rebalancing an existing financial portfolio, where transaction costs (fixed and/or variable) have to be paid if we change the amount held of any asset. We indicate the importance of the investment horizon when rebalancing such a portfolio and illustrate the nature of the efficient frontier that results when we have transaction costs. We model the problem as a mixed-integer quadratic program with an explicit constraint on the amount that can be paid in transaction cost. Results are presented for the solution of test problems involving up to 1317 assets.

3 - Information acquisition of new technology for maintenance and replacement investment decisions

Thomas Yeung, Department of Industrial Engineering & Automatic Control, Ecole des Mines de Nantes / IRCCyN, 4, rue Alfred Kastler B.P. 20722, La Chantrerie, 44307, Nantes, France, thomas.yeung@emn.fr, Khanh Nguyen, Bruno Castanier

An important mission of managers is to determine the maintenance and replacement investment plan for equipment under technological evolution. The arrival time and profitability of new technology are uncertain; however information on this process may be acquired. We formulate a partially observable Markov decisions process to decide whether to obtain additional information as well as the action for the asset (wait, maintain, replace) based on its state and the information available on new technology. We provide structural properties of the optimal policy as well as numerical examples.

4 - One approach to reduce some aspects of costs associated with long term care

Patricia Herranz, Economy, Quantitative Methods and Economic History, Universidad Pablo de Olavide, Ctra. Utrera km 1, 41013, Seville, Spain, pherpei@upo.es, Ana M. Martin Caraballo, M. Manuela Segovia-Gonzalez, Guerrero Flor

New technological and scientific advances have allowed that in some countries increases life expectancy but, unfortunately longevity causes that many people have disabilities that limit or even make it impossible to do activities of daily living. In this paper we analyze the relationship between the different diseases and different degrees of disabilities used under Spanish law. In this way the government could implement prevention policies that reduce the costs associated with long term care and improve the quality of life of disabled people. We are using the new survey data EDAD 2008.

■ WB-21

Wednesday, 10:30-12h00

RB-2115

Data Analysis in the Financial Sector

Stream: Numerical Methods in Finance

Invited session

Chair: Patricia Herranz, Economy, Quantitative Methods and Economic History, Universidad Pablo de Olavide, Ctra. Utrera km 1, 41013, Seville, Spain, pherpei@upo.es

1 - Sampling Frequency and Stochastic Diffusion Processes of Term Structure of Interest Rates and Exchange Rates

A. Can Inci, College of Business - Finance, Bryant University, 1150 Douglas Pike, 02917, Smithfield, RI, United States, ainci@bryant.edu

Recent studies conjecture that higher frequency data provide a better separation of continuous and jump components of a dynamic process. Stochastic processes such as jumps may not be fully utilized since they may be smoothed out with low frequency monthly or quarterly data. This study examines a sophisticated multi-country multi-state nonlinear stochastic model along with affine versions in the context of sampling frequency. Empirical performances of the models are documented and compared across models and across sampling frequencies.

2 - Seasonal allocation decision based on a multi-objective optimization

Fellipe Santos, UFMG, 30580530, Belo Horizonte, Brazil, fellipe.santos@cemig.com.br, Adriano Lisboa, Douglas Vieira, Rodney Saldanha, Marcus Lobato

This paper discusses and formulates a simplified model of the Brazilian energy market, from where a bi-objective optimization problem for revenue and risk is derived in order to define optimal portfolios. The resulting problem is a sub-differentiable analytical problem with guarantees to be solved to optimality by cutting-plane methods. Some case studies are presented in order to test the formulation using the ellipsoidal algorithm.

■ WB-22

Wednesday, 10:30-12h00

RB-2117

Fuzzy Optimization

Stream: Fuzzy Optimization - Systems, Networks and Applications

Invited session

Chair: Erik Kropat, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: Yoshiki Uemura, 655-1, Yuzaki, Kawanishichou, Shikigun, 636-0202, Nara, Japan, 636-0202, Nara, uemura0742@yahoo.co.jp

Chair: Kateryna Pereverza, Students Science Association, National Technical University of Ukraine, Kyiv, Scherbakova str., 42/44, app. 54, Kyiv, Ukraine, pereverza.kate@gmail.com

1 - Involving fuzzy orders for multi-objective linear programming

Olga Grigorenko, Mathematics, University of Latvia, Zellu Street 8, LV-1002, Riga, Latvia, ol.grigorenko@gmail.com

In our work we propose to involve fuzzy order relations for solving MOLP problems. We use fuzzy orders to describe the objective functions. Further the global fuzzy order relation is constructed by aggregating the individual fuzzy order relations. Thus the global fuzzy relation contains the information about all objective functions. In our approach we can naturally use compensatory aggregation functions and even more we can use weights to show the preference of objective functions. This work is supported by ESF project 2009/0223/1DP/1.1.1.2.0/09/APIA/VIAA/008.

2 - Forecasting Enrollments Based on Particle Swarm Optimization and Neural Network Based Fuzzy Time Series

Ozer Ozdemir, Statistics, Anadolu University, Anadolu University Faculty of Science, Department of Statistics, Eskisehir, Turkey, ozerozdemir@anadolu.edu.tr, Memmedaga Memmedli

Many forecasting studies used enrollments of the University of Alabama to show comparison results easily by applying the concept of fuzzy time series. So, in this paper, a forecasting study based on fuzzy time series and particle swarm optimization is presented to find the proper model for this data set. Also, a new approach for neural network based fuzzy time series is taken into account for forecasting because of neural networks' capabilities in handling nonlinear relationships. All results are compared with other studies proposed in the literature to show the performances of all models.

3 - Selection of appropriate smoothing parameter for different sample size in nonparametric fuzzy local polynomial models

Munevvere Yildiz, Statistics, Anadolu University, Turkey, munevvere@hotmail.com, *Memmedaga Memmedli*

In this paper, we considered the relationship between the smoothing parameter value and sample size as a simulation study in nonparametric fuzzy local polynomial regression. For this aim, we developed fuzzy version of generalized cross-validation criteria (GCV) for selecting smoothing parameter in nonparametric fuzzy local polynomial models. The appropriate smoothing parameters are selected by GCV criteria for different sample size and then performances of the models are compared using these appropriate smoothing parameters with sample sizes.

4 - Dynamic Clustering to Improve Marketing Decisions in Retail Stores

Richard Weber, Department of Industrial Engineering, University of Chile, Republica 701, 2777, Santiago, Chile, rweber@dii.uchile.cl, *Georg Peters*

Clustering is a common technique for customer segmentation. In real-life situations, however, customer behavior changes over time and so do customer segments. We present a methodology for dynamic rough clustering and apply it to synthetic as well as to purchase data from a retail store. Comparing clustering techniques reveals the particular advantages rough clustering offers. The results obtained from analyzing purchase data incrementally provide insights into changing buying behavior which permits to anticipate Marketing decisions, such as e.g. promotions or demand-specific advertisement.

■ WB-23

Wednesday, 10:30-12h00

RB-Delta

Recent Advances on Proximal Methods I

Stream: Convex Optimization
Invited session

Chair: *Hector Ramirez*, Mathematical Engineering Department, Universidad de Chile, Avda. Blanco Encalada 2120, Piso 5, Santiago Centro, Santiago, RM, Chile, hramirez@dim.uchile.cl

1 - Dual convergence for penalty algorithms in convex programming

Miguel Carrasco, Universidad de los Andes, Santiago, 7620001, Chile, migucarr@uandes.cl, *Felipe Alvarez*, *Thierry Champion*

We consider an implicit iterative method to solve a convex programming problem, which combines inexact variants of the proximal point algorithm with parametric penalty functions. For this primal iterative method is possible to associate a dual approximate multiplier sequence. Under some conditions on the parameters, we show the convergence of the approximate multiplier sequence towards a particular optimal solution of the dual problem

2 - Squared Hessian Riemannian metrics on convex sets and gradient-like optimization methods

Christopher Hermosilla, Equipe COMMANDS, École Polytechnique, INRIA-Saclay and ENSTA ParisTech, France, hermosilla@ensta.fr, *Felipe Alvarez*

We investigate a class of variable metric techniques to solve a convex constrained optimization problem. We investigate squared Hessian metrics induced Legendre type functions and we characterize the geodesic curves of this kind of manifold. We propose a family of gradient-like algorithms for constrained optimization based on linear search along the geodesics. We are particularly interested in finding conditions ensuring value convergence. We present two alternative characterization for this algorithm and we introduce a sort of duality scheme based on Legendre change of coordinates.

3 - Convergence of the coupling of an inexact generalized proximal algorithm with barrier methods

Julio López, Matemática, Universidad Técnica Federico Santa María, Av. Vicuña Mackenna 3939, San Joaquín, Santiago, Metropolitana, Chile, julio.lopez@usm.cl

Here, we introduce a barrier-type penalty for the nonlinear inequality constraints, then endowing the linear equality and conic constraints with the Riemannian structure induced by the Hessian of an essentially smooth convex function, and finally considering the flow generated by the Riemannian penalty gradient vector. We investigate the well-posedness of the resulting ODE and we prove that the value of the objective function converges to the optimal value. This convergence is extended to the sequences generated by a coupling of a generalized proximal method with parametric barrier schemes.

4 - Solving Network Flow Problems with General Non-Separable Convex Costs using a Two-phase Gradient Projection Algorithm

Kwong Meng Teo, Industrial & Systems Engineering, National University of Singapore, Singapore, kwongmeng@alum.mit.edu, *Trung Hieu Tran*

We propose an algorithm to solve network flow problems with generalized non-separable convex costs — problems often encountered in practical applications such as multi-commodity flows, traffic assignment and telecommunications problems. The algorithm can be implemented using general solvers such as CPLEX. Finally, we evaluate and compare the performance of the algorithm with other common approaches, using several industrial size problems.

■ WB-24

Wednesday, 10:30-12h00

CC-A11

Data Mining in Early Warning Systems

Stream: Data Mining in Early Warning Systems
Invited session

Chair: *Antonio Rodrigues*, CIO-FCUL, University of Lisbon, Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal, ajrodrigues@fc.ul.pt

1 - Detection of seasonal changes in climate data by comparative analysis; A case study for Turkey

Tülay Akal, Statistics, Middle East Technical University, Turkey, tulay_210@yahoo.com.tr, *Fidan Fahmi*, *Elcin Kartal Koc*, *Vilda Purutcuoglu Gazi*, *Cem Iyigun*, *Ceylan Yozgatligil*, *Inci Batmaz*

In this study, we consider to investigate plausible climate changes in Turkey by clustering techniques implemented in data mining field. For this purpose we choose a homogenous set of stations from the Central Anatolia region. We apply bi-plot, SAMMON mapping, fuzzy, k-means, and hierarchical clustering methods for benchmark meteorological variables monthly recorded in Turkey. We evaluate the results in two periods: i) from 1950 to 1980 and from 1980 to 2010 separately, ii) from 1950 to 2010 together. We also use paired statistical tests to detect seasonal changes in these periods.

2 - Developing precipitation models for continental central Anatolia, Turkey

Fulya Aykan, statistics, METU, atapark mah. 1335 sok., 23/16 atapark /keçiören, ankara, Turkey, e123082@metu.edu.tr, *Elcin Kartal Koc*, *Ceylan Yozgatligil*, *Cem Iyigun*, *Vilda Purutcuoglu Gazi*, *Inci Batmaz*

Precipitation models help for deciding future scenarios of early warning systems for droughts. In this study, we develop precipitation models of continental central Anatolia, where drought has been a recurrent phenomenon for the last several decades. In the study, the monthly precipitation is modeled by using Time Series Regression and Multivariate Adaptive Regression Splines methods using 13 regressor variables such as monthly mean pressure, monthly mean humidity, monthly mean vapor pressure and some temperature indices, measured for 30 years period (1980-2010).

3 - New statistical methods for climate change investigations

Gregory Gurevich, Industrial Engineering and Management, SCE - Shamoon College of Engineering, Balik Bazel, 84100, Beer Sheva, Israel, gregoryg@sce.ac.il, *Yossi Hadad*

The main goal of this study is to present and apply recently developed nonparametric change point detection and estimation techniques for confirming patterns of regional changes in temperature. Utilizing these methods, monthly temperatures (mean, mean maximum, mean minimum) and diurnal temperature ranges in different regions of Israel have been investigated over a period of 37-years, (1967-2003). Monte Carlo experiments were carried out to obtain the p-values of the proposed tests. The results were supported also by traditional statistical methods.

4 - Surveillance and security risk minimization in ports

Antonio Rodrigues, CIO-FCUL, University of Lisbon, Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal, ajrodrigues@fc.ul.pt

The protection of physical infrastructures from terrorist/criminal attacks or from natural/technological disasters heavily relies on early warning detection capabilities from sensor networks. For ports and harbours, surveillance optimization is an especially complex problem, and different types of sensors should be used complementarily. We propose a methodology to estimate risk maps, both ex-ante and ex-post the inclusion of a possible surveillance solution. Furthermore, we discuss how the cost vs. risk optimization of solutions can be supported by the estimation of response surfaces.

■ WB-25

Wednesday, 10:30-12h00

CC-A23

Smart cities and Smart grids

Stream: Long Term Planning in Energy, Environment and Climate

Invited session

Chair: *Edi Assoumou*, Centre de Mathematiques Appliquees, Mines ParisTech, Sophia Antipolis, France, edi.assoumou@cma.ensmp.fr

1 - Demand response in smart grid systems

Abhilasha Aswal, Information Technology, International Institute of Information Technology Bangalore, India, abhilasha.aswal@iiitb.ac.in, *Sunil Kumar Vuppala*, G. N. Srinivasa Prasanna

The general optimization problem in a smart grid system with demand/price uncertainty is a min-max problem. In the presence of demand response (DR) mechanisms, we show that if all the appliances on the grid are controllable, then the optimizations are polynomial time linear minimizations. We discuss algorithms to find the optimal solution in both the general case and DR case. We also discuss algorithms for cases where only a subset of appliances can be controlled - the number of uncertain variables is reduced but not eliminated completely. Our results are based on both analysis and simulation.

2 - Smart grids and prospective modeling for the electricity sector

Stephanie Bouckaert, Center for applied Mathematics, Mines ParisTech, 06560, Sophia Antipolis, France, stephanie.bouckaert@mines-paristech.fr, *Edi Assoumou*, *Nadia Maizi*

Our daily lives are facilitated by an increasing number of electric appliances. However using electricity as two implications: a real time balance between total supply and demand, and a high environmental impact. In the transition toward sustainable energy systems smart grids have the potential to transform balancing with responsive demands and to enable higher shares of renewables. Including these operational advantages in long term model is challenging. This communication describes a methodology to quantify the long term impact of smart grid on future prospects for the electricity sector.

3 - Towards Interactive Urban Planning with Local Search Techniques

Bruno Belin, LINA, France, bruno.belin@univ-nantes.fr, *Marc Christie*

The task of urban planning consists in the spatial organization of the various blocks, referred to as urban forms, that constitute a city (residential, commercial, industrial, ...). The spatial organization is guided by a collection of rules related to environmental, social, transportation, and energy questions. We propose a tool assist designers in this task by modelling the problem as a local search optimisation task. To achieve large-scale interactive editing, we introduce a dynamic list of banished candidates and demonstrate its effectiveness to reduce the exploration of neighborhoods.

4 - Sustainable development and territory planning: a prospective approach to rethink cities

Steve Lechevalier, Center for applied Mathematics, Mines ParisTech, 1 rue claude Daunesse, 06560, Sophia Antipolis, France, steve.lechevalier@mines-paristech.fr, *Sandrine Selosse*

The "serious game" ECOTYPE aims to help cities to communicate about issues of land use in a fun and interactive form. This is to design and implement an interactive device involving prospective and representations of local development plan in an immersive space where the public is invited to play the future of its territory. In a geodesic room, the public will make choices about land use thanks to an interface. Then, consequences will be represented in the present and the future thanks to lights and sound.

■ WB-26

Wednesday, 10:30-12h00

CC-A24

Multi-Criteria Decision Making and Applications 1

Stream: Multi-Criteria Decision Making and Environmental Management

Invited session

Chair: *Marta Castilho Gomes*, CESUR, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001, Lisboa, Portugal, marta.gomes@ist.utl.pt

1 - On the generation of positional voting systems with variable scores

Bonifacio Llamazares, Economía Aplicada, Universidad de Valladolid, Avda. Valle de Esgueva 6, 47011, Valladolid, Spain, boni@eco.uva.es

Scoring rules are a well-known class of positional voting systems where fixed scores are assigned to the different ranks. However, the main drawbacks of this decision rules is the choice of the scoring vector, since the winners may change according to the scores used. For this reason, several methods have been suggested so that each candidate may be evaluated with the most favorable scoring vector for him/her. In this work we propose new positional voting systems that allow to use different scoring vector for each candidate and avoid some shortcomings of the methods proposed in the literature.

2 - Rank-scaled Integral Indicators of Ecological Impact

Mikhail Kuznetsov, Moscow Institute of Physics and Technology, Russian Federation, mikhail.kuznecov@phystech.edu

To compare objects or alternative decisions one must evaluate a quality of each object. An integral indicator is a real-valued scalar which is corresponded to the object. We can construct an integral indicator having a set of objects and features and a quality criterion. We use the set of features and expert-given indicators in the rank scales. That is, every object is ranked by the certain feature. We consider every rank-scaled feature as a polyhedral cone. To find final ranking we use Minkowski sum of this cones. This methodology is used for the Croatian Thermal Power Plants evaluation.

3 - Fast order recommendation separately for each explicit customer of large product system

Peter Vojtas, Software Engineering, Charles University, Faculty of Mathematics and Physics, Malostranske nam. 25, 118 00, Prague, Czech Republic, vojtas@ksi.mff.cuni.cz, *Alan Eckhardt*

Our motivation is a personalized recommendation for a web based e-shop (no aggregated advices like average user, most popular ...). Our interest is in support of big number of users (each considered individually) for big number of alternatives (usually simple completely described products - not easy in web scaled applications). Our input is explicit user rating of a sample of products. We propose a data mining method, which based on sample rating, predicts rating (order) of all products. We calculate user's personal objectives and utility and output top-k recommendations. We evaluate our experiments wrt. speed (usually < 1 sec.) and order violations (e.g. Kendal tau rank).

4 - A bi-objective linear programming model for hazardous medical waste management

Marta Castilho Gomes, CESUR, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001, Lisboa, Portugal, marta.gomes@ist.utl.pt, *Joaquim R. Duque*

Interest in medical waste management has raised in recent years across Europe. In this work a bi-objective mixed-integer linear programming model for hazardous medical waste (HMW) management is presented. It accounts for construction and operating costs of facilities (either for waste decontamination or incineration), transportation costs and the environmental assessment of solutions using the Eco-indicator 99 methodology. The problem of expanding the HMW incineration capacity in Portugal is addressed and real data used for an economic-environmental trade-off analysis (with a Pareto curve).

WB-27

Wednesday, 10:30-12h00

CC-A25

Web-based Spatial-temporal Collaborative Decision Support Systems

Stream: Decision Support Systems

Invited session

Chair: *Fatima Dargam*, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com

1 - Scalarising methods in DSS Weboptim

Vassil Guliashki, Optimization and Decision Making, Inst. of Information and Communication Technologies - BAS, Acad. G. Bonchev str., block 2, 1113, Sofia, Bulgaria, vggul@yahoo.com, *Leoneed Kirilov*, *Krassimira Genova*, *Boris Staykov*

We present a Decision Support System for solving Multiple - objective Optimization Problems. Its basic characteristics are: user-independent, multisolver-admissibility, method-independent, heterogeneity, and web-accessibility. Core system module is an original generalized method including most MOP methods — reference point approach, reference direction approach, interval approach and etc. The choice of suitable scalarising function is made automatically depending on the Decision Maker's dialog. The system provides an API interface for external use by third party developers.

2 - Hope: a web-based SDSS for urban management

Joao Coutinho-Rodrigues, Dep. Civil Engineering, University of Coimbra, Faculty of Sciences & Tech. and INESC-Coimbra, Polo II, 3030-290, Coimbra, Portugal, coutinho@dec.uc.pt, *Lino Tralhão*, *Eduardo Manuel Natividade-Jesus*

Given the urban population growth and the increase of complexity of urban systems, engineers and decision makers have to face new daily challenges in urban management. OR techniques combined with modern information technologies may provide new avenues to tackle such challenges. An ongoing development of a GoogleMaps-based prototype - supporting user graphical edition and report through a web browser in a PC (or in a smartphone generating in situ georeferenced reports with alphanumeric and image contents) - embedding a multi-criteria models base running in an algorithm server, will be presented.

3 - Criteria weighting considering the interaction with institution's goals

Sheu-Hua Chen, Distribution Management Dept., National Chin-Yi University of Technology, 35, Lane, Section 1, Chung-Shan Road, Taipin, 411, Taichung, Taiwan, shchen@ncut.edu.tw, *Hong Tau Lee*

Conventionally, to engage new teacher the institution's goals have to be considered first, and then the criteria and their relative weights are determined. In this research, we claim the determined weights for these criteria may not appropriately reflect the preset priority of the goals. This research proposes a faculty selection mechanism that was developed based on the analytic network process to handle such an interdependent situation. The nature of the proposed mechanism gives decision makers the chance to recheck for possible bias in criteria weighting.

WB-28

Wednesday, 10:30-12h00

CC-A27

OR Military and Security Applications

Stream: OR in Military, Safety and Security Applications

Invited session

Chair: *Ana Isabel Barros*, Military Operations, TNO, POBox 96864, 2509 JG, The Hague, Netherlands, ana.barros@tno.nl

1 - Interdiction in queueing networks

Tom van der Mijden, Twente University, Netherlands, t.l.c.vandermijden@student.utwente.nl

In the literature on network interdiction focus is on time independent models, although one can imagine situations in which a successful interdiction can only take place in certain time windows. In our research we will consider time dependent network interdiction by considering an interdiction game played on a network of queues. An operator routes customers through the network towards a destination, while an interdictor attempts to intercept these customers during their service times at the queues. We analyze optimal strategies for both the operator and the interdictor.

2 - A Smuggling Game with the secrecy of smuggler's information

Ryusuke Hohzaki, Department of Computer Science, National Defense Academy, 1-10-20 Hashirimizu, 239-8686, Yokosuka, Kanagawa, Japan, hohzaki@cc.nda.ac.jp

This report deals with a two-person zero-sum multi-stage smuggling game. Customs and a smuggler are allowed to take an action of patrol and smuggling, respectively, within the limited number of chances. Customs obtains reward by the capture of the smuggler and the smuggler gets reward by the success of smuggling. Almost all past researches modeled their games by complete information game. In this report, we deal with a game with asymmetric information, where only Customs does not know past behavior of his opponent. We evaluate the value of information by deriving Bayesian equilibrium.

3 - Modelling covert social networks

Ana Isabel Barros, Military Operations, TNO, POBox 96864, 2509 JG, The Hague, Netherlands, ana.barros@tno.nl, Bob van der Vecht

Social Network Analysis has shown its potentials and shortcomings in the analysis of covert networks in a military intelligence and criminal investigation setting. In practice however, deciding whether a relation between two individuals in a covert network is present or not given the available information is not an easy task. Often partial and/or unreliable and/or contradicting information is available. In this paper we will introduce a structured method to merge information taking into account the reliability of the available sources used and context knowledge available.

■ WB-29

Wednesday, 10:30-12h00

CC-A29

Support Vector Machines. New results

Stream: Optimization and Data Mining
Invited session

Chair: *Theodore Trafalis*, Industrial Engineering, University of Oklahoma, 202 West Boyd, Rm 124, 73019, Norman, OK, United States, ttrafal@ou.edu

1 - Feature Ranking for Support Vector Machines with Second-Order Cone Programming

Sebastian Maldonado, School of Engineering and Applied Sciences, Universidad de los Andes, Av. San Carlos de Apoquindo 2200, Las Condes, Santiago, Chile, smaldonado@uandes.cl

This work addresses the issue of feature ranking for linear and kernel-based SVMs considering Second Order Cone Programming formulations. These formulations provide a robust and efficient framework for classification, while an adequate feature selection process avoids errors in estimation of mean and covariances. Our approach is based on a sequential backward elimination, proposing different contribution measures to determine the feature relevance. Experimental results on real life microarray data sets demonstrate the effectiveness and efficiency of our approach.

2 - A collaborative recommendation using edge weighted SimRank

Ayaka Inoue, Graduate School of Science and Technology, Sophia University, Kioi-cho 7-1, Chiyoda-ku, 1028554, Tokyo, Tokyo, Japan, ayaka.inoue@sophia.ac.jp, *Yuichiro Miyamoto*

We deal with a recommendation method based on the collaborative filtering. Our recommendation approach is an elementary one based on voting by similar customers. We adopt BipartiteSimRank as a measure of similarities between customers (items). Our main contribution is an extension of SimRank by introducing edge weights for practical use in electric commerce. We also report a computational result using a real-life data that includes a purchase history, personal information and site accesses of each customer.

3 - An Adaptive Weighted Kernel Technique for Online Training with Imbalanced Data

Theodore Trafalis, Industrial Engineering, University of Oklahoma, 202 West Boyd, Rm 124, 73019, Norman, OK, United States, ttrafal@ou.edu, *Nicolas Couellan*

Kernel methods are widely useful for data classification problems. In the case of imbalanced datasets kernel techniques perform poorly in predicting the minority class for imbalanced data. Imbalanced datasets exist in several application areas such as medical diagnosis problems. We develop an incremental weighted scheme of classifying imbalanced data online and provide computational results for several imbalanced data sets. Our results show that the proposed incremental scheme outperforms a batch version of weighted SVM both in terms of minority class prediction accuracy and training speed.

■ WB-30

Wednesday, 10:30-12h00

CC-A31

DEA and Performance Measurement: Applications 8

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Juha Eskelinen*, Aalto School of Economics, 00076, Aalto, Finland, juha.p.eskelinen@aalto.fi

1 - Scale efficiency analysis of Brazilian logistic service providers industry

Carlos Ernani Fries, Department of Production and Systems Engineering, Federal University of Santa Catarina, Campus Trindade - CTC/EPS, C.P. 476, 88010-970, Florianópolis, Santa Catarina, Brazil, ernani@deps.ufsc.br, *Mônica M. M. Luna*, *Antonio G.N. Novaes*

The Brazilian market for logistics services has experienced since the 90s a considerable increase in competition. To attain greater efficiency LSPs have adopted new strategies such as specialization of offered services or spreading out activities through firm growth. It is questioned if the limits of growth of LSP-scale enterprises have already been reached or if there is room for further expansion. DEA evaluation of scale efficiency of LSP in Brazil based on secondary data from 2004-2011 contributes to the definition of most promising scale for companies operating in this market.

2 - Estimating the longevity of breeding individuals in beef cattle herds

Juliana Cobre, Instituto de Ciências Matemáticas e de Computação, Universidade de São Paulo, Avenida Trabalhador são-carlense, 400, 13566-590, São Carlos, São Paulo, Brazil, jucobre@icmc.usp.br, *Erlandson Saraiva*, *Sabrina Caetano*

Beef cattle breeding is particularly important in the Brazilian meat market. The longevity maximization of breeding individuals generates higher revenues, reducing involuntary culling and also allowing genetic growth. The goal of this study is to model variables risk, calving interval and age of cow at last calving, and to obtain the permanence rate of cows in the herd (long duration). We propose a joint frailty parametric model. This modelling considers calving dates, presence of censored data and covariates. Computational results on a Nelore cattle data set validate this study.

3 - Intertemporal Sales Efficiency Analysis of a Bank Branch Network: A Stochastic Nonparametric Approach

Juha Eskelinen, Aalto School of Economics, 00076, Aalto, Finland, juha.p.eskelinen@aalto.fi, *Timo Kuosmanen*

We propose a new approach to assess the development of sales efficiency over time. It uses a stochastic nonparametric approach, StoNED. This allows us to eliminate from our efficiency estimates the impacts of both stochastic noise and changes in demand and exogenous conditions. The project is conducted in close collaboration with a retail bank. The monthly efficiencies of the branches of the case bank were estimated over several years. Our approach is applicable to the performance management of financial institutions and other network based sales organizations.

4 - An automatic democratic approach to weight setting applied to the new human development index

Chris Tofallis, Business School, University of Hertfordshire, College Lane, AL10 9AB, Hatfield, Herts., United Kingdom, c.tofallis@herts.ac.uk

Weight selection for a multi-dimensional index is a thorny problem. This is often bypassed by the 'agnostic' option of equal weights, as in the Human Development Index — a ranking of nations by the UN Development Programme. Whatever weights are chosen, some nations will feel disadvantaged. We propose a 2-step approach to avoid arbitrary weights: (1) Find the most advantageous set of weights for each nation in turn - we use multiplicative DEA as the new HDI is based on a weighted product. (2) Regress the associated optimal scores on the components to find a single weight set.

■ WB-32

Wednesday, 10:30-12h00

CC-A34

DEA and Performance Measurement: Applications 5

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Sanjeet Singh*, Operations Management, Indian Institute of Management Calcutta, DH Road, Joka, 700104, Kolkata, West Bengal, India, sanjeet@iimcal.ac.in

1 - Measuring Team Performances

Kei Ogiwara, Operating Research, 84-4 Aza Ebinokuchi Tsuchiya, 015-0055, Yurihonjo City, Japan, d12s005@akita-pu.ac.jp, *Tsutomu Mishina*, *Alejandra Gomez Padilla*

Teams are organized at any given time to pursue high levels of output in common business settings. Forming an effective team depends on who is involved in it and how the results can be evaluated as the final team outputs. Each employed member brings the necessary skills to the team to accomplish individual targets. Generally teams have multiple targets, and the team success rests on how to deploy suitable combinations of the members' skills; these issues are treated as team functions. Managing a team is another factor to success. Considering jointly team functions and management is required.

2 - Group cohesion and organizational performance

Cristina-Petronela Durneac, Sociology, S.N.S.P.A., Romania, cristina_durneac@yahoo.com

This paper aims to make a contribution to understanding the level of cohesion and performance in economic and financial organizations in Romania. The analysis was performed in 12 economic and financial organizations from Bucharest. Based on quantitative data obtained from an organizational survey, the general goal of the research is to make a contribution to the in-depth exploration, better understanding and explanation of the existence and the importance of group cohesion on organizational performance.

3 - DEAHP Approach for Manpower Performance Evaluation

Sanjeet Singh, Operations Management, Indian Institute of Management Calcutta, DH Road, Joka, 700104, Kolkata, West Bengal, India, sanjeet@iimcal.ac.in, *Remica Aggarwal*

The manpower in a company or organization constitutes an important and essential asset to an organization. In this paper we have integrated DEA to generate local weights of alternatives from pairwise comparison of judgment matrix used in the Analytic Hierarchy Process (AHP) for a three attribute system for measuring performance of manpower at different levels of managerial hierarchy. Multiple expert judgments have been considered for weight determination of the attributes. DEA-AHP (DEAHP) has been proposed in this paper as an alternative to the traditional methods of weight derivation in AHP.

■ WB-33

Wednesday, 10:30-12h00

CC-A37

OR in Sustainable Urban Development

Stream: OR for Sustainable Development
Invited session

Chair: *Vida Maliene*, School of the Built Environment, Liverpool John Moores University, Byrom Street, L3 3AF, Liverpool, United Kingdom, v.maliene@ljmu.ac.uk

1 - Sustainable and healthy housing: exploring stakeholders' views

Agne Prochorskaite, School of the Built Environment, Liverpool John Moores University, Liverpool John Moores University, Byrom Street, L3 3AF, Liverpool, United Kingdom, A.Prochorskaite@2009.ljmu.ac.uk, *Vida Maliene*

Sustainable housing policy and initiatives need greater alignment with health and well being agenda. However, implementation of this is a highly complex problem as multiple objectives and different stakeholders' views need to be considered. The paper presents a sustainable and healthy housing criteria system based on a comprehensive review of existing codes, standards and literature on housing and health. The aim of this is to allow evaluation and ranking of dwellings according to different stakeholder priorities of sustainability, health and well-being housing features.

2 - Development of a multicriteria model for comprehensive assessment of residential units

Jana Selih, Department of Civil and Geodetic Engineering, University of Ljubljana, Jamova 2, 1000, Ljubljana, Slovenia, jana.selih@fgg.uni-lj.si

The change of the buyers' position in the current economic recession conceived a need for a tool used to assess various features of the residential unit, and make the decision regarding the purchase on a rational basis. The proposed model is based on five main criteria: location, architectural design, technical quality, living comfort and energy efficiency. The sub-criteria enable thorough but still robust description of the property of the unit. The applicability of the proposed model is exhibited by the parametric analysis, where different units within Slovenian territory are assessed.

3 - Sustainable development problems of the apartment policy in Latvia

Sanda Geipele, Riga Technical University, Mezha Street 1/7, 212 room, LV-1048, Riga, Latvia, sanda_geipele@inbox.lv, *Ineta Geipele*, *Iveta Stamure*

The aim of the research is to state the problems of the Social economic environment within the apartment policy in Latvia. Results discovered would be the base to elaborate suggestions for optimization of dwelling technologies. The mathematic, monographic and statistical forecast methods were applied. The general evaluation of economical and ecological situation of two housing funds and technologies of the dwelling houses elaborated with defining principles of rent price forming justifies chances of the sustainable development of social economic environment in Latvia.

4 - Model for municipal real estate strategic management

Egl Klumbyte, Department of Civil Engineering Technologies, Kaunas University of Technology, Krasevskio 30-25, LT-50280, Kaunas, LITHUANIA, Lithuania, egleklumbyte@gmail.com, *Rasa Apanaviciene*

Municipalities are usually the largest real estate owners and managers. Only about 30% of major European cities are able to provide amount and value of their real estate portfolios. The Lithuanian Free Market Institute has introduced its first Index of Municipalities in Lithuania and states, that none of the Lithuanian municipality has been developed its real estate management strategy. The article presents the new model helping to manage municipal real estate management effectively by taking into account the priorities of strategic economic and social development tendencies of the region.

■ WB-34

Wednesday, 10:30-12h00

CC-A39

Games and decision making

Stream: Cooperative Game Theory
Invited session

Chair: *Sirma Zeynep Alparslan Gok*, Mathematics, Faculty of Arts and Sciences, Suleyman Demirel University, Faculty of Arts and Sciences, Suleyman Demirel University, Department of Mathematics, 32260, Isparta, Turkey, zeynepalparslan@yahoo.com

1 - Coalition formation in a bargaining game with a fixed payments contract and delegation

Haruo Imai, KIER, Kyoto University, Yoshida HOnmachi, Sakyo, 606-8501, Kyoto, Japan, imai@kier.kyoto-u.ac.jp

Coalition formation for bargaining is examined when coalitional contracts are limited to delegation to a member in return of fixed payments (adopted in the uniqueness literature). Specifically, SSPE of three stage games (coalition formation, coalitional bargaining, and bargaining game) are investigated. Such equilibria exist and nontrivial coalition structures emerge. We show that for order-independent equilibria, the softest player tends to be favored, but such equilibria may not exist, by means of a CRRRA example. Iterating above stages, also we show that a nested coalition structure emerges.

2 - The impact of issue salience and distance in probabilistic spatial voting indexes

Tom Blockmans, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussel, Belgium, tblockma@vub.ac.be, *Frank Plastria*, *Stefano Benati*, *Guiseppe Vittucci Marzetti*

We present a generalization of a probabilistic spatial voting index. The impact of the distance function on the results of the model is examined, comparing between (squared) Euclidean and Manhattan distance. A distinction is made between the results that are weighted and unweighted by issue salience, representing the parties' policy priorities. Instead of using the bliss points of the parties as a proxy for the coalition, we use an alternative method for estimating the coalition consensus. Empirical applications illustrate the influence these three factors have on the voting indexes.

3 - Blocks of flats renovation game

Agne Reklaitė, Vilnius University, Lithuania, agne.reklaitė@mif.vu.lt

In this paper a renovation of blocks of flats is studied. A game is constructed, which allows government to organise full-scale renovation, effectively use the resources of residents and have relatively low government expenses on renovation. In the presented game the decisions of individual residents lead to an efficient equilibrium. Vilnius' central heating data is analysed and optimal strategies are built for residents of several types of apartment blocks. The results indicate that residents' decisions highly depend on the expected heating price but may be influenced by other factors.

4 - On the interval Shapley value: two new characterizations

Sirma Zeynep Alparslan Gok, Mathematics, Faculty of Arts and Sciences, Suleyman Demirel University, Faculty of Arts and Sciences, Suleyman Demirel University, Department of Mathematics, 32260, Isparta, Turkey, zeynepalparslan@yahoo.com

The Shapley value, one of the most common solution concepts in Operations Research applications of cooperative game theory, was defined and axiomatically characterized in different game-theoretic models. In this study we focus on the Shapley value for cooperative games where the set of players is finite and the coalition values are compact intervals of real numbers. We give two new characterizations of the interval Shapley value with the aid of the properties of efficiency, symmetry and strong monotonicity and by using interval dividends.

■ WB-35

Wednesday, 10:30-12h00

CC-A41

Optimization Modeling I

Stream: Software for OR/MS

Invited session

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, United Kingdom, bjarni@maximalsoftware.com

1 - Solving Constraint Programming problems with AIMMS

Guido Diepen, AIMMS, Schipholweg 1, 2034 LS, Haarlem, Netherlands, Guido.Diepen@AIMMS.com

Besides the support for the traditional Mathematical Programming like (Non-)Linear Programs and Mixed Integer Programs, AIMMS now also supports Constraint Programming (CP). Typically CP performs very well on highly combinatorial problems, which can be difficult to model/solve with mathematical programming. AIMMS supports both common global constraints from CP (e.g., count/alldifferent), as well as specific scheduling constraints, which are useful when modeling scheduling problems in AIMMS.

2 - LocalSolver: black-box local search for combinatorial optimization

Julien Darlay, e-lab, Bouygues SA, 32 avenue Hoche, 75008, Paris, France, jdarlay@bouygues.com, *Thierry Benoist*, *Bertrand Estellon*, *Frédéric Gardi*, *Romain Megel*, *Karim Nouioua*

We present LocalSolver 2.0, a black-box solver for combinatorial optimization based on local-search techniques. It can handle very large nonlinear problems with millions of 0-1 variables on a standard computer. LocalSolver offers simple APIs as well as an efficient modeling language for fast prototyping. It has been tested on classical benchmarks and succeeded the first phase of Google ROADEF/EURO challenge. Moreover LocalSolver is used in several industrial applications: maintenance planning, energy optimization, TV media planning.

3 - Deploying MPL Optimization Models on Servers and Mobile Platforms

Bjarni Kristjansson, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, United Kingdom, bjarni@maximalsoftware.com, *Sandip Pindoria*

The IT industry is currently undergoing a major shift, away from traditional standalone applications, to new platforms such as tablet computers and mobile phones. In this presentation, we will demonstrate for the first time, a new server-based version of MPL OptiMax, that makes writing mobile applications relatively quick and easy process. We will demonstrate how to integrate optimization models seamlessly with online data, and then deploying them on a server for servicing both web and mobile clients, using standard programming languages, such as CSharp, VB, C/C++ or Python.

■ WB-37

Wednesday, 10:30-12h00

CC-Act

OR in Health & Life Sciences 6

Stream: OR in Health & Life Sciences (contributed)

Contributed session

Chair: *Vassilis Kostoglou*, Department of Informatics, Alexander TEI of Thessaloniki, P.O. Box 141, 57400, Thessaloniki, Greece, vkostogl@it.teithe.gr

1 - Improve OR utilization and reduce number of required beds

Theresia Van Essen, University of Twente, Netherlands, j.t.vanessen@utwente.nl, *Johann Hurink*, *Erwin Hans*

Due to increasing health care costs, hospitals are forced to reduce the number of beds on the nursing wards while still increasing their production. In this presentation, we solve this problem by creating an operating room (OR) schedule which maximizes the OR utilization and minimizes the number of required beds. The solution approach consists of two steps: (1) generate surgery blocks that maximize OR utilization and satisfy several resource constraints and (2) assign blocks to ORs and days such that the number of required beds is minimized. The solution approach is tested on real-life data.

2 - Optimal experimental design for a pure birth process with incomplete information

Ali Eshragh Jahromi, School of Mathematical Sciences, The University of Adelaide, North Terrace Campus, 5005, Adelaide, South Australia, Australia, ali.eshraghjahromi@adelaide.edu.au

Our goal is to estimate the rate of growth of a population governed by a stochastic model. We may choose n time points at which to count the number of individuals present, but due to detection difficulties, or constraints on resources, we are able only to observe each individual with fixed probability p . We discuss the optimal times at which to make our n observations in order to maximize Fisher Information. For computational and analytical reasons which will be discussed, we specifically focus on the cases $n=1$ and $n=2$, presenting both theoretical and numerical findings.

3 - Implementation of an OR model for the comparison of higher technological education specialties

Vassilis Kostoglou, Department of Informatics, Alexander TEI of Thessaloniki, P.O. Box 141, 57400, Thessaloniki, Greece, vkostogl@it.teithe.gr, *Michael Vassilakopoulos*, *Christos Koilias*

This work focuses on the comparison of the specialties provided by the higher technological education regarding graduates' employment status and vocational prospects. A survey OR model is introduced consisting of original data collection from 5,183 Greek graduates corresponding to 45 specialties through a structure questionnaire and telephonic interviews. Bivariate, multivariate, and cluster analysis identified the statistically significant differences, leading to findings and providing guidelines for the selection of a field of studies that leads to a more promising professional career.

■ WB-38

Wednesday, 10:30-12h00

HH-Colombus

Multiobjective Optimization and Transportation

Stream: Multiobjective Optimization

Invited session

Chair: *Anatoly Levchenkov*, Riga Technical University, 1658, Riga, Latvia, anatolijs.levchenkova@rtu.lv

Chair: *Mikhail Gorobetz*, Institute of Industrial Electronics and Electrical Engineering, Riga Technical University, 1 Kalku Street, Riga, Latvia, mihails.gorobets@rtu.lv

1 - Multi-Objective Road Pricing: A Game Theoretic and Multi-Level Optimization Approach

Anthony Ohazulike, Applied Mathematics, University of Twente, Drienerlolaan 5, 7522 NB, Enschede, Netherlands, a.e.ohazulike@utwente.nl, *Georg Still*, *Walter Kern*, *Eric van Berkum*

Using a game theoretical approach, we develop a pricing scheme that internalizes multiple traffic externalities. Further, we extend the single authority road pricing scheme to a scheme with multiple actors/stakeholders or regions. Road users' interests are represented in the upper and the same level as the decision makers, thus, making them active players in the toll setting game. Having shown that pure Nash equilibrium (NE) toll may not exist among the stakeholders (with likely opposing objectives), we design a mechanism that induces NE which coincides with system optimum.

2 - Multi-objective optimization with an immune algorithm for a railway safety control system

Andrew Mor-Yaroslavtsev, Riga Technical University, Kronvalda bulv.1, LV-1010, Riga, Latvia, andrejs@rtu.lv, *Anatoly Levchenkov*

This paper describes an immune clonal selection algorithm used together with a negative selection algorithm for use in an intelligent railway electric vehicle safety system. Embedded devices collect data

about the rolling stock location and status, communicate it to the server and other devices, and use it to avoid dangerous situations. The authors examine the means of communication between the embedded devices and their effectiveness. The authors review data analysis methods used to detect, predict and control undesirable rolling stock travel conditions.

3 - A Multi-Objective Minimum Cost Flow Problem to Design Safe Walking-Routes for School Children

Ken-ichi Tanaka, The University of Electro-Communications, 1-5-1, Chofugaoka, Chofu, Tokyo, Japan, 182-8585, Tokyo, Japan, ken1tnk@se.uec.ac.jp, *Ryuhei Miyashiro*, *Yuichiro Miyamoto*

For school children to walk safely to and from school, it is important to walk in groups, not alone. However, walking together may force children to walk longer distances than those of their shortest paths. A multi-objective minimum cost flow problem is presented in which both the total walking distance and the total distance walked alone for children are minimized. Pareto optimal solutions show that the total distance walked alone can be greatly reduced by making children slightly deviate from their shortest paths. Heuristically obtained solutions for a real road network are also analyzed.

4 - Use of Adaptive Control Systems in Multi-Criteria Tasks in Electric Transport Control

Andrejs Potapovs, Faculty of Power and Electrical Engineering, Riga Technical university, Riga Kalku 1, LV1658, Riga, Latvia, Andrejs.Potapovs@rtu.lv

Nowadays, there are very topical issues, which are connected with the security of rail transport routing and it is caused by the fact that train intensity and the speeds, which raise the requirements for an observation of a train movement timetable and for the safety level of all train movement, are constantly increasing. The following assumption is proposed: a programmable logic controller (PLC) with a control program on the basis of the adaptive control algorithms, smooth and precise braking of a train in multi-criteria motion conditions in a single train anti-collision system.

■ WB-39

Wednesday, 10:30-12h00

HH-Cousteau

Dynamic Programming 2

Stream: Dynamic Programming

Invited session

Chair: *Martina Hesse*, Chair of Production and Logistics, Georg-August-Universität Göttingen, Platz der Göttinger Sieben 3, 37073, Göttingen, Germany, Martina.Hesse@wiwi.uni-goettingen.de

1 - A Dynamic Classification and Prediction Model for Road Departure Warning Systems

Andre Possani Espinosa, Department of Digital Systems, Instituto Tecnológico Autónomo de México, Rio Hondo No.1, 01080, Mexico City, D.F., Mexico, andre.possani@itam.mx, *Marta Cabo Nodar*, *Edgar Possani*

One of the main tasks identified in the SAFESPOT IP Project, co-funded by the European Union, was the development of a Road Departure Prevention Application. This application relies on the identification and prediction of vehicle trajectories in order to provide in-advance warnings to drivers and therefore prevent deadly road accidents. Continuing with this work, we will present an application of a dynamic adaptive model evaluated with real and simulated data. Results obtained are compared with previously implemented techniques.

2 - Some applications of Optimal Control in Sustainable Fishing in the Baltic Sea

Dmitriy Stukalin, Universität Greifswald, Greifswald University, Rathenau-Str., 47, 17489, Greifswald, Germany, dimidron85@rambler.ru

Problems related to the implementation of optimal control theory for the three-dimensional dynamic model cod-herring-sprat (the fish populations management problem) are presented. They belong to a class of models called Lotka-Volterra models influenced by several natural processes and human activities. Interacting species, which inhabit in a common habitat with limited resources, will be considered. The problem of optimal harvest policy is solved for the controls of various classes and their behaviour is analyzed.

3 - Supporting Tailor-made Performance Management Systems by System Dynamics — A Multiple Criteria Based Software Evaluation

Wolfgang Ossadnik, Department Business Management / Managerial Accounting, University of Osnabrueck, Rolandstrasse 8, 49069, Osnabrueck, Germany, wolfgang.ossadnik@uni-osnabrueck.de, Ralf Kaspar

A fundamental task of Management Accounting is the development, implementation and continuous improvement of Performance Management Systems (PMS). These can be visualized by strategy maps which link key performance indicators according to relevant cause-and-effect relationships. Based on the dynamic character of PMS the use of System Dynamics (SD) is necessary to take into account temporarily delaying and retroactive influences. In our study, we show the process of dynamic modeling in performance management as well as the results of a multi-criteria evaluation of SD software products.

4 - Modeling carbon storage in cascading usage systems of wood and derived timber products

Martina Hesse, Chair of Production and Logistics, Georg-August-Universität Göttingen, Platz der Göttinger Sieben 3, 37073, Göttingen, Germany, Martina.Hesse@wiwi.uni-goettingen.de, Jutta Geldermann

The carbon storage period of forests can be extended by a material use of wood and derived timber products: the storage effect of forests is continued in wooden products. A serial connection of multiple material applications including re- and upcycling loops with a final energetic use describes the idea of cascading biomass resources. Relevant parameters and data sources for modeling carbon flows and sinks are presented and the adequacy of multi-agent and dynamic system modeling approaches is discussed.

■ WB-40

Wednesday, 10:30-12h00

HH-Livingstone

Preference Learning 5

Stream: Preference Learning
Invited session

Chair: Willem Waegeman, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure links 653, 9000, Ghent, Belgium, willem.waegeman@ugent.be

1 - Preference-based reinforcement learning

Weiwei Cheng, Mathematics and Computer Science, University of Marburg, Germany, roywwcheng@gmail.com

We discuss the integration of two sub-fields of machine learning, namely preference learning and reinforcement learning (RL). While conventional RL methods are restricted to deal with numerical rewards, in many applications the feedback signals are qualitative but not quantitative. Therefore, building on novel methods for preference learning, we equip the RL agent with qualitative policy models. We build on an existing method for approximate policy iteration based on roll-outs and make use of a specific type of preference learning methods, the label ranking method.

2 - Preference-based policy learning

Riad Akrouf, INRIA Saclay Île-de-France, 91405, Orsay Cedex, France, riad.akrouf@inria.fr, Marc Schoenauer, Michèle Sebag

The expert-robot interaction is framed as a Learning-to-rank problem: the robot demonstrates a policy, that is ranked by the expert w.r.t. to previous policies. Active Ranking and Reinforcement Learning are combined: the robot learns an estimate of the expert's preferences, and demonstrates the most informative policy w.r.t. this estimate. The difficulty comes from the fact that the preference estimate is learned from the behavioral space, while the active learning criteria are defined on the parametric space. The resulting approach is discussed w.r.t. Inverse RL on standard benchmarks.

3 - A simple algorithm for multi-label ranking

Krzysztof Dembczynski, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, kdembczynski@cs.put.poznan.pl, Wojciech Kotlowski, Eyke Hüllermeier

We discuss the problem of rank loss minimization in the setting of multi-label classification. In this setting, the rank loss counts the number of label pairs, in which a relevant label does not precede an irrelevant label in the predicted ranking. We show that a simple algorithm that trains a binary classifier for each label independently is competitive to the more complex state-of-the-art approaches that rely on minimization of pairwise convex surrogates of the rank loss. During the talk, we will give theoretical arguments that justify this simple approach.

■ WB-41

Wednesday, 10:30-12h00

HH-Heyerdahl

System Dynamics: demographics and methodology

Stream: System Dynamics Modeling and Simulation
Invited session

Chair: David Wheat, Geography, University of Bergen, Nedre Fjellsmug 6, 5018, Bergen, Norway, david.wheat@uib.no

1 - A Simulation Model of Demography & Economy in Lithuania

David Wheat, Geography, University of Bergen, Nedre Fjellsmug 6, 5018, Bergen, Norway, david.wheat@uib.no

Lithuania's shrinking labor force is a much-discussed result of emigration and more deaths than births. Yet, the long-run macroeconomic scenario is uncertain. If demographic dynamics prove problematic for economic growth, the reinforcing feedback effects will further discourage family formation and encourage emigration—a vicious circle. Will counteracting feedback effects be strong enough to avoid economic stagnation? This paper examines this question with a system dynamics model that integrates cross-disciplinary theories with data from Lithuania's economy and demography.

2 - A Simulation-based Analysis of Trends in Immigration and Crime

Richard McDowall, University of Bergen, Vilhelm Bjerknesvei 57, 5081, Bergen, Norge, Norway, richard.mcdowall@gmail.com

The connection between immigration and crime is a contentious issue in debates over immigration policy in European countries, in part because there is little consensus over the extent of immigrant criminality. This paper contributes an endogenous explanation of crime trends in Oslo, using a dynamic simulation model adapted from a cohort-survival model of immigrant populations and criminal behavior. The ultimate contribution of this study is the provision of a tool to aid criminal justice capacity planning and immigration policy design.

3 - Diagramming a Feedback Model of Emigration

Rasa Cincyte, University of Bergen, Norway, rasa.cincyte@gmail.com, David Wheat

Research on the emigration issue reveals the absence of a unified theory to guide data collection and analysis, as well as policy design. Recent contributions narrow this literature gap by identifying emigration drivers that cross disciplinary boundaries and form feedback loops.

This paper extends the endogenous perspective with causal loop diagramming—a system dynamics tool. Another contribution of this paper is a conceptual framework to facilitate developing a simulation model for empirically testing a unified emigration theory and policy options in the Lithuanian context.

4 - Modelling the Mechanisms of Behaviour Change at the Population level in a Social Marketing Context

Brian Dangerfield, Centre for Operations Management, Management Science & Statistics, University of Salford, Salford Business School, Maxwell Building, The Crescent, M5 4WT, Manchester, United Kingdom, b.c.dangerfield@salford.ac.uk, *Norhaslinda Zainal Abidin*

We need to better understand the drivers and mechanisms of population-level human behaviour change when the objective is to achieve a societal benefit. A review is made of the recent contributions which system dynamics has offered for the design, comparison and evaluation of societal policies in a social marketing context. Specifically, in the case of childhood obesity, a description is given of how a system dynamics model might be used to aid the design of policies to promote beneficial changes in eating habits.

■ WB-42

Wednesday, 10:30-12h00

BW-Amber

Energy Systems Planning

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science

Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

1 - Planning Critical Resources for Offshore Oil Field Development under Uncertainty

Leonidas Sakalauskas, Operational Research, Institute of Mathematics & Informatics, Akademijos 4, LT-08663, Vilnius, Lithuania, sakal@ktl.mii.lt, *Leonardo Moraes*, *Luiz Carlos Sousa*, *Roger Rocha*, *Adilson Elias Xavier*

This work considers the problem of planning critical resources for offshore oil field development for a horizon of one year. Field development activities comprise a complex mix of resources that are interconnected in a way that their management is a challenging task due to the uncertainties of the activities durations. In an oil field development one of the key elements are the rigs, however they can only operate effectively if they are supplied by a certain amount of resources on the right time. We model this problem using stochastic programming and compare with the deterministic model.

2 - A decision rule approach to medium-term hydropower scheduling under uncertainty

Paula Rocha, Department of Computing, Imperial College London, SE7 2AZ, London, United Kingdom, paula.martins-da-silva-rocha08@imperial.ac.uk, *Wolfram Wiesemann*, *Daniel Kuhn*

We present a multistage stochastic optimisation model for the medium-term scheduling of a cascaded hydropower system. Electricity spot prices change on a much shorter time scale than the hydrological dynamics of the reservoirs in the cascade. We exploit this property to reduce computational complexity: we partition the planning horizon into hydrological macropoints, and we account for intra-stage price variability by using price duration curves. Moreover, we restrict the space of recourse decisions to those affine in the observable data, thereby obtaining a tractable approximate problem.

3 - Refinery Operations Planning under Uncertainty

Leonardo Nascimento, Federal University Rio de Janeiro, Brazil, leo_eng99@yahoo.com, *Helder Venceslau*, *Adilson Elias Xavier*, *Virgilio Jose Martins Ferreira Filho*, *Leonidas Sakalauskas*, *Roger Rocha*

Oil refining is a series of processes that aim to separate the crude oil into pre-standardized fractions. The way these processes can be combined result in a variety of schemes where each one can be used as a production plan. This work presents a methodology, based upon stochastic programming (SP) that support the decision makers in the mid-term operations planning of an oil refinery. Results generated by running a multi-period two-stage SP model are used to measure the impact on the economic efficiency when not considering the randomness of the demand and the receipt of crude oil.

■ WB-43

Wednesday, 10:30-12h00

BW-Granite

Extended Two-Stage Linear Stochastic Programs

Stream: Stochastic Programming

Invited session

Chair: *Rüdiger Schultz*, Mathematics, University of Duisburg-Essen, Lotharstr. 65, D-47048, Duisburg, Germany, schultz@math.uni-duisburg.de

1 - Nonlinear Two-Stage Stochastic Programs

Rüdiger Schultz, Mathematics, University of Duisburg-Essen, Lotharstr. 65, D-47048, Duisburg, Germany, schultz@math.uni-duisburg.de, *Tobias Wollenberg*

The paradigms of two-stage stochastic linear programming readily extend to two-stage decision making under nonanticipativity in general. Our talk picks up this abstract observation and elaborates nonlinear two-stage models of that kind. We report on applications of nonlinear two-stage stochastic programming in areas as different as supply networks for grid-based scarce commodities and shape optimization with linearized elasticity.

2 - Some Remarks on Linear Stochastic Bilevel Programs

Charlotte Henkel, Mathematics, University of Duisburg-Essen, Forsthausweg 2, 47057, Duisburg, Germany, charlotte.henkel@uni-due.de

Compared to linear stochastic two-stage programs, linear stochastic bilevel problems (LSBP) exhibit a strongly increased complexity. Starting from a deterministic linear bilevel problem, we derive structural properties for LSBPs using state-of-the-art parametric optimization techniques. As an outcome, we obtain rather weak analytical results. This significantly effects risk measures and solution algorithms for this kind of problem. We emphasize our results by instructive examples.

3 - Decomposition Methods for Stochastic Programs with Dominance Constraints Induced by Linear Recourse

Dimitri Drapkin, Mathematics, University of Duisburg-Essen, Forsthausweg 2, D-47057, Duisburg, Germany, dimitri.drapkin@googlemail.com

We develop linear programming equivalents for two-stage stochastic models with linear recourse and dominance constraints of first and second order. In the favourable case, where only continuous variables are present in the second stage, cutting-plane decomposition algorithms are proposed and discussed along with the computational results.

4 - A stochastic programming approach to optimization of information retrieval

Vitaliy Vitsentiy, International Information, Ternopil National Economic University, Ternopil, Ukraine, v.vitsentiy@gmail.com

The research problem of optimization of the expected relevance of retrieved documents in search sessions with feedback is considered. We propose to use Multistage Stochastic Programming for this. To convey the endogenous uncertainty with gradual resolution, non-anticipativity constraints in a "tight" linear relaxed form were developed using hybrid optimization methods. In experiments with simulated database of

documents, the proposed approach showed significantly better retrieval effectiveness comparatively with traditional information retrieval and two-stage stochastic programming.

■ WB-44

Wednesday, 10:30-12h00

BW-Marble

Collective Learning Procedures

Stream: Machine Learning and its Applications
Invited session

Chair: *Michael Khachay*, Ural Branch of RAS, Institute of Mathematics and Mechanics, S.Kovalevskoy, 16, 620990, Ekaterinburg, Russian Federation, mkhachay@imm.uran.ru

Chair: *Vadim Strijov*, Russian Academy of Sciences, Computing Center, Vavilova 42-268, 119333, Moscow, Russia, Russian Federation, strijov@ccas.ru

1 - Geometrical properties of connected search spaces for binary classification problem

Oleksandr Frei, MIPT, Norway, sashafrey@gmail.com

The overfitting of machine learning algorithms is often caused by excessive complexity of the search space. In this work we study geometrical properties of connected search spaces in the special case of binary classification problem. By introducing the technique of random assignment of labels to data points, we show a couple of new properties of splitting and connectivity profiles of an arbitrary search space. These properties will be demonstrated for the set of linear classifiers in three-dimensional space and for the set of conjunctive rules.

2 - Approximation for Minimum Committee Problem

Konstantin Kobylkin, Optimization, IMM UB RAS, Sophya Kovalevskaya st., 16, 620990, Ekaterinburg, Sverdlovskaya, Russian Federation, kobylkinks@gmail.com

We consider a problem giving an approximation for NP-hard minimum committee problem for two sets on the plane, the special case of learning problem: given sets A and B, a sequence of linear functions is called a committee if for every point a of A (b of B) there exists a subsequence of functions each of which is positive (negative) over a (over b) with length exceeding a half of the sequence length; the problem is to find the smallest length committee for A and B. Experiments show the approximation problem to be reducible to the same one for sets having less cardinality.

3 - Combinatorial theory for ensemble of algorithms

Andrey Ivakhnenko, Moscow Institute of Physics and Technology, Mocsow, Russian Federation, andrej_iv@mail.ru

The combinatorial theory (CT) of machine learning was recently developed by K. Vorontsov. CT provides sharper estimations of generalization ability (GA) comparing to statistical theory of machine learning. In particular, it establishes some new overfitting bounds for logical conjunction rules. Those bounds were used to improve learning methods for logical classification algorithms on real-world data sets. In this work we extend this approach to the ensembles of algorithms. We use CT to find few simple algorithms with high GA and then combine them to ensemble by weighted voting.

4 - Computational complexity and approximability of several geometric covering problems.

Michael Khachay, Ural Branch of RAS, Institute of Mathematics and Mechanics, S.Kovalevskoy, 16, 620990, Ekaterinburg, Russian Federation, mkhachay@imm.uran.ru,
Maria Poberiy

The known Point Covering problem of finding the minimum cardinality cover of a given finite subset of the plane by straight lines (Min-2PC) is NP-hard in the strong sense. We extend this result to the k-dimensional case (for all fixed $k > 2$). By polynomial reduction of the (k-1)PC to the kPC problem we show that the latter is NP-complete in the strong sense. This reduction can be transformed into an L-reduction of the Min-(k-1)PC to the Min-kPC problem. Therefore, the Min-kPC problem is Max-SNP-hard for all $k > 2$ and consequently have no PTAS, unless $P=NP$.

■ WB-45

Wednesday, 10:30-12h00

BW-Water

Customer-Oriented Revenue Management

Stream: Advanced Inventory Control and Pricing Strategies

Invited session

Chair: *Catherine Cleophas*, Wirtschaftswissenschaften, Freie Universität Berlin, Garystr. 21, 14195, Berlin, Germany, catherine.cleophas@fu-berlin.de

1 - Selling to Heterogeneous Customers of Uncertain Value considering both Opportunity Costs and Misclassification in a Dynamic Revenue Management Approach

Michael Mohaupt, Dresden University of Technology, Germany, michael.mohaupt@mailbox.tu-dresden.de, *Andreas Hilbert*

Opportunity costs are very common practice in revenue management, but loose significance as reference value if the true worthiness of a booking request cannot be observed at the time of decision for acceptance or denial. In customer-oriented revenue management this problem may arise if customers differ in their future buying behavior (frequency, product choice) but cannot be classified into the appropriate customer segment unambiguously. By considering expected (mis)classification we extend a bid-price control and show advancements both in classification accuracy and revenues via simulation.

2 - Deterministic Aggregation for Discrete Choice Models

Jonas Rauch, JRG MathOpt, University of Heidelberg, Interdisciplinary Center for Scientific Computing, Im Neuenheimer Feld 368, 69120, Heidelberg, Germany, jonas.rauch@gmx.de, *Sebastian Sager*

While widely used in simulation, complex discrete choice models are presently not as common in optimization, mainly due a lack of efficient, accurate aggregation methods. Most current approaches involve Monte Carlo simulation, which scales poorly with desired accuracy. We propose the use state-of-the-art numerical methods to compute choice probabilities deterministically for models with a linear utility function. Moreover, we present a way to efficiently compute derivatives of choice probabilities w.r.t. various parameters, making the method especially suitable for optimization purposes.

3 - Customer-Oriented Extensions of Revenue Management Models and the Value of Intuition

Catherine Cleophas, Wirtschaftswissenschaften, Freie Universität Berlin, Garystr. 21, 14195, Berlin, Germany, catherine.cleophas@fu-berlin.de

The spread of a customer-oriented view of revenue management motivates the extension of traditional demand models. In current practice, extensions of the model — when not solved analytically — are left to the intuition of analysts. This paper categorizes customer-oriented model extensions and their requirements and suggests the systematic use of simulations to evaluate the cost and benefit of extending RM models. Finally, it proposes introducing intelligent agents to the revenue management process to complement traditional analytic approaches.

4 - Filtering techniques to improve forecasting from small numbers in revenue management

Philipp Bartke, Wirtschaftsinformatik, Freie Universität Berlin, 14195, Berlin, Germany, PHILIPP.BARTKE@gmail.com

Modern RM methods incorporate sophisticated customer choice models that call for the estimation of a variety of parameters. Estimating these parameters based on often sparse historical data becomes a key challenge previously been referred to as the problem of small numbers. This paper proposes the application of filtering techniques well studied in signal processing and control theory but rarely mentioned in RM literature so far. In an agent-based simulation system, the performance of the proposed method in life-like scenarios is evaluated and compared to more traditional methods.

Wednesday, 12:30-14:00

■ WC-01

Wednesday, 12:30-14:00

RB-Alfa

Keynote Lecture: Professor Jonathan Caulkins

Stream: Keynote, Tutorial and Plenary Lectures
Keynote session

Chair: *Richard Hartl*, Dept of Management, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, richard.hartl@univie.ac.at

1 - Providing a Scientific Basis for Managing Illegal Drugs & Markets

Jonathan Caulkins, H. John Heinz III School of Public Policy & Management, Carnegie Mellon University, 5032 Forbes Avenue, 15289, Pittsburgh, United States, caulkins@andrew.cmu.edu

What happens when formal training in operational analysis meets a classic "wicked problem" with multiple conflicting objectives, competing agency priorities, and abundant data that nevertheless do not answer the questions that really matter? This talk gives one answer, drawing on 20+ years experience working on a particularly fascinating problem — policy regarding control of illegal markets, notably those for illegal drugs.

The tools of operations research, industrial organizations, and economics can be harnessed to provide an empirical, scientific basis for drug policy making. The models discussed in this talk focus on drug initiation (product diffusion), price responsiveness (elasticity of demand), and operation of the illegal supply chain, both during normal times and when the distribution network is disrupted. Corresponding data are drawn from epidemiological studies, forensic laboratory analysis, undercover buys, and extensive interviews with incarcerated drug smugglers and dealers in Australia, France, the UK, and the US. These models provide the foundation for estimating the cost-effectiveness of different strategies for controlling drug use and associated social harms.

However, I will not tell an entirely happy tale of Operations Research (OR) as panacea, limited only by the outside world's ignorance of its power. Rather, I will tell a story of a glass that is half full and yet also half empty.

For example, these issues are truly "OR problems" in the sense that OR ideas and insights underpin key dynamics and in the sense that knowledge of OR empowers better understanding and solutions. However, they are also problems of and for economics, sociology, political science, demography, psychology, medicine, and other disciplines. OR can and should partner with other disciplines and perspectives when grappling with fundamental strategy choices related to drug policy.

Likewise, the adversarial nature of the policy making process challenges an optimization-based way of looking at the world.

The objective of this talk is to reflect on OR's success and limitations in this and some allied domains to draw meta lessons for how experts can effectively use mathematical models and operational analysis to produce insights that inform decision makers in comparably messy domains.

■ WC-02

Wednesday, 12:30-14:00

RB-Beta

Multi-Project Scheduling and Stochastic Project Scheduling

Stream: Project Management and Scheduling
Invited session

Chair: *Rainer Kolisch*, TUM School of Management, Technische Universitaet Muenchen, Arcisstr. 21, 80333, Muenchen, Germany, rainer.kolisch@wi.tum.de

1 - A modified branch and cut approach for Resource Portfolio Problem under Relaxed Resource Dedication policy

Umut Besikci, Industrial Engineering, Bogazici University, Bogazici Universitesi Guney Kampus Muhendislik Fakultesi, Bebek, 34342, Istanbul, Turkey, umutbesikci@gmail.com, *Ümit Bilge*, *Gündüz Ulusoy*

Multi-project scheduling and management problem constitutes an important part of the project scheduling literature. In this study we deal with Resource Portfolio Problem (RPP) under Relaxed Resource Dedication (RRD) policy. The Branch and Cut (B&C) procedure of CPLEX is modified with different feasible solution heuristics, branching strategies and valid inequalities. The proposed modifications utilize the insights gained from the previous studies we have carried out for RPP. The experimental results show that the proposed modifications have significant effect on solution quality.

2 - Dynamic stochastic resource-constrained multi-project scheduling

Rainer Kolisch, TUM School of Management, Technische Universitaet Muenchen, Arcisstr. 21, 80333, Muenchen, Germany, rainer.kolisch@wi.tum.de, *Thomas Fliedner*, *Philipp Melchior*, *Walter Gutjahr*

We consider the problem where project arrive stochastically over time. Projects have a deterministic network but stochastic activity durations. The objective is to minimize the average weighted makespan of the projects. We present solutions procedures which have been proposed for this problem and compare their performance in an experimental study.

3 - Assorted sensitivity results in stochastic project networks

Anand Paul, University of Florida, United States, paulaa@ufl.edu

We present some results pertaining to sensitivity issues in stochastic project networks. First, we discuss how the impact of activity correlation on mean project time depends on network topology. Second, we discuss a metric that quantifies the impact of activity variance on mean project completion time; prior analytical results in the literature are qualitative rather than quantitative. Finally, we discuss conditions under which an increase in mean activity duration results in an increase in mean project duration, keeping activity variances fixed.

■ WC-03

Wednesday, 12:30-14:00

RB-L1

EURO/ROADEF Challenge Session 4

Stream: EURO/ROADEF Challenge
Invited session

Chair: *Christian Artigues*, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, France, artigues@laas.fr

Chair: *Ender Özcan*, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, exo@cs.nott.ac.uk

Chair: *Emmanuel Guere*, Google, 38 Avenue de l'Opera, 75002, Paris, France, guere@google.com

Chair: *Eric Bourreau*, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr

Chair: *Kedad-Sidhoum Safia*, LIP6 - UPMC, 4 Place Jussieu, 75005, Paris, France, safia.kedad-sidhoum@lip6.fr

Chair: *H. Murat Afsar*, Industrial Systems, University of Technology of Troyes, 12 rue Marie Curie, BP 2060, 10010, Troyes, France, murat.afsar@utt.fr

Chair: *Marc Sevaux*, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - Offline, enhanced, adaptive large neighborhood search for the machine reassignment problem

Alberto Delgado, IT University of Copenhagen, Rued Langgaards Vej 7, 2300, Copenhagen, Denmark, alde@itu.dk, Yuri Malitsky, Dario Pacino, Kevin Tierney

We present an approach to solve the machine reassignment problem that combines complete and incomplete approaches into an offline, enhanced, adaptive large neighborhood framework. Random selection, services, and locations are the operators to create neighborhoods, while a constraint programming and MIP model, and a Tabu Search algorithm are used to re-optimize them. The selection of the neighborhood operator is made based on online information, while the approach to re-optimized them is selected based on online information and offline learning.

2 - A hybridization of Simulated Annealing and sample local search for solving the machine reassignment problem

Marcus Ritt, Departamento de Informática Teórica, Universidade Federal do Rio Grande do Sul, Brazil, euro-conference@ritt-online.de, Gabriel Portal, Leonardo de Miranda Borba, Alexander J. Benavides, Luciana S. Buriol

We propose two heuristics based on local search with two neighbourhoods: the first obtains a neighbour by moving a process to another machine, and the second by swapping two processes on different machines. The first heuristic is a sample local search. It randomly chooses one of the best neighbours in the first neighbourhood, and uses the second to escape local minima. The second heuristic is a Simulated Annealing and uses only the first neighbourhood. The hybrid approach runs Simulated Annealing with two sets of parameters in parallel, and the sample local search in the remaining time.

3 - A co-evolutionary hyper-heuristic for ROADEF/EURO Challenge 2012 Machine Reassignment problem

Wojciech Jaśkowski, Institute of Computing Science, Poznan University of Technology, ul. Piotrowo 2, 60-985, Poznan, Poland, wjaszkowski@cs.put.poznan.pl, Piotr Gawron, Marcin Szubert, Bartosz Wieloch

We propose a co-evolutionary hyper-heuristic for solving combinatorial optimization problems. Our algorithm learns how to solve a problem by selecting and generating perturbation operators using the nature-inspired concept of arm races between potential solutions and tests. It co-evolves a population of operators (solutions) with a population of states in the problem search space (tests). We evaluate the performance of the proposed method on the ROADEF/EURO Challenge 2012: Machine Reassignment problem using various operators: local-search improvements, dedicated heuristics and MIP solver.

4 - A hybrid algorithm for machine reassignment

Arnaud Liefvooghe, LIFL - CNRS - INRIA, Université Lille 1, Lille, France, arnaud.liefvooghe@lifl.fr, François Legillon, François Clautiaux, El-ghazali Talbi

We present an algorithm for the machine reassignment problem of the ROADEF/EURO 2012 challenge. Our approach is divided into two phases, applied in a sequential way. First, an iterated local search algorithm is performed. It is based on a best-improvement hill-climber, whose neighborhood consists of all the moves that reassign a given process to another machine. Second, we aim at re-balancing the overload cost over machines. We use an integer programming solver to improve the incumbent solution locally by fixing some processes on their current machine, and solving the initial model.

■ WC-04

Wednesday, 12:30-14:00

RB-L2

Combinatorial Optimization: Applications

Stream: Combinatorial Optimization

Invited session

Chair: Jan van Vuuren, Department of Logistics, University of Stellenbosch, Private Bag X1, Matieland, 7602, Stellenbosch, Western Cape, South Africa, vuuren@sun.ac.za

1 - Minimizing setup time in colour printing schedules

Alewyn Burger, Department of Logistics, Stellenbosch University, Private Bag X1, Matieland, 7600, Stellenbosch, Western Cape, South Africa, apburger@sun.ac.za, Neil Jacobs, Jan van Vuuren, Stephan Visagie

In this talk a scheduling problem is considered which arises in the food industry where packaging requires overlay printing with multiple colours. Printing machines used for this purpose typically accommodate a small number of colours simultaneously, called a pallet. To minimise operation time it is desirable to schedule print jobs so that the number of pallet changes, as well as the number of cartridges that have to be washed between pallet changes is minimized. We solve the problem exactly for small problem instances and heuristically for larger instances.

2 - The cost of link failure in network protection

Anton de Villiers, Logistics, Stellenbosch University, 53 Crown Street Vierlanden, Durbanville, 7550, Cape town, Western Province, South Africa, 14812673@sun.ac.za, Alewyn Burger, Jan van Vuuren

If the vertices of a network G denote facilities to be protected, and the links between facilities denote routes along which protecting guards can move, a secure deployment is an assignment of guards, at most one per facility, to the facilities, with the property that, for every facility v , there is either a guard at v or a guard at a facility adjacent to v who, after moving to v , leaves the resulting deployment secure again. In this talk, bounds are established on the smallest number of guards required for a secure deployment on G after randomly removing a specified number of links from G .

3 - Variable selection in NIR spectroscopy data using a hybrid PSO algorithm

Martin Kidd, Dipartimento di Elettronica, Informatica e Sistemistica (DEIS), University of Bologna, Bologna, Italy, martin.kidd@unibo.it

In chemometrics, near-infrared (NIR) spectroscopy is used to obtain spectral data on samples for the purpose of predicting various properties of these samples. NIR data are typically used in conjunction with multivariate calibration methods in order to model these properties of given samples, and a common obstacle is the presence of noise in the data. The use of heuristic methods to perform variable selection in NIR data has proved to be useful in the past, and in this talk a two-phase particle swarm optimisation algorithm is presented as a possible solution approach to this problem.

4 - An optimisation-based sugarcane harvest scheduling decision support system for commercial growers in South Africa

Jonas Stray, Textilhögskolan, Hogskolan i Boras, Bryggaregatan 17, SE-501 90, Boras, Västergötland, Sweden, jonas.stray@hb.se, Jan van Vuuren

Commercial sugarcane growers in South Africa revise their seasonal harvesting schedules continuously since factors such as environmental events, sucrose content, growth rate and cost of harvesting change over time. Our decision support system (DSS) incorporates regression analysis of sugar content and growth, costing and risk models for the events. An asymmetric travelling salesman problem with time-dependent costs model sequences the fields by maximising profit. The DSS is analysed through a case study, and results indicate that the DSS may be useful in large-scale operations.

■ WC-05

Wednesday, 12:30-14:00

RB-L3

Topics in integer and mixed integer programming I

Stream: Discrete Optimization, Geometry & Graphs (contributed)

Contributed session

Chair: Frank Fischer, Mathematics, Chemnitz University of Technology, Reichenhainer Str. 39, 09107, Chemnitz, Germany, frank.fischer@mathematik.tu-chemnitz.de

1 - Investigation of properties and solving of combinatorial optimization problems with linear constraints.

Igor Grebennik, Systems engineering, Kharkiv National University of Radio Electronics, flat 130, Geroev Truda str, 45, 61129, Kharkiv, Ukraine, IgorGrebennik@gmail.com, *Oleksii Baranov*

An optimization problem on a combinatorial set such as permutations, combinations as well as a special combinatorial set with linear constraints is considered. As a result of inclusion mapping of the combinatorial set into Euclidean space and a convex extension of objective function to convex set an equivalent optimization problem is constructed. Estimates of minima for the convex functions on the combinatorial sets under linear constraints are proposed. The estimates are based on linear combinatorial problems with constraints and used in the branch-and-bound algorithm. Examples are given.

2 - On Mixed Integer Random Convex Programs

Giuseppe Calafiore, DAUIN, Politecnico di Torino, Corso Duca degli Abruzzi, 24, 10141, Torino, Italy, giuseppe.calafiore@polito.it, *Daniel Lyons*, *Lorenzo Fagiano*

We consider mixed-integer (MI) optimization problems subject to N randomly drawn convex constraints. We provide explicit bounds on the tails of the probability that the optimal solution found under the N constraints will become infeasible for the next random constraint. First, we prove that the number of support constraints (constraints whose removal strictly improves the optimal objective) in general convex MI problems is bounded by a number depending only on the dimension of the decision vector. Then, we show that the tails of the violation probability are bounded by a binomial distribution.

3 - The SCIP Optimization Suite - It's all in the bag!

Gerald Gamrath, Zuse-Institute Berlin, Takustr. 7, 14195, Berlin, Germany, gamrath@zib.de

We present the SCIP Optimization Suite, a tool for modeling and solving optimization problems. It consists of the modeling language ZIMPL, the LP solver SoPlex, and the constraint integer programming framework SCIP. Besides being one of the fastest MIP solvers available in source code, SCIP is able to solve a much wider range of optimization problems including non-convex MINLP and provides support for branch-and-price. We report on current developments and new features in the upcoming release 3.0, including enhanced MINLP support, exact integer programming, and parallelization.

4 - Dynamic Graph Generation in Lagrangian Relaxation

Frank Fischer, Mathematics, Chemnitz University of Technology, Reichenhainer Str. 39, 09107, Chemnitz, Germany, frank.fischer@mathematik.tu-chemnitz.de, *Christoph Helmberg*

Models based on time expanded networks, which are used in many applications, grow very quickly when the number of time steps increases which makes it impossible to solve the models with standard methods. We propose a dynamic graph generation technique that can be applied in Lagrangian relaxation or column generation approaches. Instead of working on the full model, special cost structures allow to keep only small sub-networks in memory but without losing any information. Numerical tests on a large scale train timetabling problem model demonstrate the effectiveness of dynamic graph generation.

■ WC-06

Wednesday, 12:30-14:00

RB-Gamma

Mathematical Economics

Stream: Dynamical Systems and Game Theory
Invited session

Chair: *Luis Ferreira*, Matemática, Escola Superior de Estudos Industriais e de Gestão, IPP, ESEIG, Rua D Sancho I, número 981, 4480-876, Vila do Conde, Porto, Portugal, migferreira2@gmail.com

1 - On the convergence to Walrasian prices in random matching Edgeworthian economies

Luis Ferreira, Matemática, Escola Superior de Estudos Industriais e de Gestão, IPP, ESEIG, Rua D Sancho I, número 981, 4480-876, Vila do Conde, Porto, Portugal, migferreira2@gmail.com

We show that for a specific class of random matching Edgeworthian economies, the expectation of the limiting equilibrium price coincides with the equilibrium price of the related Walrasian economies. This result extends to the study of economies in the presence of uncertainty within the multi-period Arrow-Debreu model, allowing to understand the dynamics of how beliefs survive and propagate through the market.

2 - A cooperative version of one group pursuit game

Yaroslavna Pankratova, Mathematics of economic research,, International Banking Institute, Nevsky pr. 60, Saint-Petersburg, Russian Federation, yasyap@gmail.com, *Denis Kuzyutin*

We consider a nonzero-sum group pursuit game with one evader and m pursuers. At each time moment the players choose their directions of motion. Each player knows the moment t and his own and all other players' positions. Moreover, the pursuer knows the directions chosen by the evaders at the moment t . We propose a rule to associate a corresponding cooperative game to a considered nonzero-sum pursuit game. We prove that in the constructed cooperative game the core is not empty and time-consistent. Finally, we give a number of examples that illustrate the main results.

3 - On the Experimental Investigation of the Stock-Exchange Game Model

Igor Katin, Systems Analysis Department, Vilnius University Institute of Mathematics and Informatics, Akademijos str. 4, LT-08663, Vilnius, Lithuania, igor@getweb.lt, *Joana Katina*, *Jonas Mockus*

A simple SEGM was introduced by J. Mockus in 2003 to simulate the behavior of several stockholders using fixed buying-selling margins at fixed bank yield in the context of Nash equilibrium. In this paper, an extended USEGM is investigated. USEGM includes the transaction costs to reflect the reality better. To represent users that prefer linear utility functions, USEGM adds the AR-ABS(p) model, minimizing the absolute values, to the traditional AR(p) model. The objective of USEGM is not forecasting, but simulation of financial time series that are affected by predictions of the participants.

■ WC-07

Wednesday, 12:30-14:00

RB-Eta

Rich vehicle routing problems

Stream: New Trends in Vehicle Routing
Invited session

Chair: *Jorge E. Mendoza*, Institute of Applied Mathematics, Université Catholique de l'Ouest, 3 Place André Leroy, 49008, Angers, France, jorge.mendoza@uco.fr

Chair: *Victor Pillac*, Automatique - Productique, Ecole des Mines de Nantes, 4 Rue Alfred Kastler, La Chantrerie, 44300, Nantes, France, victor.pillac@gmail.com

1 - A Unified Hybrid Genetic Search for Vehicle Routing Problems

Thibaut Vidal, CIRRELT - Université de Montréal & ICD-LOSI - Université de Technologie de Troyes, 12, rue Marie Curie, BP 2060, cedex, 10010, TROYES, France, thibaut.vidal@cirrelt.ca, *Teodor Gabriel Crainic*, *Michel Gendreau*, *Christian Prins*

A unified hybrid genetic search is proposed to address multi-attribute vehicle routing problems. This meta-heuristic relies on problem-specific route evaluation and assignment operators, along with generic implementations of Split procedures, local-search improvement methods, and genetic components. Furthermore, a bi-criteria evaluation of

individuals, driven by both contribution to population diversity and solution quality, enables to enhance exploration capabilities and reduce the risks of premature convergence. High-quality results are reported for a wide range of vehicle routing variants.

2 - Constraint-based Construction Heuristics for Rich Vehicle Routing Problems

Felix Brandt, Logistics Systems Engineering, FZI Forschungszentrum Informatik, 76131, Karlsruhe, Germany, brandt@fzi.de, *Anne Meyer*

Constraint programming (CP) is successfully applied to rich vehicle routing problems (RVRP). However, during the construction phase CP is used as a mere satisfiability checker, if at all, not using its power for finding an actual solution. In this work we want to show how CP can be applied during a construction phase. Therefore, we develop branching techniques analogous to established construction heuristics from literature. Furthermore, we present our first results and compare the performance of different approaches.

3 - Generalized disaggregation algorithm for the vehicle routing problem with time windows and multiple routes

Rita Macedo, LAMIH, Université de Valenciennes, Portugal, rita.sgd.macedo@gmail.com, *Saïd Hanafi*, François Clautiaux, Cláudio Alves, J. M. Valério de Carvalho

We address the VRP with multiple routes and time windows. For this variant of the VRP, there is a time interval within which every customer must be visited, and every vehicle is allowed to perform more than one route within the same planning period. We propose a general disaggregation algorithm that improves the exact approach described in (Macedo et al., 2011), and describe a novel rounding rule and a new node disaggregation scheme based on different discretization units. In addition, we propose a new integer model for the problem, which can also assess if a solution is feasible or not.

4 - A Mixed Integer Linear Programming Model For Solving Large-Scale Integrated Location-Routing Problems For Urban Logistics Applications at Groupe La Poste

Matthias Winkenbach, Kuehne Foundation Endowed Chair in Logistics Management, WHU - Otto Beisheim School of Management, Burgplatz 2, 56179, Vallendar, Germany, matthias.winkenbach@whu.edu, *Paul Kleindorfer*, *Bernard Lemarié*, *Christèle Levêque*, *Alain Roset*, *Stefan Spinler*

We present a large-scale static, deterministic mixed inter linear programming model solving an integrated location-routing problem in the context of urban logistics services (ULS). We aim at determining an optimal infrastructure and fleet design for an urban consolidation and transportation network. The model is meant to quantitatively evaluate potential strategic moves of postal operators into the domain of ULS. Based on operating data from French La Poste, we analyse the key drivers and sensitivities of optimal infrastructure and fleet design to support the development of profitable ULS.

■ WC-08

Wednesday, 12:30-14:00

RB-Epsilon

Boolean Functions and Their Applications

Stream: Boolean and Pseudo-Boolean Optimization
Invited session

Chair: *Endre Boros*, RUTCOR, Rutgers University, 08854, Piscataway, New Jersey, United States, Endre.Boros@rutcor.rutgers.edu

1 - On the Polyhedral Set of Bipartite TSP

Bela Vizvari, Industrial Engineering, Eastern Mediterranean University, Gazimagusa, Mersin 10, Turkey, vizvaribela@gmail.com

The Bipartite TSP appears in many industrial applications, e.g., to optimize the route of an assembly robot. In many cases the numerical solution of TSP is based on the facets of its polyhedral set. The most important constraints are the degree inequalities and the subtour elimination constraints. The simplest facet-defining inequalities after these ones are the comb inequalities in the general case. However in the bipartite case the comb inequalities are not facet-defining, as it will be proven in this presentation. The case of clique-tree inequalities is also discussed.

2 - Some Results on Threshold Separability of Boolean Functions

Giovanni Felici, Istituto di Analisi dei Sistemi ed Informatica, Consiglio Nazionale delle Ricerche, Viale Manzoni 30, 00185, Roma, Italy, giovanni.felici@iasi.cnr.it, *Endre Boros*

We consider the conditions for the existence of a Linear Threshold Function that separates two sets of Boolean vectors obtained by discretization of real valued data. Problems of this type are found in Supervised Learning and Data Mining. We state a combinatorial necessary and sufficient condition for the existence of such function when points belong to the plane, and show how, when formulated as a linear program, this condition is equivalent to the Farkas' Lemma. Such equivalency provides insights for our problem in larger dimension that can be used in discretization algorithms.

3 - Hardness Results for Approximate Pure Horn CNF Formulae Minimization

Endre Boros, RUTCOR, Rutgers University, 08854, Piscataway, New Jersey, United States, Endre.Boros@rutcor.rutgers.edu, *Aritanan Gruber*

We show that for a pure Horn Boolean function on n variables, unless $P = NP$, it is not possible to approximate in polynomial time (in n) the minimum numbers of clauses and literals to within factors of $2(\log(1-o(1))n)$ even when the inputs are restricted to 3-CNFs with $O(n(1+e))$ clauses, for some small $e > 0$. Furthermore, we show that unless the ETH is false, it is not possible to obtain constant factor approximations for these problems even in sub-exponential time (in n).

■ WC-09

Wednesday, 12:30-14:00

RB-Zeta

Maritime Transportation 3

Stream: Maritime Transportation
Invited session

Chair: *Magnus Stålhane*, Industrial Economics and Technology Management, NTNU, Alfred Getz veg 3, 7491, Trondheim, Norway, stalham@iot.ntnu.no

1 - On routing and risk minimization in offshore helicopter transportation

Irina Gribkovskaia, Faculty of Economics, Informatics and Social Sciences, Molde University College - Specialized University in Logistics, Postbox 2110, 6402, Molde, Norway, irina.gribkovskaia@himolde.no, *Oyvind Halskau*, *Fubin Qian*

Helicopters are often used for transporting crews to and from offshore installations. Helicopter transportation is regarded as one of the main risks in the offshore industry and the oil companies want to minimize this risk. We show how the expected number of fatalities can be reduced by applying different routing strategies. We present trade-offs between the number of helicopters used and the expected risk using real data from the Norwegian offshore industry.

2 - A combined pickup and delivery and inventory routing problem

Magnus Stålhane, Industrial Economics and Technology Management, NTNU, Alfred Getz veg 3, 7491, Trondheim, Norway, stalham@iot.ntnu.no, *Henrik Andersson*, *Marielle Christiansen*

We present a combined pickup and delivery and inventory routing problem from the tramp shipping industry. The fleet is heterogeneous with each ship having a different load capacity, speed and cost structure. The inventories are paired, and there are additional optional cargoes available. The objective is to maximize the revenue of transporting spot cargoes, while keeping the inventory levels within their limits. Two path flow formulations are presented, and the problem is solved using a branch-and-price method. Computational results will be presented.

3 - A base integer programming model and benchmark suite for liner shipping network design

Fernando Alvarez, Goteborggata 9, 0566, Oslo, Norway, jfa2@cornell.edu, *Berit Dangaard Brouer*, *Christian Edinger*, *Munk Plum*, *David Pisinger*, *Mikkel M. Sigurd*

The potential for making cost effective and energy efficient liner shipping networks using OR is huge and neglected. We believe access to domain knowledge and data is an entry barrier to approach the liner shipping network design problem. The purpose of the benchmark suite project is to provide access to the liner shipping domain for independent OR researchers. We present the domain of liner shipping in relation to mathematical programming. An IP model and a suite of instances based on real life data from the largest liner shipping company, Maersk Line, and several other stakeholders is presented. Finally, computational results yielding the first solutions to the benchmark suite are presented.

■ WC-10

Wednesday, 12:30-14:00

RB-Theta

Humanitarian Logistics

Stream: Supply Chain Management
Invited session

Chair: *Maria Besiou*, Kuehne Logistics University, Brooktorkai 20, 20457, Hamburg, Germany, maria.besiou@the-klu.org

1 - The environmental impact of humanitarian operations

Jurgita Balaisyte, INSEAD, Boulevard de Constance, 77305, Fontainebleau, France, jurgita.balaisyte@insead.edu, *Ruth Carrasco-Gallego*, *Luk Van Wassenhove*

The negative environmental impacts of relief operations arise at the different stages of relief supply chain: from procurement, stock positioning, transportation to waste management. It is important to regard environmental issues in humanitarian supply chain decisions. As a result a growing number of humanitarian agencies are attempting to integrate environmental considerations in their activities. We map the value chain and identify its economic, environmental and social issues and look for ways to integrate environmental aspects in to humanitarian supply chains.

2 - The Effects of Unsolicited Donations in Disaster Relief Operations

Nha-Nghi Huynh, Kuehne Logistics University, Kuehne Logistics University, Brooktorkai 20, 20457, Hamburg, Hamburg, Germany, nha-nghi.huynh@the-klu.org, *Sandra Transchel*, *Maria Besiou*, *Luk Van Wassenhove*

Why do beneficiaries not get aid items they require or why do international humanitarian organizations (IHO) deliver these not fast enough? A reason is the chaotic setting in which IHO operate. But what affects high-priority (HP) deliveries more are material convergences at disaster entry points caused by unsolicited donations. They consume excessive resources and create serious bottlenecks. We present a queuing model that illustrates the effects of unsolicited donations on the Haiti relief operation and shows how systematic coordination could significantly increase the throughput of HP goods.

3 - Funding strategies in humanitarian operations for relief and development

Alfonso Pedraza-Martinez, Operations and Decision Technologies, Indiana University, 1309 10th Street, Kelley School of Business, 47405, Bloomington, INDIANA, United States, alpedraz@indiana.edu, *Arian Aflaki*

We model funding strategies for relief and development programs in a multi-donor market with donation uncertainty. Donors decide how much to donate to each program; a humanitarian organization decides between 4 different funding strategies: 1) total earmarking; 2) partial earmarking; 3) conditional earmarking; 4) no earmarking. By comparing these four strategies we offer insights to humanitarian organizations on how to improve their levels of funding while keeping operational efficiency high.

4 - Decentralisation and Earmarked Funding in Humanitarian Logistics for Relief and Development

Maria Besiou, Kuehne Logistics University, Brooktorkai 20, 20457, Hamburg, Germany, maria.besiou@the-klu.org, *Alfonso Pedraza Martinez*, *Luk Van Wassenhove*

We study the International Humanitarian Organizations dual mission of relief and development in decentralized, stochastic operations with different levels of earmarked funding, using system dynamics methodology. Focusing on equity and efficiency we find that a system with local procurement and short lead time may take longer to respond than a system with global procurement and high lead time. Our results have important implications for humanitarian fleet management practice. Specifically, what organizational structure to adopt in different organizational environments.

■ WC-11

Wednesday, 12:30-14:00

RB-Iota

Realistic parallel machines problems

Stream: Realistic Production Scheduling
Invited session

Chair: *Olga Chub*, Faculty of Applied Mathematics and Management, Kharkiv national university of radioelectronics, Lenina str., 18, 43, 61166, Kharkiv, Ukraine, ChubOlya@gmail.com

1 - Minimising tardiness in parallel machine scheduling with additional mold type restrictions

Amelia White, Engineering Science, The University of Auckland, 70 Symonds Street, Auckland, Auckland, New Zealand, awhi100@aucklanduni.ac.nz, *Andrea Raith*

We study a parallel machine scheduling problem with sequence-dependent setup times. The jobs to be produced have due dates and require a specific mold type to be installed on a machine for production. The setup time for these molds is significant and there is only a small number of each type of mold available. We present a new time-indexed IP formulation to minimise overall job tardiness, with constraints to model both the setup times of the molds on the machines and the restriction on the number of machines which can produce jobs of the same type at the same time.

2 - MIP models and algorithms for earliness/tardiness scheduling problems on parallel machines

Rosiane de Freitas Rodrigues, Institute of Computing, UFAM / UFRJ, Brazil, rosiane@icomp.ufam.edu.br, *Rainer Xavier de Amorim*, *Bruno Cardoso Dias*

Scheduling problems with earliness and tardiness penalties are presented, each one or both together, involving parallel machines, and independent jobs with distinct processing times and priorities, all of them NP-hard problems. Classical MIP models with improvements, and exact and approximate approaches have been developed with tests on - based on - OR-Library instances. Significant results were obtained, reaching optimal solutions when known, and having competitive performance compared to the works available in the literature.

3 - Multiobjective parallel machine scheduling using memetic algorithms

Felipe Baesler, Industrial Engineering, Universidad del Desarrollo, Av Sanhueza 1750, Concepcion, Chile, fbaesler@ingenieros.udd.cl, *Oscar Cornejo*

This work presents a multiobjective optimization algorithm for the parallel machine scheduling problem based on the memetic algorithms paradigm (MA). This algorithm combines genetic evolution with local search in the same way as traditional MA, but with the use of independent populations for each objective, as well as a mechanism to find compromised solutions. The algorithm was tested and compared against four multiobjective techniques available in the literature, MOGA, SPEA, NSGA II and MOGLS. Two objectives were considered for this problem, Cmax minimization and total tardiness minimization.

4 - Mathematical model and method for optimal planning several resources

Olga Chub, Faculty of Applied Mathematics and Management, Kharkiv national university of radioelectronics, Lenina str., 18, 43, 61166, Kharkiv, Ukraine, ChubOlya@gmail.com

The resource planning multicriteria model provided that the demand for enterprise services is a deterministic function has been considered. Enterprise functioning process is defined as a continuous sequence of projects. Some projects can (and should) be run simultaneously. This fact causes of distribution of several restricted resources (time, finances, machines, human resources etc.) as between the works of a single project, and between the works of various projects. Solution method based on the interpretation of work as a geometric object and use the optimal geometric design theory toolkit.

mathematical model is proposed to solve the problems of assigning one or more yard cranes and of routing by using a genetic algorithm and developing heuristics based approach.

3 - Empty container management and the linkage between global and local allocations in export oriented countries: case of Thailand

Montathip Chanpum, Institute of Transport and Logistics Studies, The University of Sydney, Room 201-5 C37, Newtown Campus, 2006, Sydney, NSW, Australia, montathip.chanpum@sydney.edu.au

The availability of empty containers is a challenge for shipping lines in deficit areas of export oriented regions. This paper considers empty container management at a global scale and its linkage to empty allocation at a local scale in deficit areas by taking Thailand as a case study. We conducted in-depth interviews with scholars and key relevant persons from private and public sectors. A framework linking empty container allocations between the global and local scales is proposed, which will help to facilitate container movement and improve the efficiency of the global supply chain.

4 - Modeling and Optimal Management of Equipments of the BMT Containers Terminal (Bejaia's Harbor)

Fazia Aoudia-rahmoune, Operational Research, Laboratory LAMOS University of Bejaia, Traga Ouzemmour, 06000, Bejaia, Algeria, fougfourah@yahoo.fr, *Sofiane Soualah*, *Aichouche Oubraham*

The performance of a containers terminal is measured by the stopover time and the transit cost. Indeed, in a world where, in addition to rivalry, the least movement is charged and where the time takes often unexpected dimensions, reducing the time and cost of treatment becomes the main objective at the expense of large investment in equipment and management techniques. In this work, we were interested in the unloading process at BMT, and we determined the optimal combinations of equipment to be used. we develop a non-Markovian queues model and solve the problem by simulation.

■ WC-12

Wednesday, 12:30-14:00

RB-Omicron

Solution Methods at Seaport Container Terminals

Stream: Container Terminal Operations

Invited session

Chair: *Erhan Kozan*, Mathematical Sciences, Queensland University of Technology, GPO Box 2434, 4001, Brisbane, Queensland, Australia, e.kozan@qut.edu.au

1 - An Integrated Approach to Optimising Container Processes at Multimodal Seaport Terminals

Erhan Kozan, Mathematical Sciences, Queensland University of Technology, GPO Box 2434, 4001, Brisbane, Queensland, Australia, e.kozan@qut.edu.au, *Brad Casey*

A Multimodal Seaport Container Terminal (MSCT) consists of sub-systems that require optimisation of the operations within them, as well as synchronisation of the movements of machines and containers between them. We present an integrated approach. Mathematical models will be presented for the Storage Area Subsystem (SAS) and Intra-terminal Transportation Subsystem (ITTS). Initial solutions are improved through an innovative hyper-heuristic algorithm that integrates the SAS and ITTS solutions together and optimises them via meta-heuristic techniques.

2 - Yard crane scheduling by using a genetic algorithm at seaport container terminals

Mehmet Ulaş Koyuncuoğlu, Industrial Engineering, Pamukkale University, Pamukkale University Information Centre, 20070, Denizli, Turkey, ulas@pau.edu.tr, *Osman Kulak*, *Olçay Polat*, *Mustafa Egemen Taner*

Effective use of container terminal equipments is the most important factors. Scheduling the yard cranes has an important role in improving the efficiency of terminals. In this paper, a novel approach is presented about free/restrictive deployment rules and also customer priority and deployment rules are examined in combination. For the purpose of minimizing total completion time of the operations, a mixed-integer linear

■ WC-13

Wednesday, 12:30-14:00

RB-Tau

Emerging Issues in Order Fulfillment

Stream: OR Applications in the Automotive Industry

Invited session

Chair: *Bart MacCarthy*, Operations Management Division, Nottingham University Business School, NG8 1BB, Nottingham, United Kingdom, Bart.Maccarthy@nottingham.ac.uk

Chair: *Philip Brabazon*, Portsmouth Business School, Richmond Building, Portland Street, PO1 3DE, Portsmouth, United Kingdom, philip.brabazon@port.ac.uk

1 - Auction-based coordination of retailers and manufacturer in the sales of configurable products

Andreas Matzke, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstr. 3, 38106, Braunschweig, Germany, andreas.matzke@tu-bs.de, *Thomas Volling*, *Thomas Spengler*

We propose a mechanism to improve channel coordination in the sales of configurable products, assuming given capacities for product options. The approach combines two selling mechanisms. At first, the common list price mechanism between a manufacturer and multiple retailers is adopted for initial configuration of products. Second, excess capacities are sold as product upgrades by an auction mechanism. A numerical study evaluates the benefits of the approach under various conditions. As compared to static list prices, the approach allows for higher revenues in the supply chain.

2 - A review of works on the planning of capacities and orders in build-to-order automobile production

Thomas Volling, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstr. 3, 38106, Braunschweig, Germany, t.volling@tu-bs.de, Martin Grunewald, Andreas Matzke, Thomas Spengler

We provide an overview about operations research (OR) models and applications in build-to-order automobile production. We focus on two important planning objects which have not been considered in prior reviews: the planning of capacities and orders. To bridge the gap between conceptual works on the one hand and quantitative contributions on the other we provide a framework for the structuring of planning tasks. 45 works have been identified in the literature and are classified according to the proposed framework. Open issues that should be addressed by OR are discussed based on that.

3 - Optimal design of open pipeline order fulfilment processes in the volume automotive sector

Philip Brabazon, Portsmouth Business School, Richmond Building, Portland Street, PO1 3DE, Portsmouth, United Kingdom, philip.brabazon@port.ac.uk, Bart MacCarthy

Order fulfillment processes used by volume automotive producers are characterized by high variety and large scale. Simulation is used to study the effect of 11 principal control parameters on performance metrics in different customer markets. The experimental study uses an NOLH design and a CHAID factor analysis. The parameter settings minimizing the cost of fulfillment in a market do not necessarily minimize the customer-centric metrics of lead time or the degree of compromise experienced by customers. The results of the study show the complexity in this type of order fulfillment process.

■ WC-14

Wednesday, 12:30-14:00

RB-Omega

Timetabling and People

Stream: Timetabling and Rostering
Invited session

Chair: Sara McComb, Purdue University, United States, sara@purdue.edu

1 - Deterministic Optimization of Examination Timetables

Siti Khatijah Nor Abdul Rahim, School of Computer Science, University of Nottingham, Jalan Broga, 43500, Semenyih, Selangor, Malaysia, khyx8skn@nottingham.edu.my, Andrzej Bargiela, Rong Qu

We introduce a new optimization method for the examinations scheduling problem by performing permutations of slots and reassignments of exams upon the feasible schedules. The permutations minimize the number of students taking exams in adjacent slots and guarantee a significant reduction of the cost which is further reduced by reassigning exams to other slots. Our method delivers competitive results compared to other constructive methods in the literature and maintains the same deterministic optimization pattern on all benchmark datasets proving the generality and consistency of the method.

2 - The Classroom Allocation Problem in University Timetabling

Antony Phillips, Engineering Science, University of Auckland, 70 Symonds St, 1010, Auckland, New Zealand, aph038@aucklanduni.ac.nz, Hamish Waterer, Matthias Ehrgott, David Ryan

University timetabling is a large resource allocation problem, in which both times and rooms are determined for each class meeting. Due to the difficulty of the problem, it is often solved in two stages: timetable generation followed by room allocation. This paper looks at exact optimisation-based methods for allocating rooms to a timetable in which times are preassigned. Computational results on full size datasets are presented, and the trade-off between different approaches is discussed.

3 - Decision Support System for Modification of Timetables After Completion of Registration Process Involving Backlog Subjects

Sanjeev Kumar Guleria, Office of Dean, Academic Affairs, Thapar University, P.B. No. 32, 147004, Patiala, Punjab, India, skguleria@thapar.edu, A.k. Lal, Daljit Singh Bawa

The classes of backlog subjects are registered in the free slots of the normal subjects. A free slot in a section of normal subjects is occupied in some other section for studying a backlog subject. The methodology involves the identification of all students who will get affected by this change followed by the identification of clashes this change will make to any of the affected students. The proposed change is made only if no student suffers due to the proposed change.

4 - Examining Team Communication Using Questionnaires, Simulation, and Optimization

Sara McComb, Purdue University, United States, sara@purdue.edu, Ralitzza Vozdolska, Deanna Kennedy

Communication is essential for coordinating team activities and executing a team's project. The relationship between communication and successful performance, however, is complex. We examine this relationship, as well as the impact of information exchange, team size, interdependence among teammates, and media choice on it. The results from questionnaire data, simulation, and optimization suggest a curvilinear relationship dependent upon information exchange efficiency, communication requirements as a function of team composition, and whether exchanges are synchronous or asynchronous.

■ WC-15

Wednesday, 12:30-14:00

RB-2101

Discrete bilevel optimization and Variational inequalities

Stream: Variational Inequalities and Bi-Level Problems
Invited session

Chair: Diana Fanghaenel, Fachbereich Elektrotechnik/Informatik, Universität Kassel, Wilhelmshöher Allee 73, 34121, Kassel, Germany, d.fanghaenel@uni-kassel.de

1 - Global Optimization of Mixed-Integer Bilevel Programming Problem

Zhaohui Xu, Fakultät für Mathematik, Technische Universität Chemnitz, Reichenhainer Str. 41/718 D-09107, Chemnitz, Sachsen, Germany, zhaohui.xu@mathematik.tu-chemnitz.de

This paper is concerned with mixed-integer nonlinear bilevel programming problem, which has a nonlinear objective function and one parameter on the right-hand sides of the constraints in the lower level problem. We propose an algorithm via an approximation of the optimal value function of the lower level problem to solve the bilevel programming problem globally.

2 - The Branch-and-Sandwich Algorithm for Mixed-Integer Nonlinear Bilevel Programming Problems

Polyxeni-Margarita Kleniati, Chemical Engineering, Imperial College London, South Kensington Campus, SW7 2AZ, London, United Kingdom, polyxeni.kleniati03@imperial.ac.uk, Claire Adjiman

We extend our newly introduced algorithm for general bilevel programming problems, named Branch and Sandwich (B&S), to the discrete case. Auxiliary bounding problems are constructed in order to bound the inner optimal value function and provide constant bound cuts for the outer bounding problems. The originally proposed KKT-based relaxations for the inner-upper and outer-lower bounding problems are applicable with respect to the continuous inner variables and for fixed integer inner variables. A hierarchical branching scheme with additional lists of nodes, as developed in B&S, is investigated.

3 - A bilevel problem with supermodular objective function in the lower level

Diana Fanghaenel, Fachbereich Elektrotechnik/Informatik, Universität Kassel, Wilhelmshöher Allee 73, 34121, Kassel, Germany, d.fanghaenel@uni-kassel.de

We investigate a bilevel programming problem with continuous variables in the upper level and a parametric supermodular maximization problem in the lower level. We analyze the structure of this bilevel problem to transform it into an equivalent one-level combinatorial problem. Furthermore, we discuss the properties of the equivalent problem.

4 - Existence results for quasivariational inequalities

Didier Aussel, Lab.PROMES UPR 8521, University of Perpignan, Technosud, Rambla de la thermodynamique, 66100, Perpignan, France, aussel@univ-perp.fr

A quasi-variational inequality is a variational inequality in which the constraint set depends on the current point. Based on fixed point and convergence techniques we prove various existence results under weak assumptions on the set-valued operator defining the quasi-variational inequality, namely quasimonotonicity and lower or upper sign-continuity. Applications to quasi-optimization and traffic network problem are also considered.

■ WC-16

Wednesday, 12:30-14:00

RB-2103

Linear programming: Algorithms and Applications

Stream: Linear and Conic Programming
Invited session

Chair: *S.M.Atiqur Rahman Chowdhury*, Department of Mathematics, University of Dhaka, 1000, Dhaka, Bangladesh, Chowdhury_sher@yahoo.com

1 - The primal-dual column generation method

Pablo Gonzalez-Brevis, School of Mathematics, University of Edinburgh, United Kingdom, P.Gonzalez-Brevis@sms.ed.ac.uk, *Jacek Gondzio*, *Pedro Munari*

In this talk we will introduce a column generation method which uses a primal-dual interior point method to obtain well-centred non-optimal solutions of the restricted master problems. We will show that the method converges to an optimal solution of the master problem even though non-optimal solutions are used in the course of the procedure. Computational experiments will be presented using linear-relaxed reformulations of three classical integer programming problems. The results indicate that the method reduces the number of iterations and running times when compared with standard approaches.

2 - Compact Formulations of the Steiner Traveling Salesman Problem

Saeideh D. Nasiri, Mathematics & Statistics and Operational Research, STOR-i DTC, Lancaster University, B44, Fylde college, Lancaster University, LA1 4YF, Lancaster, Lancashire, United Kingdom, s.deghannasiri1@lancaster.ac.uk, *Adam Letchford*, *Dirk Oliver Theis*

The Steiner Traveling Salesman Problem (STSP) is a variant of the Traveling Salesman Problem (TSP) that is particularly suitable when dealing with sparse networks, such as road networks. The standard integer programming formulation of the STSP has an exponential number of constraints, just like the standard formulation of the TSP. On the other hand, there exist several known compact formulations of the STSP, i.e., formulations with a polynomial number of both variables and constraints. In this study, we show that some of these compact formulations can be adapted to the STSP.

3 - Computational experiments with a cutting plane algorithm for a time-indexed formulation

Lotte Berghman, FEB, KU Leuven, Naamsestraat 69, 3000, Leuven, Belgium, lotte.berghman@econ.kuleuven.be, *Frits Spieksma*

We consider an unrelated parallel machine scheduling problem where the processing cost of each job is an arbitrary function of its starting time. It is shown that valid inequalities known from the literature can be applied to our time-indexed formulation. A new class of valid inequalities that contains variables related to multiple machines is presented. All these inequalities are incorporated in a cutting plane algorithm. Experiments show how the different classes of inequalities contribute to closing the gap between the linear programming relaxation and the integer optimum.

4 - A Computer Technique for Solving Linear Programming Problems with Bounded Variables

S.M.Atiqur Rahman Chowdhury, Department of Mathematics, University of Dhaka, 1000, Dhaka, Bangladesh, Chowdhury_sher@yahoo.com

Linear Programming problems (LPPs) with upper bounded variables can be solved using the Bounded Simplex method (BSM), without the explicit consideration of the upper bounded constraints. The upper bounded constraints are considered implicitly in this method which reduced the size of the basis matrix significantly. In this paper, I developed MATHEMATICA codes for solving such problems. A complete algorithm of the program with the help of a numerical example has been provided. Finally a comparison with the built-in code has been made for showing the efficiency of the developed code.

■ WC-17

Wednesday, 12:30-14:00

RB-2105

Nonconvex Programming

Stream: Nonconvex Programming: Local and Global Approaches

Invited session

Chair: *Hoai An Le Thi*, Computer Science, University of Lorraine, Ile du Saulcy, 57 045, Metz, France, hoai-an.le-thi@univ-lorraine.fr

1 - Solving the Multidimensional Assignment Problem via the Cross-Entropy method

Manh Nguyen Duc, LMI, INSA de Rouen, Avenue de l'Université, 76801, Saint-Étienne-du-Rouvray Cedex, Rouen, France, nguyenducmanh1982@yahoo.com, *Hoai An Le Thi*, *Tao Pham Dinh*

The multidimensional assignment problem (MAP) is a higher dimensional version of the linear assignment problem, where we find tuples of elements from given sets, such that the total cost of the tuples is minimal. The MAP has many recognized applications such as data association, target tracking and resource planning. While the linear assignment problem is solvable in polynomial time, the MAP is NP-hard. In this work, we propose a new approach based on the Cross-Entropy (CE) method for solving the MAP. The efficiency of our method will be shown by testing for the large-scale problems.

2 - On the Permuted Perceptron Problem - A New formulation and approach

Hoai Minh Le, Université Paul Verlaine Metz, LITA, UFR MIM, Ile du Saulcy, 57000, Metz, France, lehoai@univ-metz.fr, *Hoai An Le Thi*, *Tiru Arthanari*

The permuted perceptron problem (PPP) has received renewed interest due to its application in Cryptanalysis. The problem can be cast into the DC (Difference of Convex functions) programming framework and solved by DC Algorithm as shown in: 'Solving the Perceptron Problem by deterministic optimization approach based on DC programming and DCA', Le Thi et al., Proc. of the IEEE Conference INDIN 2009. In this work we give a new formulation to PPP by using a parametric fow problem. An algorithm to solve the parametric fow problem and a probabilistic search of the parameter space are developed.

3 - Rare event simulations applied to hierarchical sensor planning with partially known subprocess models

Frédéric Dambreville, DGA, 16bis Av. Prieur de la Cote d'Or, 94110, Arcueil, France, submit@fredericdambreville.com

Information collection in the context of Intelligence process usually takes the form of a hierarchical, typically bi-level, planning problem. We are especially interested in the planning at the coordination level: a constraint oriented multisensor planning associated with a variety of mono-sensor control optimizations. In this contribution, we will model our sensor models an approximation noise. Real sensor models will provide indications for successive corrections of the planning process. This paper studies strategies for optimizing these plan corrections.

4 - optimisation in water management with passive aeration of tanks

Nataliya Metla, AMS (MODSI), CRP Henri Tudor, 29 av. John F. Kennedy, L-1855, Luxembourg-Kirchberg, Luxembourg, nataliya.metla@tudor.lu

A multi-objective formulation is proposed for optimal design of a small water distribution system with a special issue on aeration of reservoirs linked to water quality. Model Predictive Control approach is used to create a sequence of corresponding optimization problems over finite time horizon. A specific feature belongs to the aeration component which is non-convex. A practical approach to cope with this problem will be discussed. Finally, based on realistic consumption scenarios numerical results for control strategy will be shown.

■ WC-18

Wednesday, 12:30-14:00

RB-2107

Location Routing

Stream: Network and Discrete Location

Invited session

Chair: *Maria Albareda Sambola*, Statistics and Operations Research, Technical University of Catalonia, C. Colom, 11, 08222, Terrassa, Spain, maria.albareda@upc.edu

1 - Adaptive large neighborhood search for the two-echelon capacitated location routing problem

Vera Hemmelmayr, Vienna University of Economics and Business (WU), Nordbergstrasse 15, 1090, Vienna, Austria, vera.hemmelmayr@wu.ac.at, *Claudio Contardo*, *Teodor Gabriel Crainic*

We present an adaptive large neighborhood search heuristic (ALNS) for the two-echelon location routing problem (2E-CLRP). The 2E-CLRP is an important problem arising in freight distribution and addresses simultaneous location-routing within two-tiered systems. The number and location of capacitated facilities has to be decided on both levels while also routing a fleet of vehicles on each level. Computational results conducted on several sets of instances are presented. We compare the performance of the ALNS to several other methods proposed in the literature.

2 - A Particle Swarm Optimization Approach for the Location-Routing Problem with Simultaneous Pickup and Delivery

Ismail Karaoglan, Department of Industrial Engineering, Selcuk University, 42075, Konya, Turkey, ikaraoglan@selcuk.edu.tr, *Fulya Altiparmak*

This paper considers a Location-Routing Problem with Simultaneous Pickup and Delivery which is defined as finding locations of the depots and designing vehicle routes in such a way that pickup and delivery demands of each customer must be performed with same vehicle and the overall cost is minimized. We propose a hybrid heuristic approach based on particle swarm optimization, simulated annealing and integer programming formulation to solve the problem. Computational results indicate that the proposed approach is able to find optimal/good quality solutions in a reasonable computation time.

3 - Sparsing arrival times in discrete location

Maria Barbati, Business and Management Engineering Department, University of Naples Federico II, P.le Tecchio 80, 80078, Naples, Italy, maria.barbati@unina.it, *Giuseppe Bruno*, *Alfredo Marin*

We consider a discrete two-stage location problem where the minimum difference between two consecutive time arrivals of customers to a depot has to be balanced. Customers have to be allocated before to a facility and after to the depot. In order to avoid the congestion of the depot the flow of customers will be the most balanced in the time. We propose different Integer Programming formulations and we identify different valid inequalities. Computational experiments have been performed and the results have been discussed.

4 - The reliable p-median problem with at-facility service

Maria Albareda Sambola, Statistics and Operations Research, Technical University of Catalonia, C. Colom, 11, 08222, Terrassa, Spain, maria.albareda@upc.edu, *Yolanda Hinojosa*, *Justo Puerto*

This work deals with a facility location model where service is provided at the facility sites. It is assumed that failures on facilities can occur and, as a consequence, customers may need to follow a path through the opened facilities until finding one that is available to provide them service. The goal of the problem is to locate p facilities so that the expected total travel cost of the customers is minimized. Two alternative mathematical programming formulations for this problem are presented and an approximation based on network flows is analyzed.

■ WC-19

Wednesday, 12:30-14:00

RB-2111

Simulation in Estimation

Stream: Simulation Methods in Finance

Invited session

Chair: *Ahmet Çalik*, Statistics, Selcuk University, Selçuk University Science Faculty, Campus Konya, 42075, Konya, Turkey, ahmetcalik@selcuk.edu.tr

Chair: *Aysegul Iscanoglu Cekic*, Statistics, Selcuk University, KONYA, Turkey, iaysegul@selcuk.edu.tr

1 - Estimation of Stress-Strength Reliability for Exponential Geometric Distribution

Aydın Karakoca, Department of Statistics, Selcuk University, Faculty of Arts and Sciences, Konya, Turkey, akarakoca@selcuk.edu.tr, *İsmail Kınacı*, *Adem Yılmaz*

In this study we are interested in estimation of the stress-strength reliability $R=P(X>Y)$, X and Y are independent exponential-geometric (EG) random variables. The confidence intervals of R based on maximum likelihood and bootstrap methods are derived. An extensive computer simulation is used for comparing the performances of these confidence intervals.

2 - Simulation Study for the Comparison of Maximum Likelihood and Modified Maximum Likelihood Estimators in Logistic Regression

Yunus Akdoğan, Statistics Department, Science Faculty, Selcuk University, Selcuk University, 42225, Konya, Turkey, yakdogan@selcuk.edu.tr, *Evrin Oral*, *Muslu Kazım Körez*, *Coskun Kus*

The maximum likelihood (ML) equations are generally intractable and therefore the ML estimators are elusive. To rectify this situation, Tiku developed the method of modified maximum likelihood (MML) estimation in 1967. The method is now well established and gives estimators which are simple, unique and highly efficient. In fact, they are asymptotically fully efficient. Tiku and Vaughan (1997) used the method to extend the techniques of binary regression to nonlogistic density functions. In this study, we consider the ML and MML estimators in logistic regression. We compare the ML and MML estimators with respect to their mean square errors via a Monte Carlo simulation study. We also investigate the coverage probabilities of confidence intervals of logistic regression parameters based on ML and MML estimators via simulations. We investigate the revised MML estimators

proposed by Tiku and Vaughan (1997) with respect to their initial values as well. We show that using least squares estimators as initial values provides approximations as good as those proposed by Tiku and Vaughan (1997). REFERENCES

Tiku, M. L. and Vaughan, D. C., 1997, Logistic and nonlogistic density functions in Binary Regression with nonstochastic covariates, *Biometrical Journal*, 39, 883-898.

3 - Estimation of stress-strength parameter for exponential distribution based on masked data

Demet Sezer, Statistics, Selcuk University, Selcuk University Faculty of Science, Department of Statistics, Konya, Turkey, dsezer@selcuk.edu.tr, *İsmail Kınacı*

In this study, we estimate the stress-strength parameter(R) for serial systems with two components based on masked data. In particular, we compute the maximum likelihood and Bayes estimates of R. The considered systems consist of two independent components having non-identical complementary exponential lifetime distributions. Also in the numerical simulation study a comparison between Bayes and maximum likelihood estimates is introduced.

4 - Fuzzy AHP/DEA Approach For Relative Efficiency Of Private Universities In Turkey

Ahmet Çalk, Statistics, Selcuk University, Selçuk University Science Faculty, Campus Konya, 42075, Konya, Turkey, ahmetcalik@selcuk.edu.tr, *Nimet Yapıcı Pehlivan*, *Ahmet Pekgör*

In the study we apply integrated multi-criteria decision making (MCDM) approach, including the fuzzy analytic hierarchy process (FAHP) and data envelopment analysis (DEA) model. FAHP method is fuzzy extension of AHP applied to solve decision making problems in fuzzy environment. DEA method is a MCDM tool which solve problems that don't require prior information for ranking the decision making units. In application part, integrated FAHP/DEA is applied to private universities in Turkey. At first, for determining weights of criteria, FAHP is used and then DEA is applied to rank universities.

■ WC-20

Wednesday, 12:30-14:00

RB-2113

Financial Optimization 2

Stream: Financial Optimization

Invited session

Chair: *Mariya Nikitina*, International Banking Institute, Russian Federation, maryaniki@gmail.com

1 - Investment timing with fixed and proportional costs of external financing

Michi Nishihara, Graduate School of Economics, Osaka University, 1-7, Machikaneyama, Toyonaka, 560-0043, Osaka, Japan, nishihara@econ.osaka-u.ac.jp, *Takashi Shibata*

We develop a dynamic model in which a firm exercises an option to expand production with cash balance and costly external funds. While related papers explain their results only by numerical examples, we analytically prove the following results. In the presence of only a proportional cost of external financing, the firm with more cash balance invests earlier; however, the presence of both proportional and fixed costs leads to a non-monotonic relation between the investment time and cash balance. Our results can potentially account for a variety of empirical results.

2 - On optimal strategies for long-term business

Efim Bronshtein, Numerical Mathematics and Cybernetics, Ufa State Aviation Technical University, K.Marx str., 12, USATU, 450000, Ufa, Russian Federation, bro-efim@yandex.ru

The problem of optimal allocation of resources, that the company received at time $n = 1, 2, \dots$ on the consumption and the production is considered. The company's activities we describe as the production

functions for all time moments. The production functions are monotonically increasing, strictly concave, bounded and differentiable. We use the consumption in the discounted form as an indicator of the effectiveness. The solution is given for stable and depressive companies.

3 - Longevity Risk Management and Financial Uneasy Premonition

Tadashi Uratani, Industrial and System Engineering, Hosei University, Kajinocho 3-7-2, Koganei, 184-8584, Tokyo, Japan, uratani@k.hosei.ac.jp

We consider longevity risk in aspect of national budget and social security expenditure. Longevity is breaking national budget system through pension and health-care deficits in Japan. The national debt is accumulated in commercial banks as a major asset that becomes their crisis in some conditions. We will examine the theoretical possibility of application of longevity bond and derivatives to the risk management of pension budgetary system.

4 - On Minimizing the Ruin Probability by Investment

Mariya Nikitina, International Banking Institute, Russian Federation, maryaniki@gmail.com

A generalization of collective risk model is considered. We propose a model in view of the possibility of investing part of the surplus in a risky asset. The assumption allows minimizing the probability of ruin of an insurance company by investment. This generalization of classical model was computer simulated. The exact solutions and asymptotic approximations to the probability of ruin were obtained.

■ WC-21

Wednesday, 12:30-14:00

RB-2115

Ratings of Banks and Companies

Stream: Numerical Methods in Finance

Invited session

Chair: *Wissem Ennouri*, Industrial Management, High Institute of Industrial Management of Sfax-Tunisia, 74 Mecca Street, 3001, Sfax, Sfax, Tunisia, wissemennouri@yahoo.fr

1 - Cluster Analysis of Banks in Croatia Regarding their Characteristics

Ante Rozga, Faculty of Economics, Quantitative methods, University of Split, Matice Hrvatske 31, 21000, Split, Croatia, rozga@efst.hr, *Ksenija Dumcic*, *Blanka Škrabić Perić*

Croatia privatized her banks to increase their financial performance. As a result 95% of the banking sector is owned by foreigners. Cluster analysis used eight indicators. The analysis is done for 2003 and 2008. There were 18 most important banks used. For 2003 two clusters were obtained, almost completely divided into domestic and foreign owned banks but one. First cluster had worse financial indicators suggesting successful privatization. Results for 2008 show one change in cluster membership, but the difference in their performance has narrowed between two clusters, which is good result.

2 - Effectiveness of Credit Ratings

Ivan Lichner, Economic modeling and analysis, Institute for Economic Research SAS, Sancova 56, 81105, Bratislava, Slovakia, ivan.lichner@savba.sk

Credit rating agencies (CRAs) play an important role in the global financial markets because many market participants use their rating assessments. As CRAs have a history of failing to foresee the real future development this paper aims to find answer whether or not should financial markets trust CRAs. To find answer to this question the ratings of sovereign debt of selected EU countries will be compared with Value-At-Risk measure based on fundamental economic factors. The analysis focuses on the ability of ratings to capture economic performance of assessed country.

3 - Small and Medium-Sized Businesses through the Credit Crunch: Evidence from the UK

Meng Ma, Business School, The University of Edinburgh, 29 Buccleuch Place, EH8 9JS, Edinburgh, United Kingdom, M.Ma-4@sms.ed.ac.uk, Galina Andreeva, Jake Ansell

Access to credit is a vital condition for SMEs survival and development, especially for young start-up enterprises. The credit crisis has put the problem of SME financing to the fore, with governments putting considerable pressure on banks to lend to SMEs. This presentation looks at the credit risk modelling of the UK SMEs via logistic regression applied to a large proprietary dataset, and explores the behaviour of small businesses during the credit crisis and beyond (2007-2010) across industrial sectors, geographical regions, financial situation and for start-ups versus mature businesses.

4 - Pricing Default and Financial Distress Risks in Foreign Currency Corporate Loans in Turkey

Aycan Yilmaz, Institute of Applied Mathematics/ Financial Mathematics, Middle East Technical University, Istanbul, Turkey, aycanyilmaz@gmail.com, Işıl Erol

Latest trends show that non-financial corporations are heavily financed by foreign exchange loans (fx-loans). The paper contributes to the literature on contingent claims pricing by developing a structural model to value 'the exchange rate risk' and 'the interest rate risk' of fx-loans at the corporate level under volatile economic conditions in Turkey. The paper uses explicit finite difference method and evaluates both financial distress and default risks. The results suggest that currency depreciation and decline in interest rates result in financial distress and trigger defaults.

■ WC-22

Wednesday, 12:30-14:00

RB-2117

Fuzzy Scheduling and Fuzzy Quality Management

Stream: Fuzzy Optimization - Systems, Networks and Applications
Invited session

Chair: Erik Kropat, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: Alexej Orlov, Students Science Association, Institute for applied system analysis of the National Technical University of Ukraine, Peremohy ave. 37, 03056, Kyiv, Ukraine, orlov.alexej@gmail.com

1 - A comparison study of Wilcoxon and fuzzy Wilcoxon tests

Gultekin Atalik, Statistics, Anadolu University, Anadolu University Faculty of Science Department of Statistics, Eskisehir, Turkey, gultekinatalik@anadolu.edu.tr, Sevil Senturk

Parametric tests depend on the population distributions to be normal and independently. Nonparametric tests do not require assumptions which parametric tests require. Parametric and nonparametric tests also handle crisp values in statistics. In the real world, data may not be measured so precisely. In these situations, fuzzy sets' approaches are applied the data sets. In this study, Wilcoxon and Fuzzy Wilcoxon tests are compared with each other and all results are indicated clearly.

2 - A design for sampling plans by attributes under fuzzy environment

Ebru Turanoglu, Industrial Engineering, Selcuk University, Department of Industrial Engineering Selcuk University, Campus, Selcuklu, Konya, 42031, Turkey, 42031, Konya, Turkey, ebruturanoglu@gmail.com, Cengiz Kahraman

In the design of accurate acceptance sampling plan, it is usually needed to know the actual quality level entailed by the customer. Particularly in production environments, it may not be easy to define acceptance sampling parameters including fraction of nonconforming, acceptance number, or sample size as crisp values. The purpose of this paper is to develop a new design procedure for single and double sampling plans by attributes based on the fuzzy set theory by formulating this problem as a multi-objective mathematical programming considering producer's and consumer's risks.

3 - Task Flow Control in the GRID-System

Vlad Kucher, Educational-scientific complex - Institute for applied system analysis, National Technical University of the Ukraine (KPI), 04111, Kiew, Ukraine, commastergm@gmail.com

The model of the planning process for the task performance in the GRID-system with the multilevel hierarchical structure is introduced. The fuzzy-set approach and the application of the principle of square stowage into the band of a given width, as well as the choice of an aggregate system as a mathematical model of the planning process, have allowed the development of an algorithm, which minimizes the time of task performance as well as balances workload of resource suppliers.

4 - The analysis of influence of a choice of a class of membership functions on quality of work of recognition system

Nigar Aliyeva, Institute of Information Technologies, National Academy of Sciences of Azerbaijan, Baku, Azerbaijan, aliyevanig@rambler.ru, Elviz Ismayilov

Was analyzed effectiveness of the hand-printed recognition system using neuro-fuzzy sets with membership functions from different classes. For pattern features was constructed smooth membership functions, and also known triangular, trapezoidal, Gaussian and bell membership functions. Analyzed results of numerical experiments of recognition system with membership functions from different classes. Revealed comparative advantage of smooth membership functions offered by authors.

■ WC-23

Wednesday, 12:30-14:00

RB-Delta

Recent Advances on Proximal Methods II

Stream: Convex Optimization
Invited session

Chair: Hector Ramirez, Mathematical Engineering Department, Universidad de Chile, Avda. Blanco Encalada 2120, Piso 5, Santiago Centro, Santiago, RM, Chile, hramirez@dim.uchile.cl

1 - Lagrangian-penalization algorithm for constrained optimization

Juan Peypouquet, Mathematics, Universidad Tecnica Federico Santa Maria, Av Espana 1680, 2340000, Valparaiso, Valparaiso, Chile, juan.peypouquet@usm.cl

We present a proximal algorithm that provides solutions to constrained optimization problems - constrained variational inequalities - where observations of the state variable are required to belong to some closed convex set in a Hilbert space. The algorithm combines an exact penalization procedure involving a bounded sequence of parameters, with the predictor-corrector multiplier method. As applications, we describe how the algorithm can be used to find sparse solutions of linear inequality systems and solve partial differential equations by domain decomposition.

2 - Interior Proximal Algorithm with Variable Metric for Second-Order Cone Programming: Applications to Structural Optimization

Hector Ramirez, Mathematical Engineering Department, Universidad de Chile, Avda. Blanco Encalada 2120, Piso 5, Santiago Centro, Santiago, RM, Chile, hramirez@dim.uchile.cl, Felipe Alvarez, Julio López

We propose an inexact interior proximal type algorithm for solving convex second-order cone programs. The proposed algorithm uses a variable metric and an appropriate choice of a regularization parameter. This choice ensures the well-definedness of the proximal algorithm and forces the iterates to belong to the interior of the feasible set. Thus, under suitable assumptions, it is proven that each limit point of the sequence generated by the algorithm solves the problem. Finally, computational results applied to structural optimization are presented.

3 - A Projected Subgradient -type method for Equilibrium Problems

Susana Scheimberg, COPPE/ Engenharia de Sistemas e Computação-Instituto de Matemática, COPPE/PESC-IM, Universidade Federal do Rio de Janeiro, Caixa Postal 68511,, Bloco H/319, 21941-972, Rio de Janeiro, RJ, Brazil, susana@cos.ufrj.br, *Paulo Sergio Santos*

We consider an explicit algorithm for solving Equilibrium Problems in a finite dimensional space. We combine reflections onto suitable hyperplanes to achieve feasibility with a projected subgradient-type iteration. The algorithm has a low computational cost per iteration and some numerical results are reported.

4 - Proximal Alternating Direction Methods Combining Quadratic Regularization with Divergence Kernels

Natalia Ruiz, Mathematical Engineering, Universidad de Chile, Blanco Encalada 2120, fifth floor, Santiago, Región Metropolitana, Chile, nruiz@dim.uchile.cl, *Felipe Alvarez*

We will introduce a new alternating minimization algorithm for solving a convex program with separable structure involving linear coupling and non negativity constraints. Our algorithm consists of two proximal minimization steps applied to an augmented Lagrangian, which are performed alternatively, using quadratic regularization for the variable defined in the whole euclidean space and divergence type for non negativity one; then a proximal maximization step is performed on the dual variable. The global and full convergence of primal-dual variables to optimal solutions are established.

■ WC-25

Wednesday, 12:30-14:00

CC-A23

OR and Environmental Management - Decision Processes

Stream: OR and Environmental Management
Invited session

Chair: *Susanne Wiedenmann*, Chair of Production and Logistics, University of Goettingen, Platz der Goettinger Sieben 3, 37073, Goettingen, Germany, susanne.wiedenmann@wiwi.uni-goettingen.de

1 - Supply Planning under Uncertainty for the Industrial Use of Renewable Resources

Susanne Wiedenmann, Chair of Production and Logistics, University of Goettingen, Platz der Goettinger Sieben 3, 37073, Goettingen, Germany, susanne.wiedenmann@wiwi.uni-goettingen.de, *Jutta Geldermann*

We investigate the supply planning of a processor of agricultural goods which are required as raw materials in industrial production. The use of linseed and linseed oil is one example that promises to be relevant in the future. Problems arise from uncertain quality, quantity and price. A two stage stochastic program is used as a decision support and its results are evaluated. We use data from linseed and linseed oil for validation.

2 - Hydro-turbines Optimization: Especification and Operation

Jéssica Pillon Torralba Fernandes, Energy Department, UNICAMP, Rua Roxo Moreira 1406 apto 19, 13083592, Campinas, São Paulo, Brazil, pillon@fem.unicamp.br

This paper aims to present a methodology focused at the optimization of the Brazilian hydroelectric power plants potential, based on the specification of hydroelectric turbines to power plants in construction. This methodology choose and compare the efficiency curves of Kaplan and Propeller turbines, showing that, with an appropriate operation it is possible to obtain technical and economic improvements to the plants. The mathematical model is a non-linear mixed integer and aims to maximize the plant generation. The resolution is done by Genetic Algorithms.

3 - Integrated Risk Management Applications in Electricity Retailing

Fehmi Tanrisever, Industrial Engineering, TU/e, Netherlands, f.tanrisever@tue.nl, *Geert Jongen*

This paper examines the risk management practices of an electricity retailer in the Dutch electricity market. We derive the optimal futures hedging policy for the retailer in the presence of demand and price risk using base- and peak-load futures contracts. We also develop an ARIMA-GARCH model for the electricity spot prices and test the effectiveness of our hedging policies. We show that, on average, by hedging with base-load contracts the firm may reduce the variance of its cash flows by 91%. Including peak-load contracts into the hedging portfolio increases the efficiency of hedging to 95%.

■ WC-26

Wednesday, 12:30-14:00

CC-A24

Criteria Weighting in Decision Support

Stream: Multi-Criteria Decision Making and Environmental Management

Invited session

Chair: *Alexander Bolshoy*, Evolutionary Biology, University of Haifa, Mt. Carmel, 39105, Haifa, Israel, bolshoy@research.haifa.ac.il

Chair: *Mikhail Kuznetsov*, Moscow Institute of Physics and Technology, Russian Federation, mikhail.kuznetsov@phystech.edu

1 - A comparison of weight distributions in multi-attribute value theory

Jyri Mustajoki, Department of Automation Science and Engineering, Tampere University of Technology, P.O.Box 692, 33101, Tampere, Finland, jyri.mustajoki@tut.fi

In multi-attribute value theory, various approaches to model uncertainties with distributions on importance weights have been presented in the literature. We carry out a simulation study in which we analyze the effects of three different weight distributions in terms of the marginal weight and weight ratio distributions they produce. According to our results, there are clear differences in the spread of weights the different distributions generate. We also discuss on what grounds and on what types of applications the use of each distribution can be justified.

2 - "Hit and Run" for the efficient generation of weights

Gert van Valkenhoef, Faculty of Economics and Business, University of Groningen, PO Box 800, 9700 AV, Groningen, Netherlands, g.h.m.van.valkenhoef@rug.nl, *Tommi Tervonen*, *Nalan Baştürk*, *Douwe Postmus*

Multi-criteria decision analysis is often based on weighted aggregation of per-criterion scores, where weights represent preferences. To enable specifying preferences as linear constraints on the weights, simulation-based methods sample from a uniform distribution on the feasible weight space. Efficient samplers are known for special cases, but no method can efficiently sample weights with general linear constraints. We show how the "Hit and Run" sampler can be used to perform this type of sampling in fast polynomial time. We also discuss the problem of diagnosing convergence of such samplers.

3 - Non-profit project portfolio evaluation and selection: A multicriteria approach

Nassim Dehouche, LAMSADE- Université Paris-Dauphine, Place du Maréchal de Lattre de Tassigny, 75775, Paris, Ile de France, France, dehouche@lamsade.dauphine.fr, *Daniel Vanderpooten*

We study settings in which a review committee is to select a portfolio of the best projects among a set of proposals. We propose a new two-stage multiple criteria parameterizable rule-based sorting methodology. First, an evaluation process is carried out, in which the focus is on an accurate capture of the knowledge created during the work of the committee. Then, a selection process takes place, in which the preferences of the decision maker regarding the portfolio are modeled in a linear program, the resolution of which specifies values for the parameters of the rule-base.

4 - Maximization of a Sum of Kendall's Tau Rank-Correlation Coefficients

Alexander Bolshoy, Evolutionary Biology, University of Haifa, Mt. Carmel, 39105, Haifa, Israel, bolshoy@research.haifa.ac.il

Given data on a set of objects, while every object is defined by a set of characters, the object ranking problem is to rate each object according to its characters. The input data is a matrix $R[n, m]$ with an element (object, character). We study rating problem in context of molecular evolution. The objective is to find an optimal scale which most accurately recovers the across-object characters. As solving of this optimization problem is NP-hard, we propose an original heuristic method, a special simulation annealing scheme.

■ WC-27

Wednesday, 12:30-14:00

CC-A25

Knowledge Management & Decision Systems

Stream: Decision Support Systems

Invited session

Chair: *Shaofeng Liu*, School of Management, Plymouth University, PL4 8AA, Plymouth, Devon, United Kingdom, shaofeng.liu@plymouth.ac.uk

1 - Extending the analysis of the EURO Working Group on DSS Research Collaboration Network (EWG-DSS Collab-Net V.2)

Pascale Zaraté, Institut de Recherche en Informatique de Toulouse, Toulouse University, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr, *Fatima Dargam*, *David Dadenne*, *Isabelle Linden*, *Shaofeng Liu*, *Rita Ribeiro*, *Wei Sun*

EWG-DSS-Collab-Net explores the group's research collaboration since 1989. It considers a hybrid methodology for data collection, manual and automatic, incorporating web mining of electronic databases. It embeds an enhanced model of publication structure, extending the network statistics to collaboration trend analysis, with co-authorships and co-citations to further illustrate the dynamics of publications over time. These features reveal the growth of the community, find researchers for reviewing papers and projects, and encourage collaboration not only among existing but also new members.

2 - Applying ontology in the analysis of a DSS Research Collaboration Network

Fatima Dargam, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com, *Antonio C. S. Branco*, *Alexandre Rademaker*, *Renato Rocha Souza*

This work specifies ontology for the EWG-DSS-Collab-Net network. This network was designed to show the research collaboration dynamics in the EWG-DSS. It considers a publication relationship structured

model with authors-publications and multiple keywords-topics. The network analysis shows co-authorships and co-citations overtime. In order to refine the identification of publications that are closely related to a given topic, an ontology model is specified. This way, a common vocabulary of classifications of the publications main areas can be defined and matched with the key-words.

3 - Ranking the seawater desalination methods by using multi criteria decision making approaches

Amin Esmaeeli, DEpartment of Civil Engineering, Tabriz university, 51579-13573, Tabriz, Iran, Islamic Republic Of, aminesmaeeli88@gmail.com, *Hooman Baghban Asghari nejad*, *Mahdi Zarghami*

In this paper we compared common desalination alternatives such as Reverse Osmosis (RO), Mechanical Vapor Compression (MVC), Multi Stage Flash (MSF), Multi Effect Distillation-Thermal Vapor Compression (MED-TVC) by using the multi criteria decision making methods based SAW and TOPSIS. The assessment criteria are energy requirement, water production cost, environmental impact, and maintenance and water quality. According to the outcomes of research for the capacity of 1200 m³/day, RO method is the best decision by the SAW method and MVC becomes the best alternative by the TOPSIS method.

■ WC-28

Wednesday, 12:30-14:00

CC-A27

OR Military Applications II

Stream: OR in Military, Safety and Security Applications

Invited session

Chair: *Ana Isabel Barros*, Military Operations, TNO, POBox 96864, 2509 JG, The Hague, Netherlands, ana.barros@tno.nl

1 - Convoying against piracy

Rien van de Ven, Netherlands Defence Academy, Postbus 10000, 1780 CA, Den Helder, Netherlands, MPA.vd.Ven@NLDA.NL, *Jack Vermeulen*

The last years have seen an increase in the incidence of piracy near Somalia. The Somali East Coast and the Gulf of Aden are high-risk areas. The Gulf of Aden is an important shipping lane due to its location. The fact that it is a relatively narrow area means that traffic flows in only two directions. So convoying merchant vessels is one of the solutions to the problem of piracy. This paper presents a mathematical model how to optimize the number of merchant vessels that can be protected by a warship. Through simulation effectiveness of such a system can be quantified.

2 - Counter improvised explosive devices game

Toru Komiya, Dept. of Computer Science, Japan National Defense Academy, Hashirimizu 1-10-20, 2398686, Yokosuka, kanagawa, Japan, komiya@nda.ac.jp, *Akinori Yasue*

In Iraq or Afghanistan peace keeping operation (PKO), many soldiers are victimized by Improvised Explosive Devices (IED). We have modeled the counter IED operation. A patrol car drives along the road where IED may be planted. Terrorist can explode hidden IED according to his ability. He can also decide number, planting place and power of the bomb in advance. On the other hand, the PKO vehicle passes beside the IED without knowing it, but he can decide physical and operational parameters of the vehicle beforehand. By using the gaming context, we decide the optimal strategies on both sides.

3 - A NATO Guide for Judgement-based Operational Analysis

Ingrid Bastings, Military Operation Research, TNO Defence, Safety and Security, PO Box 96864, 2509JG, The Hague, Netherlands, ingrid.bastings@tno.nl, *Diederik J.D. Wijnmalen*

The SAS Panel of NATO/RTO tasked a group to write a Code of Best Practice for Judgement-based OA in Defence Decision Making. Its aim is not only to create an understanding of what judgement-based

OA is, how it can address messy defence problems and how they can be coped with, but also how to conduct a judgement-based OA study in order to maximise the validity, credibility and acceptance of such a study and its outcomes. We will clarify some of the analyst- and client-oriented highlights of the Guide.

4 - Topology of Military C2 Systems and its relation to cyber warfare

Herman Monsuur, Faculty of Military Sciences, Netherlands Defence Academy, P.O. Box 10.000, 1780 CA, Den Helder, Netherlands, h.monsuur@nlda.nl

We relate aggregate qualities found in the military C2 literature to the axiomatic approach in network theory. We address multi-layered networks and metrics for network control and for the feedback of operational links, as well as the merging of network metrics and C2 socio-technical covariates. We also apply our findings to cyber warfare.

■ WC-29

Wednesday, 12:30-14:00

CC-A29

Optimization and Data Mining (I)

Stream: Optimization and Data Mining

Invited session

Chair: *Concha Bielza*, Inteligencia Artificial, Universidad Politécnica de Madrid, Campus de Montegancedo, 28660, Madrid, Spain, mcbielza@fi.upm.es

Chair: *Rubén Armañanzas*, Artificial Intelligence Department, Technical University of Madrid, Facultad de Informática, Campus de Montegancedo, 28660, Madrid, Spain, r.armananzas@upm.es

1 - Mathematical Models of Supervised Learning and Application to Biomedical Problems

Mario Guarracino, Istituto di Calcolo e Reti ad Alte Prestazioni, 80131, Napoli, Italy, mario.guarracino@na.icar.cnr.it, *Roberta De Asmundis*

Supervised learning models are applicable in many fields of science. Among them, there are Support Vector Machines (SVM), which exhibit accurate solutions and low training time. SVM are based on the statistical learning theory and provide the solution by minimizing a quadratic type cost function. SVM, in conjunction with the use of kernel methods, provide non-linear classification models, namely separations that cannot be expressed using inequalities on linear combinations of parameters. We describe here some applications to biomedical problems, with the support of numerical experiments.

2 - Incorporating Partially Labeled Information into Kernel Spectral Clustering

Carlos Alzate, IBM Research, Ireland, carlos.alzate@gmail.com, *Johan Suykens*

Kernel Spectral Clustering (KSC) corresponds to a primal-dual formulation to clustering allowing out-of-sample extensions and model selection in a learning setting. The primal is defined in terms of high-dimensional feature maps and the dual is an eigenvalue problem of a weighted kernel matrix. We extend the core KSC model by adding extra terms in the objective function related to the labeled information together with regularization constants. The resulting dual is no longer an eigenvalue problem but a linear system. Simulation results show the applicability of the proposed method.

3 - Restating clinical impression of severity index for Parkinson's disease using just non-motor criteria

Rubén Armañanzas, Artificial Intelligence Department, Technical University of Madrid, Facultad de Informática, Campus de Montegancedo, 28660, Madrid, Spain, r.armananzas@upm.es, *Pablo Martínez-Martin*, *Concha Bielza*, *Pedro Larrañaga*

Clinical impression of severity index (CISI) for Parkinson's disease (PD) is an index to assess PD severity based on four clinical domains. Since this is a continuous value, a categorization policy is proposed

by solving an optimization problem. Using this encoding, different comparisons between CISI and other non-motor indexes or items are addressed using wrapper item subset selection and estimation of distribution algorithms. Results show how some of the non-motor items are very relevant, achieving good classification performances when used to predict the CISI severity index.

■ WC-30

Wednesday, 12:30-14:00

CC-A31

DEA and Performance Measurement: Applications 9

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Ahti Salo*, Systems Analysis Laboratory, Aalto University School of Science and Technology, P.O. Box 11100, Otakaari 1 M, 00076, Aalto, Finland, ahti.salo@aalto.fi

1 - Measuring the Operation Efficiency for Bus Transit in Taiwan with Undesirable Outputs

Chao-Chung Kang, Department of Business Administration and Graduate Institute of Management, Providence University, 200, Chung-Chi, Rd., 433, Shalu, Taichung, Taiwan, cckang@pu.edu.tw

This paper studies the operating efficiency for bus transit with undesirable outputs by slack-based data envelopment analysis (SBM-DEA) in Taiwan. Data of Taipei over 2007-2010 is drawn for the study. Vehicle-kilometer and operation revenue are taken as desirable outputs; vehicle emission as undesirable output; labor, vehicle, and fuel are the inputs. We compare the differences in efficiency evaluation produced by DEA and SBM-DEA. The effects in relative efficiency of desirable and undesirable output can suggest practical strategies for improving the operating efficiency of bus transit.

2 - Factors defining Effectiveness of automatic vehicle location systems

Daniil Opolchenov, Department of Electronics, Transport and Telecommunication Institute, Lomonosova street 1, LV-1019, Riga, Latvia, Opolchenov.D@tsi.lv

This work is devoted to solving the problem of AVL systems effectiveness estimation. In this work we consider the tasks of defining the factors which determine the effectiveness of AVL systems, and of obtaining their numerical values and distribution laws. To reduce the analysis complexity, we divide AVL systems into subsystems and re-define accordingly the factors defining their effectiveness. The results of this work can be used to obtain an effectiveness index.

3 - Chinese Companies Distress Prediction: An Application of Data Envelopment Analysis

Zhiyong Li, Business School, University of Edinburgh, Flat 13, 35 Peffer Bank, EH16 4FE, Edinburgh, Scotland, United Kingdom, zhiyong.li@ed.ac.uk, *Jonathan Crook*, *Galina Andreeva*

Traditional distress prediction models employ financial ratios to predict distress. We investigate the predictive accuracy of efficiency measures along with ratios in predicting distress in Chinese companies. Unlike previous studies where DEA was used to generate a single efficiency-TE, we decompose TE into PTE and SE. These variables are introduced into LR to make prediction. Efficiency of firms for several industrial sectors is integrated in one industry-specific LR. The results show the predictive power is improved by this efficiency. Both Cross-sectional and panel models are tested.

4 - Analyzing Portfolios of DMUs with Ratio-Based Efficiency Analysis (REA)

Ahti Salo, Systems Analysis Laboratory, Aalto University School of Science and Technology, P.O. Box 11100, Otakaari 1 M, 00076, Aalto, Finland, ahti.salo@aalto.fi, Juuso Liesiö, Yongjun Li

In this paper, we extend Ratio-Based Efficiency Analysis [Salo and Punkka, 2011, Mgmt Sci 57/1] for the comparison of portfolios, defined as combinations of DMUs where the share of each DMU is required to satisfy linear constraints. In particular, we establish a dominance relationship among such feasible portfolios in order to determine which portfolios are more efficient than others. We also examine the composition of efficient portfolios, which allows us to determine minimum and maximum bounds on the share of any DMU across all efficient portfolios.

■ WC-31

Wednesday, 12:30-14:00

CC-A33

OR and Ethics I

Stream: OR and Ethics

Invited session

Chair: *Cristobal Miralles*, Depto. Organización de Empresas, Universidad Politecnica de Valencia, Cami de Vera s/n, 46022, Valencia, Spain, cmiralles@omp.upv.es

Chair: *Fred Wenstøp*, Strategy and Logistics, BI Norwegian School of Management, Nydalsveien 37, 0483, Oslo, Norway, fred.wenstop@bi.no

1 - On Multidimensional Performance Measures — A Critical Reflection and Future Developments

João Clímaco, INESC-Coimbra, 3004-512, Coimbra, Portugal, jclimaco@inescc.pt

In this communication we start by summarizing and exemplifying the difficulties to build quality of life indicators and sustainability indicators, aggregating several dimensions. Ethical, methodological and practical issues are emphasised. Secondly, we discuss how and in which cases the notion of capability, proposed by A.Sen, could be useful, and we propose a multidimensional visual procedure to explore the information provided by adequate dashboards, helpful in those situations. A software demonstration will be done. Finally, future trends of research are outlined.

2 - Responsibility in Decision-Support

Sven Diekmann, Philosophy & Ethics of Technology, Eindhoven University of Technology, P.O. Box 513, IPO 1.14, 5600 MB, Eindhoven, Netherlands, s.diekmann@tue.nl

Operations Researchers (ORs) often influence decisions on ethical issues, e.g. HIV policies. Although they do not decide themselves, their work makes them accountable for consequences of supported decisions. However, are ORs also morally blameworthy? Are they accountable for unforeseeable consequences? I distinguish responsibility, accountability and blameworthiness. In the following, I investigate criteria for holding ORs accountable or blameworthy. I conclude that ORs can always be held accountable for consequences related to their work, while blameworthiness depends on specific conditions.

3 - Multicriteria analysis ranking the most developed EU countries

Zeljko Racic, Operational research, Faculty of economics, Majke Jugovica 4, Banjaluka, Bosnia And Herzegovina, zeljko.racic@efbl.org, *Matea Zlatkovic*

Analysis of socio-economic development shows that it is a multidimensional category. That multidimensionality of socio-economic development will be the subject of this paper; specifically, the group of the most developed EU countries. Starting with the selection of development indicators, executed based on principal components analysis using the statistical software SPSS, ie. the latest version of PASW Statistics 20, through their determination of satisfactory or "optimal" number and order of importance, using the PROMETHEE method, it will be up to the value of a synthetic indicator of the development level derived from the set of selected indicators.

4 - A value structured approach to conflicts in environmental management

Fred Wenstøp, Strategy and Logistics, BI Norwegian School of Management, Nydalsveien 37, 0483, Oslo, Norway, fred.wenstop@bi.no

The paper aims to suggest how OR practitioners ought to approach value conflicts in environmental management. The approach is practical and founded on three pillars: ethics, neuro-economics, and decision sciences. A rational approach problems is too often hampered by strong emotions elicited by value conflicts among stakeholders. Thus, considerable resources are often squandered on ill founded projects with detrimental effects. This could be mitigated if the OR analyst has a deeper understanding of ethical reasons for choice, and knowledge of practical methods to deal with values.

■ WC-32

Wednesday, 12:30-14:00

CC-A34

DEA and Performance Measurement: Applications 6

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Chih-Hai Yang*, Economics, National Central University, 300 Jhongda Road, 320, Jhongli, Taiwan, chyang@mgt.ncu.edu.tw

1 - Comparing groups of efficiency in Algarve Portuguese Hotels

Isabel Pedro, CEG-IST, Avenida Rovisco Pais, 1049-001, Lisboa, Portugal, ipedro@ist.utl.pt, *Ricardo Oliveira*, *Rui Marques*

This paper uses non-parametric techniques to investigate the efficiency of Algarve Portuguese hotels. The Algarve is one of the most important tourism places in Europe and a popular destination for tourists from several countries. By using a recent statistical test, this research investigates the influence of star rating, golf courses and location in hotel efficiency. We concluded that star rating does not matter as far as efficiency is concerned and that location and the existence of golf courses might be relevant. Our study points out hotels without golf courses as more efficient.

2 - On the need for reform of the Portuguese Judicial System — Does Data Envelopment Analysis evidence support it?

Sérgio Santos, Faculty of Economics, University of Algarve, Campus de Gambelas, 8005-139, Faro, Portugal, ssantos@ualg.pt, *Carla Amado*

The Portuguese judicial system has attracted considerable criticism in recent years and demands for reform have gained prominence. By using DEA and focusing on first instance courts, we found evidence that supports these calls for reform. We found a fairly inefficient sector, with only one fifth of the 206 courts analysed in 2009 being efficient, and a potential to reduce the courts' caseload by around 30%. Although most of this improvement can be achieved with a better management of cases, scale factors also seem to play an important role in explaining inefficiency.

3 - Evaluation of alternative targets for graduate distance courses in brazil using multiobjective models based on data envelopment analysis

Silvio Gomes Júnior, Coordenação de Engenharia de Produção, UEZO-Fundação Centro Universitário Estadual da Zona Oeste, Avenida Manuel Caldeira de Alvarenga, 1203, Campo Grande, 23070-200, Rio de Janeiro, Rio de Janeiro, Brazil, silviofgj@gmail.com, *Lidia Angulo-Meza*, *João Carlos Soares de Mello*

Classic DEA models determine efficiency indexes of DMUs. For an inefficient DMU one target is found. Subsequent works use multiobjective models, called MORO, that determine alternative targets. These projections are obtained with non proportional variations of the variables. In some real problems, some variables cannot change their levels. These variables are called non discretionary variables. In this paper, we present a case study that involves the efficiency evaluation of the Center for Higher Distance Education in Brazil with an integration of MORO models and non discretionary variables.

- 4 - Produce Patents or Journal Articles? A Cross-Country Comparison of R&D Productivity Change**
Chih-Hai Yang, Economics, National Central University, 300 Jhongda Road, 320, Jhongli, Taiwan,
 chyang@mgt.ncu.edu.tw

This paper compares R&D productivity change across countries considering two outputs: patent and journal articles. Using directional distance function we develop a Luenberger R&D productivity change index. We then decompose it into efficiency change and technical change. Estimates show that R&D productivity growth is mainly attributed to technical changes. However, non-OECD countries perform better on both efficiency and technical changes than OECD countries. Moreover, the main source of R&D productivity growth is patent-oriented rather than the journal article-oriented.

■ WC-33

Wednesday, 12:30-14:00
 CC-A37

Sustainable Construction Processes and supplier selection

Stream: OR for Sustainable Development
 Invited session

Chair: *Folke Björk*, Civil and Architectural Engineering, KTH - Royal Institute of Technology, Brinellv. 23, SE 10044, Stockholm, Sweden, folke.bjork@byv.kth.se

- 1 - Multi-criteria assessment of the sustainable renovation according on the methodology of the building certification system**
Milena Medineckiene, Department of Civil and Architectural Engineering, Royal Institute of Technology, Brinellvagen 23, SE 10044, Stockholm, Sweden,
 milenamedineckiene@gmail.com, *Folke Björk*, *Zenonas Turskis*

This research deal with how Multi Criteria Decision Making (MCDM) can be applied when building renovation is to be connected to environmental certification. The presentation will highlight the methodology of the MCDM methods and explain about how the criteria from the certification systems can be adapted to mathematical algorithms of the MCDM. The research will result in a methodology for the building owner in public or private sector, which will help to integrate sustainable technology with competitiveness. This should help the building owners to make decisions for sustainable renovation.

- 2 - Classification of factors influencing environmental management of enterprise**
Tatjana Tambovceva, Faculty of Engineering Economics and Management, Riga Technical University, Mezha Street 1/7-213, LV-1048, Riga, Latvia, tatjana.tambovceva@rtu.lv

In article the analysis of different factors influencing environmental management was done. Company's external and internal environment elements were clustered. The author distinguishes between the following groups of factors: production — technical, economic, political — legal, organizational, ecological and risk factors, as well as education and culture level. The study is based on the theoretical analyses of literature and scientific publications, as well as on research based on survey results collected from Latvian companies.

- 3 - Sustainability prioritizing constructing projects of municipalities based on AHP and COPRAS-G: a case study about construction of footbridges in Iran**
Edmundas Kazimieras Zavadskas, Department of Construction Technology and Management, Vilnius Gediminas Technical University, Sauletekio ave. 11, LT01001, Vilnius, Lithuania, edmundas.zavadskas@vgtu.lt,
Mohammad Hasan Aghdaie, *Sarfraz Hashemkhani Zolfani*

This study gives a framework for municipalities to prioritize their projects based on this framework. The footbridge project of Sari City in Iran is selected as a case study for this research. Selecting area for constructing footbridges including quantitative and qualitative factors such as the Total cost, Environmental factors, Socio-economic factors can be viewed as a kind of Multi-Attribute Decision Making (MADM) problem. The aim of this study is to use Analytic Hierarchy Process (AHP) and COPRAS-G methods for evaluation and selection the new footbridges alternatives.

- 4 - Sustainability assessment model of supplier selection problem**
Jolanta Tamosaitiene, Department of Construction Technology and Management, Vilnius Gediminas Technical University, Sauletekio ave. 11, LT-10223, Vilnius, Lithuania, jolanta.tamosaitiene@vgtu.lt, *Edmundas Kazimieras Zavadskas*, *Zenonas Turskis*

This paper aims to utilize a hybrid multi-criteria decision making (MCDM) model in supplier selection. Eight evaluation criteria — cost, quality, distance, delivery reliability, reputation, technology level, compatibility and development ability are identified. The Analytic Hierarchy Process is initially used for calculating the weight of each criterion and the Complex Proportional Assessment of alternatives with Grey relations (COPRAS-G method) is adopted for ranking suppliers. In order to illustrate the model's functional ability, Kalleh Company is chosen as a case study.

■ WC-34

Wednesday, 12:30-14:00
 CC-A39

Economic modeling and finance

Stream: Cooperative Game Theory
 Invited session

Chair: *Sirma Zeynep Alparslan Gok*, Mathematics, Faculty of Arts and Sciences, Suleyman Demirel University, Faculty of Arts and Sciences, Suleyman Demirel University, Department of Mathematics, 32260, Isparta, Turkey,
 zeynepalparslan@yahoo.com

- 1 - The Choquet Integral as a continuous certainty equivalent**
Gianni Bosi, Dipartimento di Scienze Economiche, Aziendali, Matematiche e Statistiche, University of Trieste, Italy,
 giannibo@econ.units.it, *Magali E. Zuanon*

The concept of a certainty equivalent is relevant in many fields when preferences over stochastic situations are considered (for example, stochastic cooperative games or risk attitudes in a multiperiod context). We present a characterization of the existence of a continuous certainty equivalent which can be represented as the Choquet integral with respect to a concave probability distortion, therefore continuing in some sense previous work by Bosi, Zuanon et al. [Mathematical Social Sciences, 2003, 2007].

- 2 - An Adversarial approach to maximize gain due to finite precision errors in basic financial computations**
Ganesh Perumal M, International Institute of Information Technology, Bangalore, Electronics City, Hosur Road, 560100, Bangalore, Karnataka, India,
 ganesh_perumal@iiitb.ac.in, *Abhilasha Aswal*, *G. N. Srinivasa Prasanna*

Basic Financial transactions including deposit, withdrawal and currency conversion may be erroneous due to the usage of IEEE 754 binary standards. This cumulative error can be significantly maximized in ones favour (especially in multicurrency transactions), using a clever adversary, utilizing information about the error generation and propagation process. We give an optimization model to maximize gain due to such errors.

3 - Handling peak loads in queuing service systems

Abraham Seidmann, University of Rochester, 14627, Rochester, NY, United States, seidmannav@simon.rochester.edu, *Mariya Bondareva*

We study the efficient design of queuing service systems with tight service level constraints and non-stationary periodic arrival rates. The research introduces the concept of 'peaker' capacity services for handling variable peak-load demands. Internal expert teams handle the base-load of transactions, while the external peaker team is contracted to handle only the peak demand. We developed a two-staged game to choose the optimal contracting policy with the peaker, and a robust procedure to determine both the base-load - and the peaker's capacity levels.

4 - Pricing Strategies for Gaming-on-Demand

Sumanta Basu, Operations Management, Indian Institute of Management Calcutta, K-302, New Academic Block, IIM Calcutta, D.H. Road, Joka, 700104, Kolkata, West Bengal, India, sumanta@iimcal.ac.in, *Soumyakanti Chakraborty*

Social gaming has pushed the traditional video gaming industry to the brink of disruption using concepts like cloud gaming or gaming-on-demand. However, the success of the gaming-on-demand model would depend to a large extent on pricing, e.g. non-linear usage based fee, a fixed fee or a combination of both. In this paper, we develop a pricing schedule for a typical cloud game provider by modeling the alternatives available to a consumer and the propensity to engage in gaming. We also determine the conditions that determine the switching behavior of customers from usage based to fixed fee plan.

■ WC-35

Wednesday, 12:30-14:00

CC-A41

Recent Achievements in Regression and Classification

Stream: Computational Statistics

Invited session

Chair: *Fatma Yerlikaya Ozkurt*, Scientific Computing, Institute of Applied Mathematics, Industrial Engineering Department, Middle East Technical University, 06800, Ankara, Turkey, fatmayerlikaya@gmail.com

Chair: *Semih Kuter*, Department of Forest Engineering, Cankiri Karatekin University, Cankiri Karatekin Universitesi, Orman Fakultesi, 18200, Cankiri, Turkey, semihkuter@yahoo.com

1 - Restructuring the forward step of CMARS by a mapping approach

Elcin Kartal Koc, Statistics, Middle East Technical University, Department of Statistics, No:234, 06800, Ankara, Turkey, kartalelcin@gmail.com, *Cem Iyigun*, *Inci Batmaz*, *Gerhard-Wilhelm Weber*

CMARS is proposed as a new approach to MARS with its model-based alternative to the backward step. Instead of stepwise elimination step, a penalized residual sum of squares is used as a Tikhonov regularization problem which is solved with a conic quadratic programming. The drawback of CMARS is its time inefficiency. In this study, to increase the run time of CMARS, a mapping idea is proposed for knot selection in the forward step. Integration of mapping idea into CMARS-forward algorithm can decrease the computing time significantly by considering less number of data points as candidate knots.

2 - Balance Optimization Subset Selection (BOSS) for Causal Inference with Observational Data

Alexander Nikolaev, Department of Industrial and Systems Engineering, University at Buffalo (SUNY), 409 Bell Hall, 14260-2050, Buffalo, NY, United States, anikolae@buffalo.edu, *Sheldon Jacobson*

To make causal inferences outside the experimental realm, researchers attempt to post-process large observational data sets to mimic experimental data. The primary approach used has been to match treated and untreated units to achieve a measure of balance. We explain BOSS, a novel approach that eliminates the matching stage and directly optimizes balance. It identifies sets of statistically indistinguishable treatment and control groups, perfectly optimized with respect to one or more pre-defined balance measures, giving a minimally biased estimator of the treatment effect.

3 - Testing of MARS on MODIS Images for Local Atmospheric Correction

Semih Kuter, Department of Forest Engineering, Cankiri Karatekin University, Cankiri Karatekin Universitesi, Orman Fakultesi, 18200, Cankiri, Turkey, semihkuter@yahoo.com, *Zuhal Akyurek*, *Gerhard-Wilhelm Weber*, *Ayse Ozmen*

In this study, Multivariate Adaptive Regression Splines (MARS) is used for local atmospheric correction. Being adaptive and flexible, both linear and non-linear problems with large data sets can be handled by MARS. Local atmospheric correction is carried out by applying MARS method on real data, sets of MODIS (Moderate-resolution Imaging Spectroradiometer) images over Europe and Turkey. Obtained results are compared with the results of SMAC (Simplified Method for Atmospheric Correction — a numerical radiative transfer model) algorithm both numerically and visually.

4 - Estimation of Multi-dimensional Stochastic Differential Equations with CMARS Method

Fatma Yerlikaya Ozkurt, Scientific Computing, Institute of Applied Mathematics, Industrial Engineering Department, Middle East Technical University, 06800, Ankara, Turkey, fatmayerlikaya@gmail.com, *Gerhard-Wilhelm Weber*

CMARS, an alternative approach to the well-known data mining tool MARS, is based on a penalized residual sum of squares for MARS as a Tikhonov regularization problem. It treats this problem by a Conic Quadratic Programming. Stochastic Differential Equations are widely used to represent noisy and real world problems. SDEs are usually hard to represent and to resolve by a computer. Before, we identified 1-dimensional SDE in a simplified manner by using CMARS. Now, we aim to estimate multi-dimensional SDEs with CMARS. The theoretical results and implementation of this study will be presented.

■ WC-36

Wednesday, 12:30-14:00

CC-A43

Recent Advances of OR on Societal Complexity

Stream: Methodology of Societal Complexity

Invited session

Chair: *Dorien DeTombe*, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB, Amsterdam, Netherlands, detombe@nosmo.nl

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - By revitalization of ancient abandoned cemeteries to societal and economic strengthening of small sites

Eva Kralova, Institute of History and Theory of Architecture and Monument Restoration, Slovak university of technology, Faculty of architecture, Namestie slobody 19, 81245, Bratislava, Slovakia, Slovakia, kralova@fa.stuba.sk

For societal and economic development of small sites, it is important to utilize local potential. Cultural traditions, local monuments and memory places are parts of the potential source for revitalization. Abandoned cemeteries represent a special group of such socially accepted and venerated places; without an active local societal life it becomes a complex societal problem. We present the case study of an old cemetery in Banska Stiavnica, Slovakia (UNESCO World Heritage). We introduce the approach and processes of revitalization using operational research.

2 - A surprising equivalence between Consolation of Philosophy and Methodology for Societal Complexity

Nicolae Bulz, National Defence College, Romania, nbulz@yahoo.com

There is the affirmation on equivalence: two attempts toward difficult "problem solving". 1) Consolation of Philosophy, by Roman philosopher Boetius and 2) Methodology for Societal Complexity, by prof. Dorien J. DeTombe. To point on a single occurrence of the concept problem/solve across the text of Consolation of Philosophy: Book III. True Happiness and False. "I understand the problem, but I desire to hear how thou wouldst solve it." An inquiry within the entire content of Boetius' texts would possible depict significant equivalence between his and our attempts on "problem solving".

■ WC-37

Wednesday, 12:30-14:00

CC-Act

Operations Research in Health Care I

Stream: Health Care Management

Invited session

Chair: *Patrick Hirsch*, Institute of Production and Logistics, University of Natural Resources and Life Sciences, Vienna, Feistmantelstrasse 4, 1180, Wien, Austria, patrick.hirsch@boku.ac.at

1 - Weekly routing and scheduling of home health care services

Andrea Trautsamwieser, Institute of Production and Logistics, University of Natural Resources and Life Sciences, Vienna, Feistmantelstraße 4, 1180, Vienna, Austria, andrea.trautsamwieser@boku.ac.at, *Patrick Hirsch*

The task of planning the visits of mobile nurses can be modeled as rich periodic vehicle routing problem. However, several constraints have to be met. The clients need to be visited regularly during the week by appropriately skilled nurses who should not change too frequently. Moreover, working time regulations, time windows, and interdependent visits have to be considered. We propose a new metaheuristic method that combines a Branch-Price-and-Cut approach with a Variable Neighborhood Search based metaheuristic. This new approach is tested in extensive numerical studies with real life data.

2 - Scheduling of urban home health care services using time-dependent multimodal transport

Klaus-Dieter Rest, Institute of Production and Logistics, University of Natural Resources and Life Sciences, Vienna, Feistmantelstrasse 4, 1180, Vienna, Austria, klausdieter.rest@boku.ac.at, *Patrick Hirsch*

Optimization of home health care services is a rather young but quickly evolving research area due to the expected significant increase in demand. We present a Tabu Search based solution approach where nurses can use public transport (bus, tram, subway, and train) in addition to cars, bikes, and walks. While the latter are currently considered as time-independent, public transport is based on actual time-tables. The developed solution approach is tested with real world data from the Austrian Red Cross in Vienna.

3 - Using agent-based modelling and simulation in patient adherence to medication

Christos Vasilakis, Clinical Operational Research Unit, University College London, 4 Taviton Street, WC1H 0BT, London, United Kingdom, c.vasilakis@ucl.ac.uk, *Christina Pagel*, *Steve Gallivan*, *Nick Barber*, *Martin Utley*

It is known that patient adherence to medication can determine the effectiveness of a therapy. It is less known what the impact on clinical effectiveness is of a number of interacting factors: the pharmacokinetic features of a drug and drug regimen, the different patterns of patient adherence and the interaction of patients and prescribers in improving adherence. In this study we used agent-based modelling and simulation to explore the impact of hypothetical patterns of behaviour and interaction between patients and prescribers on drug concentrations.

4 - Uncovering the hospital length of stay distribution: a finite mixture model approach

Maria Guzman Castillo, University of Southampton, United Kingdom, M.Guzman-Castillo@soton.ac.uk, *Sally Brailsford*, *Honora Smith*

Most of the research on modelling length of stay (LoS) attempts to find a suitable probabilistic distribution to describe patient LoS. However, single distributions have shown limited success for this task. Lately, it has been suggested that LoS data may in fact represent a mixture of several distributions. These models are referred as finite mixture models, where a continuous variable consists of 2 or more clusters of observations with different parameters. This research extends previous work by exploring different types of mixtures and by integrating patient attributes into the model.

■ WC-38

Wednesday, 12:30-14:00

HH-Colombus

Applications of Multiobjective Optimization

Stream: Multiobjective Optimization

Invited session

Chair: *Carlos Henggeler Antunes*, DEEC, University of Coimbra and INESC Coimbra, Rua Antero de Quental 199, 3000-033, Coimbra, Portugal, ch@deec.uc.pt

1 - A multi-objective model to determine electrical load control actions

Carlos Henggeler Antunes, DEEC, University of Coimbra and INESC Coimbra, Rua Antero de Quental 199, 3000-033, Coimbra, Portugal, ch@deec.uc.pt

The exploitation of demand-side resources using load control actions (LCA) in electricity distribution networks has the potential to bring benefits to several stakeholders (customers, utilities, etc.). LCA consist in the application of power curtailment actions (on-off patterns), changing the usual working cycles, to obtain operational and economic benefits. A multi-objective model for determining those LCA is presented, which takes into account different stakeholder perspectives. An overall energy resource management is provided, including loads, local generation and storage.

2 - A Fuzzy Goal Programming Model for Solving Aggregate Production-Planning Problems under Uncertainty

Fernando Marins, Production, UNESP - São Paulo State University, Av. Ariberto Pereira da Cunha, 333, 12516-410, Guaratinguetá, SP, Brazil, fmarins@feg.unesp.br, *Aneirson Silva*, *José Arnaldo Montevechi*, *Ubirajara Ferreira*

We propose a Fuzzy Goal Programming Model (FGP-APP) for the aggregate production-planning problem. It was made an application in a Brazilian company of sugar and ethanol milling. The FGP Model depicts the comprehensive production process of sugar, ethanol, molasses and derivatives, and considers the uncertainties involved in the

ethanol and sugar production, as well as in decisions related to agricultural and logistics phases, on a weekly-basis planning horizon, including the whole harvesting season and the periods between harvests. The model was applied to a real case with excellent results.

3 - A Multi-objective Portfolio Optimization Model with Higher Order Moments

Bijaya Krushna Mangaraj, Production & Operations Management Area, XLRI School of Business & Human Resources, Jamshedpur-831001, India, C.H. Area(East), Jamshedpur, Jamshedpur, Jharkhand, India, mangaraj@xlri.ac.in, *Gayatri Biswal*

Markowitz's seminal work on modern portfolio theory is based on a strong normality assumption of the distribution of portfolio returns and proposed a parametric approach using mean and variance. However, due to non-parametric nature of such distributions, study on modern portfolio efficiency measure has been extended to a mean-variance-skewness-kurtosis framework. We discuss a multi-objective approach of portfolio optimization using fuzzy goal programming for generating a non-dominated portfolio in a four-dimensional case. We test the model with a sample of stocks from Mumbai Stock Exchange.

4 - Trade-off in statistical design process

Samuel Bohman, Department of Computer and Systems Sciences, Stockholm University, Forum 100, 164 40, Kista, Kista, Sweden, samboh@dsv.su.se, *Maria Kalinina*, *Aron Larsson*

The design and planning of a statistical survey can be regarded as a complex decision process involving multiple stakeholders and a diverse set of users. The process involves finding a balance between statistical quality, burden on respondents and costs. Our research is aimed towards developing a prototype system consisting of computational core based on the combination of multi-objective optimization, multi-criteria analysis, and a user-friendly interface. The overall objective of the research is to maximize statistical quality while minimizing the burden on respondents and costs.

■ WC-39

Wednesday, 12:30-14:00

HH-Cousteau

Cops and Robber Games

Stream: Graph Searching
Invited session

Chair: *Nancy Clarke*, Mathematics and Statistics, Acadia University, 12 University Avenue, B4P2R6, Wolfville, Nova Scotia, Canada, nancy.clarke@acadiau.ca

1 - Slow Firefighting on Graphs

Margaret-Ellen Messinger, Mathematics Department, Mount Allison University, New Brunswick, Canada, mmessinger@mta.ca

In firefighting and graph searching problems, a contaminant typically spreads very quickly. We introduce a variant in which the contaminant spreads at a slower rate. At each time step, the searchers (or firefighters) protect one vertex and the contaminant (or fire) spreads from one vertex to all unprotected, unburned neighbours. On infinite graphs, the goal of the firefighter is to surround the burned vertices with a set of protected vertices, while the goal of the fire is to avoid such containment. We will consider results on both the two-dimensional and three-dimensional grids.

2 - Cops and a Robber on a graph embedded into a surface

Dirk Oliver Theis, Mathematics, Otto von Guericke University Magdeburg, Germany, dotjimdot@gmail.com, *Nancy Clarke*

Given a graph embedded on a surface genus g , what is the minimum number of Cops needed to catch a Robber?

We discuss an approach based on covering spaces. For non-orientable surfaces, this technique improves the formerly known bounds effortlessly. For orientable surfaces, with considerable effort, we reduce the

question to one concerning a polytope in the homology space of the surface defined by the cycles of the graph.

Joint work with Nancy Clarke (Acadia, NS) and Samuel Fiorini, Gwenaël Joret, Mathieu Carette (ULB, Brussels).

3 - Ambush Cops and Robbers

Nancy Clarke, Mathematics and Statistics, Acadia University, 12 University Avenue, B4P2R6, Wolfville, Nova Scotia, Canada, nancy.clarke@acadiau.ca

A variation of the Cops and Robber game is introduced in which the robber side consists of two robbers. The cops win by moving onto the same vertex as one of the robbers after a finite number of moves. The robbers win by avoiding capture indefinitely or by both moving onto the same vertex as the cop. (Otherwise, the robbers are on distinct vertices.) We present a variety of results including a recognition theorem for graphs on which a single cop can guarantee a win, as well as a strategy that can be used by the cop to win on such graphs.

■ WC-40

Wednesday, 12:30-14:00

HH-Livingstone

Model quality and modelling sustainable energy and transport systems

Stream: SD Modelling in Sustainable Development
Invited session

Chair: *Pierre Kunsch*, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be

1 - Comparing a BRT and a PRT system

Tsutomu Mishina, Systems Science and Technology, Akita Prefectural University, 84-4 Tsuchia-Ebinokuchi, 015-0055, Akita, Japan, mishina@akita-pu.ac.jp, *Alejandra Gomez Padilla*

Bus Rapid Transit (BRT) is a proven effective method for mass transportation. Developing countries have introduced it big cities. Personal Rapid Transit (PRT) is a relatively new transportation system, with developing applications usually in developed countries. This work compares of both systems. The data of an actually operating BRT system is considered, and this data is used supposing that a PRT system is running instead. This is, for the same demand of passengers, smaller vehicles are used, which pass more frequently, run faster and will only stop at the final destination station.

2 - Automatic control of turbo generators setting automatic frequency

Meglouli Hocine, Automatique, Université de Boumerdes, boulevard de l'indépendance, cité 392 lgts bt 17 G08, 35000, Boumerdes, Boumerdes, Algeria, meg.hocine@yahoo.fr

The production-consumption balance is ensured, in normal operation, two additional automatic actions: setting primary and secondary control. Their performance is critical to the safety of the system.

The primary control, it is crucial for power system reliability during the large amplitude variations, to master quickly the transition frequency so as not to reach the top levels of shedding frequency.

3 - Phasing-out nuclear energy in Belgium: is it feasible?

Pierre Kunsch, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be

The Belgian government has decided to phase-out nuclear power plants from 2015 on till 2025 while they represent today more than half the electricity production. By means of system dynamics modelling this presentation investigates different scenarios to check the feasibility of such decisions. It is found that gas and coal would be the winners, rather than renewable energy sources; this is rather the opposite of the sought for environment-friendly evolution.

4 - Model Quality: How to Build Better Models

Markus Schwaninger, Institut für Betriebswirtschaft,
Universität St.Gallen, Dufourstrasse 40a, 9000, St.Gallen,
St.Gallen, Switzerland, markus.schwaninger@unisg.ch

Building high-quality models is perhaps the primary challenge ahead of us in modeling and simulation. This rationale is grounded in the Conant/Ashby-theorem, which will be introduced. Thereafter, strategies and methods for the validation of dynamic-simulation models, and other measures for the enhancement of model quality, will be presented.

■ WC-41

Wednesday, 12:30-14:00

HH-Heyerdahl

Modern project for involvement young people in OR community and OR education

Stream: Young People for System Theory, Optimization and Education

Invited session

Chair: *Bohdan Pukalskyi*, Students Science Association, National Technical University of Ukraine, Kovalskyi provulok 5, 03057, Kyiv, Ukraine, bogdanpukalsky@gmail.com

Chair: *Kateryna Pereverza*, Students Science Association, National Technical University of Ukraine, Kyiv, Scherbakova str., 42/44, app. 54, Kyiv, Ukraine, pereverza.kate@gmail.com

1 - Achieving interdisciplinarity in OR by additional educational activities. Example of Summer School AACIMP

Iryna Smolina, Metal Physics, NTUU "KPI", 03056, Kyiv, Ukraine, irina.smolina@gmail.com

Interdisciplinarity is one of essential characteristics of OR as well as of all modern science. Additional educational activities like summer schools, on-line courses and internships are effective tools for spreading this principle among new generations of OR researchers. Summer school "AACIMP" is good example of such educational activities, which combines different OR approaches to solve various problems and provide students with better understanding of interdisciplinarity of contemporary science. We present the experience of organization of the Summer School "AACIMP".

2 - Odss.4SC: A summer school in Optimization and Decision Support Systems for Supply Chain Management

Giuseppe Bruno, Dipartimento di Ingegneria Economico-Gestionale, Università Federico II di Napoli, Piazzale Tecchio n.80, I80125, Napoli, IT, Italy, giuseppe.bruno@unina.it, *Ana Amaro*, *Miguel Casquilho*, *Albert Corominas*, *Andrea Genovese*, *Juan Manuel Garcia Lopez*, *Amaia Lusa*, *Johan Magnusson*, *Henrique Matos*, *Joao Miranda*, *Sergio Rubio*

Our Summer School is taking place in Portalegre, Portugal, July, 1-15, within the Erasmus Intensive Programme. The audience is formed by MSc./PhD. students on Engineering and Logistics specialties, from more than 12 countries. It aims at: (a) describing the industry-based supply chain operations with a particular concern to the green logistic aspects; (b) using optimization models to solve specific problems. The lectures follow a pull approach, from distribution to supply subjects; the lab sessions are supported by IBM/ILOG. We present the program and the future perspectives.

3 - Mathematically formalized methodology for scenario study. Approaches for scenario space exploration

Kateryna Pereverza, Students Science Association, National Technical University of Ukraine, Kyiv, Scherbakova str., 42/44, app. 54, Kyiv, Ukraine, pereverza.kate@gmail.com

Scenario analysis is well known technique for exploration of future development of different complex systems as countries, cities, companies etc. The stage of scenario space exploration is one of the most relevant in scenario study. Big amount of built scenarios can be explored using different OR methods as associated analysis, Bayes network etc. The mathematically formalized methodology for scenario study will be present in the talk. The example of scenario space analysis for country using mentioned methods will be shown.

■ WC-42

Wednesday, 12:30-14:00

BW-Amber

Queueing Systems II

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science

Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: *Devin Sezer*, Middle East Technical University, Institute of Applied Mathematics, Eskisehir Yolu, 06531, Ankara, devin@metu.edu.tr

Chair: *Basak Tanyeri*, Bilkent University, Turkey, basak@bilkent.edu.tr

1 - Analyzing Multi-server Queueing Model with no Waiting Line

Hanifi Okan Isguder, Statistics, Dokuz Eylul University, Dokuz Eylul University Faculty of Science, Department of Statistics Tinaztepe Buca, 35160, Izmir, Turkey, okan.isguder@deu.edu.tr, *Sener Akpinar*, *Atabak Elmi*, *Alper Hamzadayi*, *Simge Yelkenci Kose*

In this study a queueing system with recurrent arrivals, three heterogeneous servers, and no waiting line is examined. In the system customers choose only one server among the empty servers with different probabilities. When all servers are busy, customers depart from the system without taking any service. These customers are called "lost customer". The probability of losing a customer is computed for the queueing system.

2 - Distribution Evaluation and Decomposition for Queueing Networks Modelling

Jean-Sébastien Tancrez, Louvain School of Management, Université catholique de Louvain, UCL - LSM, 151, Chaussée de Binche, 7000, Mons, Belgium, js.tancrez@uclouvain-mons.be

A modeling methodology is presented for queueing networks with general assumptions: fork/join networks, general service time distributions and finite buffers. The general distributions are discretized by aggregation of the probability masses, and the transformed system is analytically modeled using a Markov chain. First, we show that it allows a fine estimation of the cycle time distributions. Second, we introduce a decomposition approach to analyze larger queueing networks. Using computational experiments, we show that it leads to accurate performance evaluation and that the fine distribution estimation seems to bring an improvement.

3 - Alternative stochastic approaches for condition-based production-maintenance control

Michael Kaluzny, Business Administration, Production and Logistics, University of Dortmund, Germany, michael.kaluzny@tu-dortmund.de, *Ralf Gössinger*

Condition-based maintenance is analysed for a decentralised production-maintenance system where deterioration depends on production parameter settings. In order to keep up a defined machine availability an information exchange protocol is developed. On this basis alternative stochastic approaches to calculate the machine condition triggering the order release are formulated and numerically analysed. These approaches take waiting time between maintenance order release and order fulfillment as well as possibly modified production parameter settings during this waiting time into account.

4 - Optimal Control Formulation of Query Model for Authentication Systems

Devin Sezer, Middle East Technical University, Institute of Applied Mathematics, Eskisehir Yolu, 06531, Ankara, devin@metu.edu.tr, *Ferruh Ozbudak*, *Yildirim Ustun*

This research studies the N step adaptive attack on an authentication system using an authentication oracle described in (Safavi-Naini, Wild, 2008). We represent the maximum success probability of this type of attack as the value function of an optimal control problem and derive the dynamic programming equation that the value function satisfies. The same paper cited above proves that randomized queries in such an attack have the same probability of success as that of a deterministic attack. We rederive this fact using our control representation.

■ WC-44

Wednesday, 12:30-14:00

BW-Marble

Information and Intelligent Systems I

Stream: Information and Intelligent Systems
Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Wuyi Yue*, Intelligence and Informatics, Konan University, 8-9-1 Okamoto, Higashinada-ku, 658-8501, Kobe, Japan, yue@konan-u.ac.jp

1 - Malfunction diagnosis on air-conditioning using rough sets approach

Hong Tau Lee, Industrial Engineering and Management, National Chin-Yi University of Technology, Taipin, Taichung County, 411, ROC, Taiwan, leeht@ncut.edu.tw, *Sheu-Hua Chen*

In order to effectively diagnose faults causing, this paper purposes a simplified approach for diagnosing air conditioning system which is based on rough sets theory. This approach converts the reasons and symptoms to condition and decision attributes respectively. Finally, possible reasons can be diagnosed while the specific set of core attributes of symptom occurred. This is a simplified way of avoiding the testing of all the items that are usually used in the traditional method of determining the fault cause.

2 - Approach for the prolongation of the lifetime of a wireless sensor network

Abdelmalek Boudries, University of Bejaia, university of Sétif, Algeria, Boumansour Cne Oued-Ghir W- Béjaia, Béjaia, Algeria, am_boudries@yahoo.fr, *Makhlouf Aliouat*

We propose an approach for the connectivity maintenance in the wireless sensor networks. The principle of the solution is the following: a node which wants to transmit data chooses the way of the greatest weight. The idea is that if the remaining rate of energy decreases then the weight of the way containing this node decreases. The aimed objective is to maintain the connected network for longest time possible by prolonging the lifetime of the nodes sensors which have consumed much energy. The suggested approach was tested on an example of scenario and showed its effectiveness.

3 - Analysis of real-time traffic with the sleep mode in IEEE 802.16m networks

Wuyi Yue, Intelligence and Informatics, Konan University, 8-9-1 Okamoto, Higashinada-ku, 658-8501, Kobe, Japan, yue@konan-u.ac.jp, *Shunfu Jin*, *Xiaofei Zhang*

In this paper, based on the working principle of the sleep mode in IEEE 802.16m, a queueing model with multiple heterogeneous vacations is presented. Considering the packet correlation in real-time traffic, the system arrival is supposed to be a discrete-time Markovian process. The formulas for the average latency and energy saving ratio are obtained, and the numerical results are given. The time length of the sleep cycle is optimized by constructing a cost function. The authors are grateful to Prof. M. Kokai for his helpful comments in this paper.

4 - Planning of Map Making Technique by Planning Method with Continuously Operating Reference Station (CORS-TR)

Omur Eren, Office of Construction and Infrastructure, Selcuk University, Division of Cartography, 42250, Konya, Selcuklu, Turkey, omuresen@hotmail.com, *I.Bulent Gundogdu*

CORS project has started in USA and Turkey as part of the project CORS-TR approved by Istanbul Culture University, General Directorate of Land Registry and Cadastre and General Command of Mapping cooperation and by The Scientific and Technological Council of Turkey sponsorship. Aim is to determine data by 7/24 observation in Turkey according to geographical position real time and by post processing in a fast and economical way and at the same time modeling of ionosphere and troposphere, requiring geological data and determining transformation parameters between ED50 and ITRF Dates.

■ WC-45

Wednesday, 12:30-14:00

BW-Water

Advanced Revenue Management

Stream: Advanced Inventory Control and Pricing Strategies

Invited session

Chair: *Claudius Steinhardt*, Department of Analytics & Optimization, University of Augsburg, Universitätsstraße 16, 86159, Augsburg, Germany, claudius.steinhardt@wiwi.uni-augsburg.de

1 - Pricing-cum-Inventory Decisions in Supply Chain Networks

Lambros Pechlivanos, Athens University of Economics and Business, Greece, lpech@aueb.gr, *Panos Seferlis*

An optimization-based control framework that simultaneously determines the optimal inventory and product pricing policies is developed for multi-product, multi-echelon supply chain networks. Product price manipulation can be used to alleviate congested transportation routes, by altering appropriately the demand profile at the end-point nodes of the network. A flexible node-level pricing policy can be understood as a substitute instrument to supply chain management, as it succeeds in altering the flow of orders customers place by redirecting orders to the desired end-point nodes.

2 - Modeling of customer choice behavior in revenue management

Petr Fiala, Dept. of Econometrics, University of Economics Prague, W.Churchill Sq. 4, 13067, Prague 3, Czech Republic, pfiala@vse.cz

Revenue management is the process of understanding, anticipating and influencing customer behavior in order to maximize revenue. The common modeling approaches assume that customers are passive. Today's customers actively evaluate alternatives and make choices. Revenue management pays increasing attention to modeling the behavior of individual customers. A modeling approach for strategic customer behavior is proposed. The evaluation of alternatives can be done by DEA based evaluation methods. The approach is based on instruments of artificial neural networks and Petri nets.

3 - Incorporating Auction Games in Logistics Optimization Academic Course

Charis Marentakis, Industrial Management and Technology, University of Piraeus, Karaoli and Dimitriou Street, 18534, Piraeus, Greece, chmarent@unipi.gr, *Dimitrios Emiris*, *Maria Giannopoulou*

Auctions and Revenue Management methods are currently evolving in the research and practice of Logistics Management. Several Operations Research techniques are engaged in this direction, aiming to support pricing decisions related to optimal capacity and resource management. The present article describes experiences from the enrichment

of a Logistics Optimization course with an auction-based freight transport business game. It explains why and how to engage auctions in conformance with the theoretic operations research part of the course and demonstrates major outcomes focusing mainly on the behavioral study of participants and the convergence between participants' valuations.

4 - Decision tools for online pricing and sourcing for truckload trucking

Hani Mahmassani, Transportation Center, Northwestern University, 600 Foster St, 60208, Evanston, Illinois, United States, masmah@northwestern.edu, *Diego Klabjan*, *Hamed Babai*, *Young Woong Park*, *Christopher Lindsey*

This study develops tools to support online operations of a third-party non-asset carrier in matching truckload shipments between shippers and carriers. The model considers respective shipper and carrier acceptance likelihood in an optimal pricing engine that maximizes profit for the matching agent.

Wednesday, 14:30-16:00

■ WD-01

Wednesday, 14:30-16:00

RB-Alfa

Tutorial Lecture: Professor Karla Hoffman

Stream: Keynote, Tutorial and Plenary Lectures

Tutorial session

Chair: *Mikael Rönnqvist*, Département de génie mécanique, Université Laval, G1V 0A6, Québec, Canada, mikael.ronnqvist@nhh.no

1 - Auctions: Why they proliferating and what you need to know to participate

Karla Hoffman, Department of Systems Engineering and Operations Research, George Mason University, Mail Stop 4A6, 4400 University Drive, 22030, Fairfax, Virginia, United States, khoffman@gmu.edu

The advent of the Internet has led to the creation of global marketplaces in which sales of everything from low-cost used merchandise to billion dollar government procurements are conducted by auction. While some auction designs have been extremely successful, others have failed disastrously. This talk will describe a variety of alternative auction designs, and will explore why one design is likely to be more appropriate than another for a given application. We will begin with a brief history of auctions, provide reasons for eBay's spectacular success, and highlight the Internet's impact on auction theory and practice. We will then move on to a discussion of the strategies that are available to bidders in the most-utilized auction formats, thereby providing each of you with hints on how to be more successful when participating in auctions. Throughout the talk, we will highlight the role that operations research analysts can play in designing, running, and assisting participants in business-to-business and high-stakes government auctions.

■ WD-02

Wednesday, 14:30-16:00

RB-Beta

Methods for Resource-Constrained Project Scheduling

Stream: Project Management and Scheduling

Invited session

Chair: *Vincent Van Peteghem*, People, markets and humanities, EDHEC Business School, 24, avenue Gustave Delory, 59057, Roubaix, France, vincent.vanpeteghem@edhec.edu

1 - Solving resource-constrained project scheduling problems with new mathematical programming formulations

Thomas Kyriakidis, Department of Engineering Informatics & Telecommunications, University of Western Macedonia, Karamanli and Lygeris Street, 50100, Kozani, Kozani, Greece, tkiriakidis@uowm.gr, *Georgios Kopanos*, *Michael Georgiadis*

In this work, 2 binary-integer programming discrete-time models and 2 mixed-integer continuous-time formulations are presented for the solution of resource-constrained project scheduling problems. These formulations are compared with 4 state-of-the-art literature models using a total of 2760 benchmark problem instances (j30 and j60 from PSPLIB, and 1800 problem instances generated by RanGen2). A detailed computational comparison study illustrates the efficiency of the proposed mathematical formulations, with the continuous-time mathematical formulations featuring the best overall performance.

2 - Solving the resource-constrained project scheduling problem using large neighborhood search

Wolfgang Summerauer, Department of Business Administration, University of Vienna, Bruenner Strasse 72, 1210, Vienna, Vienna, Austria,
wolfgang.summerauer@univie.ac.at, *Christian Almeder, Richard Hartl*

We present an algorithm based on large neighborhood search (LNS) to solve the resource-constrained project scheduling problem (RCPS), where a project consists of activities that have to be scheduled under resource and precedence constraints. The objective is to find a schedule that minimizes the makespan of the project. We developed new tailor-made destroy and repair operators and also adapted existing operators from the literature to tackle the RCPS. Preliminary results for the benchmark instances of the literature look promising with respect to solution quality and computational time.

3 - An Invasive Weed Optimization algorithm for the resource availability cost problem

Vincent Van Peteghem, People, markets and humanities, EDHEC Business School, 24, avenue Gustave Delory, 59057, Roubaix, France, vincent.vanpeteghem@edhec.edu, *Mario Vanhoucke*

In this study, an Invasive Weed Optimization (IWO) algorithm for the resource availability cost problem is presented, in which the total cost of the (unlimited) renewable resources required to complete the project by a pre-specified project deadline should be minimized. The IWO algorithm is a new search strategy, which makes use of mechanisms inspired by the natural behavior of weeds in colonizing and finding a suitable place for growth and reproduction. All algorithmic components are explained in detail and computational results for the RACP are presented.

■ WD-03

Wednesday, 14:30-16:00

RB-L1

Demand Responsiveness and Transportation Network Design

Stream: Optimization in Public Transport
Invited session

Chair: *Gabriel Gutiérrez-Jarpa*, School of Industrial Engineering, Pontificia Universidad Católica de Valparaíso, 2362807, Valparaíso, Chile, Chile, gabriel.gutierrez@ucv.cl

1 - An analytical model to estimate the optimal cycle length of demand responsive feeder transit services

Luca Quadrioglio, Civil Engineering, Texas A&M University, CE/TTI Bldg. Room 301-I, 3136 TAMU, 77843-3136, College Station, Texas, United States, quadrifo@tamu.edu, *Shailesh Chandra*

An increase of "livability" depends on solutions to the issue of first/last mile access to transit. We are working to identify the feeder's optimal cycle duration to maximize LOS. At first, a simulation case study with demand data from El Cenizo, TX has been conducted by simulation. We are now developing a handy analytical model to obtain results, without relying on extensive simulation analyses. Experiments appear to validate our model, which would allow planners, decision makers to quickly identify the best feeder transit operating design of any given residential area.

2 - Dynamic Vehicle Routing for Demand Responsive Transportation Services

Jorge Pinho de Sousa, Faculdade de Engenharia da Universidade do Porto / INESC Porto, Campus da FEUP, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jsousa@inescporto.pt, *Rui Gomes, Teresa Galvão Dias*

Providing quality public transportation may be very expensive in low and unpredictable demand scenarios. Demand Responsive Transportation (DRT) services address these issues with flexible routes and frequencies. We present an innovative approach for designing and operating these services, considering the perspectives of the different stakeholders. This multi-objective approach integrates simulation and heuristics in a DSS, aiming at minimizing operating costs and maximizing service quality. The DSS is also a tool to assess the performance of different DRT deployments and operating rules.

3 - Cut and Branch Synchronization Bus Timetabling

Yasmin Rios-solis, Graduate school of systems engineering, Universidad Autonoma de Nuevo Leon, Facultad de Ingenieria Mecanica y Electrica, Av. Universidad s/n, 65450, Monterrey, Nuevo Leon, Mexico, agueda.riosolis@uanl.edu.mx, *Omar Ibarra-Rojas*

We focus on bus timetabling problems of typical networks of Latin America: large network where passenger transfers must be favored, almost evenly spaced departures are sought, bus bunching of different lines must be avoided, timetable generation is needed several times a day, and travel times are irregular. We formulate this timetabling problem with the objective of maximizing the number of synchronizations. We provide valid inequalities to tighten the formulation. Experimentation shows that our methods obtains solutions less than 1% from the optimum in minutes even for large instances.

4 - The Hierarchical Network Design Problem with Traffic Capture

Gabriel Gutiérrez-Jarpa, School of Industrial Engineering, Pontificia Universidad Católica de Valparaíso, 2362807, Valparaíso, Chile, Chile, gabriel.gutierrez@ucv.cl, *Pablo Ibacache, Vladimir Marianov*

The hierarchical network design problem with traffic capture (HNDP-TC) finds a main path joining an origin and a destination, and secondary paths that start on the main path and visit some nodes. Total construction costs of the main and secondary paths are minimized, and captured traffic maximized. Traffic is captured if the use of the network is more convenient than competing systems. Applications are found in transportation and distribution systems, and telecommunications. We use Branch and Bound for small instances, and an ad hoc heuristic for large instances.

■ WD-04

Wednesday, 14:30-16:00

RB-L2

Advances for solving Quadratic and Other Difficult 0-1 Optimization Problems

Stream: Combinatorial Optimization
Invited session

Chair: *Monique Guignard-Spielberg*, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard_monique@yahoo.fr

Chair: *Peter Hahn*, Electrical and Systems Engineering, University of Pennsylvania, 200 South 33rd Street, 19104-6314, Philadelphia, PA, United States, hahn@seas.upenn.edu

1 - Eigenvalues of Voting Power Indexes

Lee Papayanopoulos, MSIS, Rutgers University, RBS, 1 Washington Park, 07102, Newark, NJ, United States, lp1@business.rutgers.edu

We explore the eigenvectors and eigenvalues of power indexes used in legislative representation and their use in integer/mixed integer search methods for "fair" weighted votes, namely, votes that render the voting power distribution (a combinatorial vector function) near-collinear with an associated population vector of constituencies.

2 - Extensive experiments with the improved hybrid genetic algorithm for the quadratic assignment problem

Alfonsas Misevicius, Multimedia Engineering, Kaunas University of Technology, Studentu st 50-400a/416a, LT-51368, Kaunas, Lithuania, alfonsas.misevicius@ktu.lt

Hybrid genetic algorithms (HGAs) are among the most efficient optimization techniques. In contrast to the standard GAs, which are based on natural evolution in a straightforward manner, the hybrid GAs can be understood as modeling of more complex environments, where the lifecycle transformations play the important role. In this work, several modifications of the improved HGA for the quadratic assignment problem (QAP) are tested, in particular: initial burst, incorporating the iterated local search, extra improvement, cohesive crossover, different population update schemes, using restarts, etc.

3 - The hypergraph assignment problem

Olga Heismann, Zuse Institute Berlin, Germany,
heismann@zib.de, *Ralf Borndörfer*

The hypergraph assignment problem (HAP) is the generalization of assignments on directed graphs to directed hypergraphs. It serves, in particular, as a universal tool to model several train composition rules in vehicle rotation planning for long distance passenger railways. Even for problems with a small hyperarc size and hypergraphs with a special partitioned structure the HAP is NP-hard. We present interesting polyhedral results derived from a complete facet classification of small HAP polytopes. These can be generalized to cut inequalities for the LP relaxation of large-scale problems.

4 - 0-1 quadratic optimization problems: convexification and solution.

Monique Guignard-Spielberg, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States,
guignard_monique@yahoo.fr, *Lucas Létocart*, *Gérard Plateau*

Convexification of the objective function of a 0-1 quadratic optimization problem (GQAP, QKP,...) is theoretically possible using an SDP model and its dual. We will discuss the numerical difficulties encountered in the process, and will show that for small to medium size instances, one may be able to obtain an equivalent convex model and a reasonable lower bound. One can also try to generate improved bounds and good feasible solutions using the convex hull relaxation (CHR), and/or try to solve the convex model by standard MIQCP software, such as CPLEX.

As shown by R. Gomory, the set of vertices of the master corner polyhedron over a group is the union of orbits under the stabilizer of a certain group element. We prove that two combinatorial operations transforming vertices to their neighbors map the orbits onto the others. So any system of representatives for some special orbits forms a polyhedron vertex basis, often small in size. We geometrically characterize the irreducible points and establish relations between the coefficients of the facets through a given vertex. The computational potential of the results is discussed.

3 - The K-Separator Problem

Mohamed Ahmed Mohamed Sidi, Telecom SudParis, 9 Rue Charles Fourier, 91000, Evry, France,
m-ahmed.m-sidi@telecom-sudparis.eu, *Walid Ben-ameur*,
Jose Neto

Let G be a vertex-weighted undirected graph and k be a positive number. We want to compute a minimum-weight subset of vertices whose removal leads to a graph where the size of each connected component is less than or equal to k . Let us call such a set a k -separator. If $k=1$ we get vertex cover problem. The case $k=2$ is equivalent to compute the dissociation number of a graph (case of unit weights). We give some formulations of the problem. We point out some cases where the problem is easy to. Some simple approximation algorithms are described. Numerical results are also reported.

4 - s-Fold Feasibility of Integer Knapsacks

Iskander Aliev, School of Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, alievi@cf.ac.uk

The integer knapsack problem is a well-known problem in integer programming. Since this problem is NP-hard in general, we are interested in well-solved special cases. In particular, when the right-hand sides satisfy certain geometric criteria, the existence of a feasible solution can be determined immediately, without the need for complex optimization techniques. We focus on the case where the knapsack polytope contains at least a prescribed number of integer points. We show that the feasibility of the problem appears to be closely related to the behaviour of the s -covering radius.

■ WD-05

Wednesday, 14:30-16:00

RB-L3

Topics in integer and mixed integer programming II

Stream: Discrete Optimization, Geometry & Graphs (contributed)

Contributed session

Chair: *Iskander Aliev*, School of Mathematics, Cardiff University, Senghennydd Road, CF24 4AG, Cardiff, alievi@cf.ac.uk

1 - Optimize the payout probability table in slot machines

Xiaoming Liu, FBA, University of Macau, University of Macau, Macau, NA, MACAU, China, xmliu@umac.mo,
Zhaotong Lian, *Xin Li*

This paper theoretically derives the game values of slot machines from the payout probability distribution. It provides explicit formulas for all quantitative measurements that are of interest to both casino managers and players. Optimization of the pay-out distribution is also given to maximize the pulls per losing player. The optimal payout and probability lists are shown. Some numerical results are given. These results can be utilized by slot managers to choose the best trade-off customer experience and casino gain.

2 - The Master Corner Polyhedron: Vertices

Vladimir Shlyk, Mathematics 3, Belarusian State Technical University, 65 Independence av., 15 Kulman str., Apt. 27, 220100, Minsk, Belarus, v.shlyk@gmail.com

■ WD-06

Wednesday, 14:30-16:00

RB-Gamma

Game Theory Applications

Stream: Dynamical Systems and Game Theory

Invited session

Chair: *Luis Ferreira*, Matemática, Escola Superior de Estudos Industriais e de Gestão, IPP, ESEIG, Rua D Sancho I, número 981, 4480-876, Vila do Conde, Porto, Portugal,
migferreira2@gmail.com

1 - Analysis of stroke patients EEG signals on the base of cooperative game theory

Hamidreza Navidi, science, Shahed University, 0098, Tehran, Iran, Islamic Republic Of, navidi@shahed.ac.ir, *Majid Hassanpour-ezatti*, *Saeid Barjesteh*, *Hadi Aghayari*

Electroencephalogram (EEG) is useful tool for detection of stroke. Here, a model presented on the base of cooperative game theory to analyses of features extraction of stroke patient EEG signals and the contribution rate of these features on outbreak of stroke is calculated. This features obtained from EEG by use of detrended fluctuation analysis method. In this research the data set were collected from 27 stroke patients. The result showed that some channels of EEG in stroke patients have more contribution rate in stroke detection. This finding is correlated with some practical observation.

2 - A game theoretical approach to the Emergency Medical Vehicle - Emergency Department interface

Vincent Knight, School of Mathematics, Cardiff University, CF24 4AG, Cardiff, United Kingdom, Knightva@cf.ac.uk

At the forefront of any healthcare system are two interacting services: the Emergency Medical Vehicle (EMV) service and the Emergency Department (ED). Often EMVs are subject to long delays at a particular ED whilst the ED suffers from upstream congestion due to arrivals of other patients. In this work, a game theoretical model is given. The ED's strategies correspond to the allocation of resources throughout the hospital whilst the EMV service is modelled as a routing game. Various insights are given that inform as to optimal levels of policy regulation.

3 - Non-conflicting redistribution of optimal income for non-cycling network systems

Sergei Schneider, School of Mathematical and Geospatial Sciences, RMIT University, GPO Box 2476V Melbourne, 3001, Melbourne, Victoria, Australia, sergei.schneider@rmit.edu.au

For LP optimized systems whose network structure is represented with a graph without inner cycles (which is a particular case of Berge's normal hypergraph) the stable optimal solution exists. The stability means that the total optimal income of the system can be distributed between players in the way that no individual player or coalition of players can be better off playing individually. Such stable income redistribution was found for two network systems, one of which water allocation and the second one represents the natural gas allocation system.

4 - Strategy for Land Acquisition: a game-theoretical model

S Deman, Economics & Statistics, Centre for Statistics, Economics & Finance, PO Box 17517, SE9 2ZP, London, United Kingdom, s_deman2000@yahoo.co.uk

The process by which houses, land, and other forms of real property are sold has been the subject of considerable economic research over the last few decades. However, the recent crash in housing prices in US and in Western European countries made the study of this subject even more important.

The cross entropy (CE) method was developed to estimate rare event probabilities through simulation, and has been applied to some optimization problems. To solve a VRP we try to estimate the probability that the total distance traveled is less than a given value, over all feasible routes. We have developed new CE heuristics based on a cluster-first route-second scheme which do not limit the search over the solution space as the existing CE algorithm did. We also tackle the SVRP where the demands follow a given distribution. We present computational results to evaluate these approaches.

3 - Orienteering Problem with Hotel Selection: A Variable Neighborhood Search Method

Ali Divsalar, Center for Industrial Management/Traffic & Infrastructure, KULeuven, Belgium, Ali.Divsalar@cib.kuleuven.be, *Pieter Vansteenwegen*, *Dirk Cattrysse*

In the orienteering problem with hotel selection (OPHS) a set of vertices with a score and a set of hotels are given. The goal is to determine a fixed number of connected trips that visits some vertices and maximizes the sum of the collected scores. Each trip is limited in length and should start and end in one of the hotels. A variable neighborhood search algorithm is developed to solve the OPHS based on a neighborhood search operator designed for the hotel selection and some neighborhoods for the regular OP. Two appropriate sets of instances with known optimal solutions are designed.

4 - Improved Methods for the Travelling Salesperson Problem with Hotel Selection

Marco Castro, Faculteit Toegepaste Economische Wetenschappen, Universiteit Antwerpen, Prinsstraat 13, 2000, Antwerpen, Belgium, marco.castro@ua.ac.be, *Kenneth Sørensen*, *Pieter Vansteenwegen*, *Peter Goos*

In this talk, a new formulation and a new metaheuristic solution procedure for the travelling salesperson problem with hotel selection (TSPHS) is presented. The metaheuristic is a multi-start procedure that outperforms existing heuristics on all benchmark instances. We also provide a number of new optimal solutions found by a commercial solver extended with a dedicated cutting plane procedure, as well as new best known solutions for most benchmark instances.

■ WD-07

Wednesday, 14:30-16:00

RB-Eta

Applications of Vehicle Routing 2

Stream: Vehicle Routing and Logistics Optimization
Invited session

Chair: *Marco Castro*, Faculteit Toegepaste Economische Wetenschappen, Universiteit Antwerpen, Prinsstraat 13, 2000, Antwerpen, Belgium, marco.castro@ua.ac.be

1 - An Exact Approach for the Clustered Vehicle Routing Problem

Daniele Vigo, DEIS, University of Bologna, Via Venezia 52, 47023, Cesena, Italy, daniele.vigo@unibo.it, *Maria Battarra*, *Gunes Erdogan*

We consider the Clustered Vehicle Routing Problem (Clu-VRP), which is a generalization of the well-known Capacitated Vehicle Routing Problem (CVRP) in which the customers are grouped into clusters. Whenever a vehicle visits one customer in a cluster it must visit all the remaining vertices of the cluster before leaving it. The Clu-VRP is NP-Hard and has many applications in distribution logistics. We present an integer programming formulation which is used as a base for exact Branch and Cut and Branch and Cut and Price algorithms which are tested on instances adapted from the literature.

2 - A Comparison of Cross Entropy Algorithms for the Vehicle Routing Problem

Edgar Possani, Department of Mathematics, Instituto Tecnológico Autonomo de Mexico, Rio Hondo No.1, Col. Progreso Tizapan, C.P. 01080, Mexico City, D.F. - Mexico, Mexico, epossani@itam.mx, *Marta Cabo Nodar*

■ WD-09

Wednesday, 14:30-16:00

RB-Zeta

EURO/ROADEF Challenge Session 5

Stream: EURO/ROADEF Challenge
Invited session

Chair: *H. Murat Afsar*, Industrial Systems, University of Technology of Troyes, 12 rue Marie Curie, BP 2060, 10010, Troyes, France, murat.afsar@utt.fr
Chair: *Eric Bourreau*, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr
Chair: *Emmanuel Guere*, Google, 38 Avenue de l'Opera, 75002, Paris, France, guere@google.com
Chair: *Ender Özcan*, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, exo@cs.nott.ac.uk
Chair: *Kedad-Sidhoum Safia*, LIP6 - UPMC, 4 Place Jussieu, 75005, Paris, France, safia.kedad-sidhoum@lip6.fr
Chair: *Christian Artigues*, LAAS, CNRS, 7 avenue du Colonel Roche, 31077, Toulouse Cedex 4, France, artigues@laas.fr
Chair: *Marc Sevaux*, Lab-STICC - CNRS UMR 3192, Université de Bretagne Sud - UEB, Centre de Recherche - BP 92116, 2 rue de Saint Maude, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - A late acceptance metaheuristic for the machine re-assignment problem

Wim Vancroonenburg, CODES, KAHO Sint-Lieven, KAHO Sint-Lieven, Gebroeders De Smetstraat 1, B-9000, GENT, Belgium, wim.vancroonenburg@kahosl.be, *Tony Wauters*

A local search method with a Late Acceptance strategy for the machine reassignment problem is proposed. Two neighborhoods have been developed: probabilistic single reassignment and swap assignment. Both have been equipped with an efficient delta evaluation procedure. Each iteration, one of the two is chosen at random, and only one neighboring solution is evaluated. The results show great performance on the small dataset, and managed to obtain the first place in the qualification round. Further tuning will be performed on the medium and large instances for the final phase of the challenge.

2 - Basic VNS for Machine reassignment

Nenad Mladenovic, School of Mathematics, Brunel University, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, *Nenad.Mladenovic@brunel.ac.uk*, *Bassem Jarboui*, *Dragan Urošević*

We propose Basic VNS for Challenging machine reassignment. Two neighborhood structures are used for Shaking: reassignment and swap. Local search uses re-assignment moves. We divide the set of constraints into hard and soft. Hard constraints are always taken into account in any move, while soft are included into objective function with increasing penalty function. In other words, our objective function is dynamic and includes some constraints, if they are violated.

3 - ROADEF/EURO Challenge 2012 : Final Results announcement

Eric Bourreau, COCONUT, LIRMM, 161 Rue Ada, 34000, Montpellier, France, *eric.bourreau@lirmm.fr*, *H. Murat Afsar*, *Christian Artigues*, *Emmanuel Guere*, *Kedad-Sidhoum Safia*, *Ender Özcan*, *Marc Sevaux*

We present the results of the ROADEF/EURO 2102 challenge, an international optimization contest propose jointly by EURO, the French OR society (ROADEF) and an industrial partner (GOOGLE). Many prizes are offered. Google propose 5000 euros in the junior category, 5000 euros in the senior category and 10 000 euros for a specific Open Source category. Intermediate qualification results (available since february 2012 on <http://challenge.roadef.org/>) have already shown that the competition is very tight, but after this presentation, the suspense will be over as the winners will be revealed.

■ WD-10

Wednesday, 14:30-16:00

RB-Theta

Integrated Planning of Operations

Stream: Supply Chain Management

Invited session

Chair: *Thomas Makuschewitz*, BIBA - Bremer Institut für Produktion und Logistik GmbH at the University of Bremen, Hochschulring 20, 28359, Bremen, Germany, *mak@biba.uni-bremen.de*

Chair: *Marc-André Isenberg*, BIBA - Bremer Institut für Produktion und Logistik GmbH at the University of Bremen, Germany, *ise@biba.uni-bremen.de*

1 - A graph theory based heuristic for capacity and cost oriented integrated production and maritime transport scheduling

Jens Hartmann, BIBA - Bremer Institut für Produktion und Logistik GmbH at the University of Bremen, Hochschulring 20, 28359, Bremen, Bremen, Germany, *hmn@biba.uni-bremen.de*, *Thomas Makuschewitz*, *Enzo Frazzon*, *Bernd Scholz-Reiter*

Interdependencies between production scheduling and maritime transport determine costs and lead times in global supply chains. An integrated scheduling combines flexible production and land transport schemes with overseas transport running a given timetable. In our talk we present a heuristic scheduling method based on the construction of a cost-weighted graph for each shipment, containing only feasible paths regarding time and capacity. In an iterative approach an overall schedule is obtained by finding shortest paths for shipments. The results are obtained using a real world test case.

2 - Solution of facility layout problem through discrete particle swarm optimization algorithm and an application

Abdullah Oktay Dundar, Akoren Vocational School, Selcuk University, Akoren, KONYA, Turkey, *aodundar@selcuk.edu.tr*, *Mehmet Akif Sahman*, *Muhammet Bezirci*, *Ali Alagoz*

It is aimed in this study to demonstrate the difference in business costs that will emerge after situating the units of the manufacturing plant in the best way and thus reducing the movement within the plant. In this context, the facility layout problem of a manufacturing business located in the city of Konya was re-designed through Discrete Particle Swarm Optimization algorithm, and the cost differences between the current and the designed plant location were demonstrated.

3 - Scheduling a flowshop of batch processors containing individual job families

Marc-André Isenberg, BIBA - Bremer Institut für Produktion und Logistik GmbH at the University of Bremen, Germany, *ise@biba.uni-bremen.de*, *Bernd Scholz-Reiter*

We introduce a scheduling problem consisting of a batch processor flow shop. Each stage has one batch processor working by the batch availability model. The problem contains stage specific incompatible job families. This induces non-permutation schedules, inconsistent batches and stage across interdependencies of jobs. Additionally, it includes unequal processing times, distinct due dates, time periods and batch size proportional setup times. Batch sizes underlie minimal and maximal bounds. We present the corresponding ILP, a greedy heuristic, a genetic algorithm and experimental results.

■ WD-12

Wednesday, 14:30-16:00

RB-Omicron

Port and Liner Management

Stream: Container Terminal Operations

Invited session

Chair: *Haakon Lindstad*, Marintek AS, Otto Nielsensvei 10, 7450, Trondheim, Norway, *Haakon.Lindstad@marintek.sintef.no*

1 - Integrated and robust planning of bulk port operations

Nitish Umang, Transport and Mobility Laboratory (Transp-OR), Ecole Polytechnique Federale De Lausanne, Avenue Tir Federale 92, 1024, Ecublens, Vaud, Switzerland, *nitish.umang@epfl.ch*, *Michel Bierlaire*

Bulk ports have received considerably less attention than container terminals in the field of large scale optimization. We present two exact solution approaches based on mixed integer programming and generalized set partitioning, and a heuristic approach to model the dynamic, hybrid berth allocation problem in bulk ports. We make the model robust to uncertainties and present a dynamic recovery algorithm to solve the berth allocation problem in real time. We also formulate a MIP to consider the integrated planning of berth and yard space allocation, and implement it using column generation.

2 - Port dynamics - A challenge for network optimization in liner shipping

Nguyen Khoi Tran, Logistics System, Institute of Shipping Economics and Logistics, Universitaetsallee 11-13, 28359, Bremen, Germany, *khoi@isl.org*, *Hans-Dietrich Haasis*

The presentation aims to review port development as well as optimization study in liner network. Ports have integrated into global supply chain. Their scope has surpassed traditional sea side and included also land side connection. Optimization review concentrates on route optimization, fleet operation, container planning with various problems and methodologies. Naturally, network optimization should be considered both sea and land factors. Our simulation illustrates the impact of various logistics costs on total door-to-door cost, in particular inland and inventory carrying costs.

3 - Knowledge Management of Macro and Micro Seaport Repositories using Data Mining Techniques

Ana Halabi Echeverry, Computing, Macquarie University, 17a Gilda St, North Ryde, 2113, Sydney, NSW, Australia, ana.halabiecheverry@mq.edu.au, Deborah Richards, Ayse Bilgin, Jairo Montoya-Torres

We propose that repository data can be connected into a systemic framework for decision-making of port authorities (PAs). We propose a systemic model we call the Port Decision System Approach (PDSA). Initially we test it, using cluster analysis to identify patterns with the available data. Results help to understand the similarities and differences between subsystems of PDSA. Secondly, we use neural networks as a method to validate the associations by using combinations of inputs and outputs. Thus, we provide a proof of concept of a strategic decision making tool for PAs in emerging regions

4 - Multi objective scheduling and environmental routing of maritime vessels

Haakon Lindstad, Marintek AS, Otto Nielsensvei 10, 7450, Trondheim, Norway, Haakon.Lindstad@marintek.sintef.no

Ship scheduling and routing which concerns the optimal assignment of available cargoes to maximize profit is a complex problem. Increased environmental concern due to climate change adds another dimension to the scheduling and makes it multi objective. This study has focused on developing a methodology for calculating fuel consumption and emissions as function of sea conditions and vessel characteristics. And to use it for scheduling in a multi objective environment where voyage requirement will vary between minimizing voyage emissions, minimize voyage cost or maximizing profit.

■ WD-13

Wednesday, 14:30-16:00

RB-Tau

Emerging Issues in New Product Development

Stream: OR Applications in the Automotive Industry
Invited session

Chair: *Thomas Volling*, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstr. 3, 38106, Braunschweig, Germany, t.volling@tu-braunschweig.de

1 - A Proposal of Diagnosis Procedure for BTO Products

Yuji Sato, Graduate School of Policy Science, Mie Chukyo University, 1846 Kubo, 515-8511, Matsusaka, Mie, Japan, ysatoh@1988.jukuin.keio.ac.jp

The objective of this paper is to propose a diagnosis procedure of user's preference for a BTO product, and to subsequently optimize the specification of the product for a manufacturing company. By combining cost-benefit analysis which evaluates potential products, and AHP which quantifies subjective judgment in evaluations, user's preference is diagnosed. The benefit of this approach is to be able to provide both the decision support and corporate strategy necessary to ensure success in the future. A case study is carried out to demonstrate the applicability of the proposed approach.

2 - Algorithms for Extending Battery's lifespan in Electric Vehicles

Ron Adany, Computer Science, Bar-Ilan University, 52900, Ramat-Gan, Israel, adanyr@cs.biu.ac.il, Doron Aurbach, Sarit Kraus

In this paper we propose algorithms to improve the battery's lifespan. The battery, which is actually a pack of batteries, is designed to be discharged in a specific current whereby other currents, higher or lower, have negative effects on its lifespan. The common discharge method supplies the current demand using all the batteries in the pack. Since the discharge current demands are not constant, there is room for improvement. We propose a switching algorithm which, for each discharge demand, selects a subset of batteries to be discharged as well as the discharge current for each.

3 - Coordination by contracts in decentralized product development processes with uncertain development results

Kerstin Schmidt, Institute of Automotive Management and Industrial Production, Technische Universität Braunschweig, Katharinenstraße 3, 38106, Braunschweig, Germany, kerstin.schmidt@tu-bs.de, Thomas Volling, Thomas Spengler

Product development processes in the automotive industry are distributed over various companies. If inappropriate contracts are used within these collaborations, inefficiencies can occur due to existing uncertainties with regard to the development results and differing objectives of the independent companies. To this end, we develop an analytical optimization model for the representation of decentralized product development processes, taking into account uncertainties and substitution possibilities. Based on this model, the coordination ability of different kinds of contracts is analyzed.

■ WD-15

Wednesday, 14:30-16:00

RB-2101

Theory and algorithms of bilevel programming II

Stream: Variational Inequalities and Bi-Level Problems
Invited session

Chair: *Alain B. Zemkoho*, Mathematics and Computer Sciences, Technical University Bergakademie Freiberg, Akademiestr. 6, 09599, Freiberg, Saxonia, Germany, zemkoho@student.tu-freiberg.de

1 - Solution algorithm for linear bilevel programming problem

Stephan Dempe, Mathematics and Computer Sciences, Technische Universität Freiberg, 09596, Freiberg, Germany, dempe@math.tu-freiberg.de, *Shili Peng*

Let $S(x)$ be the solution set mapping of a parametric linear optimization problem having the parameter in the right-hand side of the linear constraints. Then, the linear bilevel programming problem consists in minimizing a linear objective function subject to the variable x being an element of a certain polyhedron and y being an element of $S(x)$. An optimal solution can be found at a vertex of the underlying polyhedron and a simplex-like algorithm is formulated which moves along the feasible vertices. This algorithm can be globalized using a tunneling idea.

2 - Some results in semivectorial bilevel optimal control problem

Henri Bonnel, ERIM, University of New Caledonia, B.P. R4, F98851, Noumea, New Caledonia, bonnel@univ-nc.nc, *Jacqueline Morgan*

I will present optimality conditions for the bilevel optimal control problems where the upper level is a scalar optimal control problem to be solved by the leader, and the lower level is a multiobjective convex optimal control problem to be solved by several followers acting in a cooperative way inside the greatest coalition. I will consider the so-called optimistic case as well as the pessimistic one.

3 - On an enumerative algorithm for solving eigenvalue complementarity problems

Joaquim Judice, Instituto de Telecomunicações, Polo II, 3000, Coimbra, Coimbra, Portugal, Joaquim.Judice@co.it.pt, *Luís Fernandes, Hanif Sherali, Maria Forjaz*

In this talk, we discuss the solution of linear and quadratic eigenvalue complementarity problems (EiCPs) using an enumerative method. The algorithm solves these EiCPs by finding global minima of special nonlinear programs (NLPs). Procedures for computing the interval that contains all the eigenvalues are introduced. Necessary and sufficient conditions for stationary points of these NLPs to be solutions of the EiCPs are established. Some computational experience is reported to highlight the efficiency and efficacy of the enumerative algorithm for solving the EiCPs.

■ WD-16

Wednesday, 14:30-16:00
RB-2103

Recent Advances in Linear Programming and Related Subjects

Stream: Linear and Conic Programming
Invited session

Chair: *Tibor Illés*, Differential Equations, Budapest University of Technology and Economics, Egrý J. u. 1., 1111, Budapest, Hungary, illes@math.bme.hu

1 - Advantages and disadvantages of successive linear programming methods for solving non-linear problems

Zsolt Csizmadia, Xpress, FICO, FICO House, Starley Way, Birmingham, United Kingdom, zsoltsizmadia@fico.com

For solving general non-linear problems using out of the box solution methods, choosing second order algorithms is often the rule of thumb entrusting in their general robustness and their ability to solve many problems without extensive tuning. However, there are several problem classes and applications where a first order method is better suited for efficiently solving the right formulation. The talk will present examples and applications where an integrated successive linear programming method outperforms second order approaches by magnitudes.

2 - The numerical behavior of s-monotone index selection rules for the simplex algorithm

Adrienn Nagy, FICO, FICO House, Starley Way, Birmingham, United Kingdom, adriennnagy@fico.com, *Tibor Illés*

Several variations of index selection rules for Simplex algorithms like the Last-In-First-Out or the Most-Often-Selected-Variable rules not only are theoretically finite, but also provide significant flexibility in choosing a pivot element. Based on an implementation of the primal Simplex and the Monotone Build-Up (MBU) Simplex method using the callable library of FICO Xpress, the practical advantage of these methods are evaluated using public benchmark LP test sets. Our results also provide numerical evidence that the MBU-Simplex algorithm is a viable alternative to the Simplex algorithm.

3 - Cutting Plane Methods for Solving Inexact Problems

Fariba Pidani, Department of Mathematics, Mahshahr Branch, Islamic Azad University, Mahshahr, Iran, Islamic Republic Of, faribapidani@yahoo.com

In this paper we study some well-known cases of nonlinear programming problems, presenting them as instances of Inexact Linear Programming. The class of problems considered contains, semidefinite programming, second order cone programming and special cases of inexact semidefinite programming. Strong duality results for the nonlinear problems studied are obtained via Lagrangian duality. Using these results we propose some dual algorithms. The proposed algorithms can be interpreted as cutting plane (also non polyhedral) or discretization algorithms.

4 - The s-Monotone Index Selection Rules for Pivot Algorithms of Linear Programming

Tibor Illés, Differential Equations, Budapest University of Technology and Economics, Egrý J. u. 1., 1111, Budapest, Hungary, illes@math.bme.hu, *Zsolt Csizmadia*, *Adrienn Nagy*

We introduce the concept of s-monotone index selection rule for linear programming problems. We show that several known anti-cycling pivot rules like the minimal index, last-in-first-out and the most-often-selected-variable pivot rules are s-monotone index selection rules. Furthermore, we show a possible way to define new s-monotone pivot rules. We prove that several known algorithms like the primal (dual) simplex, MBU-simplex algorithms and criss-cross algorithm with s-monotone pivot rules are finite methods.

■ WD-17

Wednesday, 14:30-16:00
RB-2105

DC programming and DCA 2

Stream: Nonconvex Programming: Local and Global Approaches
Invited session

Chair: *Tao Pham Dinh*, INSA Rouen, 76131, Rouen, France, pham@insa-rouen.fr

1 - DC Programming via BMI constraints

Yi-Shuai Niu, CORIA UMR 6614, French National Centre for Scientific Research, Site Universitaire du Madrillet BP 12, 76801, SAINT ETIENNE DU ROUVRAY, France, niuys@insa-rouen.fr, *Tao Pham Dinh*

We propose efficient method for DC programming via BMI (Bilinear Matrix Inequality) constraints which has important applications in robust control. This is a very difficult NP-hard problem, the difficulty lies in the nonconvexity of the objective function and BMI constraints. We reformulate the problem as a DC program with convex constraints via penalization techniques and propose DC Algorithm (DCA) for numerical solution. DCA requires solving a convex program via LMI constraints in each iteration. Numerical simulations and comparisons with PENBMI show good performance of our method.

2 - Combining multiobjective constraint satisfaction and sequential control for solving the sensors management of the intelligence process

Ali Khenchaf, Lab-Sticc UMR CNRS 6285, ENSTA Bretagne, 2 Rue François Verny, 29806, Brest, France, ali.khenchaf@ensta-bretagne.fr, *Manh Nguyen Duc*, *Dambreville Frédéric*, *Christophe Osswald*, *Abdelmalek Toumi*, *Jean-Christophe Cexus*

This paper deals with problems of information collection in the intelligence process. The intelligence process takes place within hierarchical military organizations. That leads to bi-level sensor management optimization problems, consisting of both a coordination level and sensors control level. We will consider problems derived from actual operational scenarios, combining a multiobjective constraint satisfaction problem at the coordination level with sequential optimal controls at the sensors level. The modeling of the problem and solution methods will be presented and compared.

3 - A new efficient deterministic approach for mixed 0-1 multiobjective programming. Application to shift scheduling problems.

Viet Nga Pham, Mathematics, National Institute for Applied Sciences, Rouen, France, Avenue de l'Université BP8, 76801, Saint-Étienne-du-Rouvray, Haute Normandie, France, viet.pham@insa-rouen.fr, *Hoai An Le Thi*, *Tao Pham Dinh*

In this paper, we propose a new deterministic approach for mixed zero-one linear multiobjective programming. It consists in solving only one mixed zero-one linear program by either CPLEX solver or DC algorithm (DCA). Computational results applying to shift scheduling problems demonstrate the efficiency of our method with respect to existing algorithms, especially in the large-scale setting.

Keywords: mixed zero-one multiobjective linear optimization, integer programming, DC algorithm (DCA), shift scheduling problems.

■ WD-18

Wednesday, 14:30-16:00
RB-2107

Location Analysis and Disruptions

Stream: Network and Discrete Location
Invited session

Chair: *Mozart Menezes*, MIT-Zaragoza International Logistics Program, Zaragoza Logistics Center, 50197, Zaragoza, Zaragoza, Spain, mmenezes@zlc.edu.es

Chair: *Serigne Gueye*, Computer Science, University of Avignon, 88212, Avignon, France, sgueye@zlc.edu.es

1 - An exact cooperative method for the simple plant location problem

Philippe Michelon, LIA, Université d'Avignon et des Pays de Vaucluse, 339 Ch. des Meinajaries, Agroparc BP 91228, 84911, Avignon Cedex 9, France, philippe.michelon@univ-avignon.fr

In this paper, we present a cooperative primal-dual method to solve the SPLP exactly. It consists of a primal process, and effective tabu search, and a dual process, which performs a LaGrange branch-and-bound search. Both processes cooperate by exchanging information which helps them find the optimal solution. Further contributions include new techniques for improving the evaluation of the branch-and-bound nodes: decision-variable bound tightening rules applied at each node, and a sub gradient caching strategy to improve the bundle method applied at each node.

2 - Critical Facility Capacitated r-Interdiction Location Problem: an example of grocery stores with limited demand

Yuran Choi, Systems and Information Engineering, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki, 305-8537, Tsukuba, Japan, r1030173@risk.tsukuba.ac.jp, *Tsutomu Suzuki*

Our focus is on maximal covering problem which considers two interacting players: interdiction and prevention. This study aims to minimize the maximum increase of cost caused by disruption so the system can retain the highest coverage on the next interdiction step. We specify the facilities as grocery stores with limited demand. The interdiction is capacitated according to the size of stores and total interdiction is bounded. With this problem, it is possible to discuss the necessity of participation of governments for preventing critical stores from disruption on a supposition of stagnation.

3 - A Bilinear Programming Formulation for the p-Median Problem with Unreliable Facilities and Disruption Probability Classes

Serigne Gueye, Computer Science, University of Avignon, 88212, Avignon, France, sgueye@zlc.edu.es, *Mozart Menezes*

The p-Median problem with unreliable facilities is the problem of locating unreliable facilities on a network that minimize the expected cost of serving the customers. The facility availability depends on a disruption probability which is independent of its location. We assume that a finite number of different probabilities exist. The approach corresponds to aggregating different designs into risk classes. A Bilinear Programming Formulation is proposed to solve exactly the problem. Some numerical results are given using randomly generated instances.

■ WD-19

Wednesday, 14:30-16:00

RB-2111

Survival Analysis and Simulation

Stream: Simulation Methods in Finance

Invited session

Chair: *Coskun Kus*, Statistics, Selcuk University, 42225, Faculty of Science, Campus, Konya, Turkey, coskun@selcuk.edu.tr

Chair: *Aysegul Iscanoglu Cekic*, Statistics, Selcuk University, KONYA, Turkey, iaysegul@selcuk.edu.tr

1 - A new lifetime distribution with increasing failure rate

İsmail Kınacı, Statistics, Selçuk University, Selçuk University, Science Faculty,, Konya, Turkey, ikinaci@selcuk.edu.tr, *Demet Sezer*

In this study, a new two-parameter lifetime distribution with increasing failure rate is introduced. Various properties of this distribution are discussed. The Fisher information matrix is derived analytically in order to obtaining the asymptotic covariance matrix. Simulation studies are performed and experimental results are illustrated based on a real data set.

2 - Optimal Warranty Policy for a Pareto Distributed Products based on Progressive Censored Sample

Neriman Karadayı, Statistics Department, Selcuk University Faculty of Science, Selcuk University, 42225, Konya, Turkey, nkaradayi@selcuk.edu.tr, *Yunus Akdoğan*, *Coskun Kus*, *Shuo-Jye Wu*

It is important to attract consumers in highly competitive markets. One of the effective ways of doing this is through warranties granted to the products. Consumers would like to buy high-priced products so long as they are supplied a reliability for the products in question. A decision problem related with the warranty involving a combination of free replacement and pro-rata policies is examined. Bayesian approach based on progressive censored product failure time data having Pareto distribution is used to determine the optimal warranty lengths. An numerical example is also given.

3 - Optimal Progressive Group Censoring Scheme under Cost Considerations for Pareto Distribution

Coskun Kus, Statistics, Selcuk University, 42225, Faculty of Science, Campus, Konya, Turkey, coskun@selcuk.edu.tr, *Yunus Akdoğan*, *Shuo-Jye Wu*

In this article, optimal design under the restriction of pre-determined budget of experiment is developed for the Pareto distribution when the life test is progressively group censored. We use the maximum likelihood method to obtain the point estimator of the Pareto parameter. We propose two approaches to decide the number of test units, the number of inspections, and the length of inspection interval under limited budget such that the asymptotic variance of estimator of Pareto parameter is minimum. A numerical example is given to illustrate the proposed method. Some sensitivity analysis is also studied.

4 - Generalized Linear Mixed Models (GLMMs) with a Financial Application

Neslihan İyit, Statistics Department, Selcuk University, Faculty of Science Faculty, Konya, Turkey, niyit@selcuk.edu.tr

A generalized linear model (GLM) is used to determine the relationship between a response variable and fixed effects. A generalized linear mixed model (GLMM) is a statistical model that extends the class of GLMs by incorporating random effects.

GLMMs are important in the analysis of finance data. When dealing with the finance data, the distribution of the response variable can be chosen from the exponential family. In this study, GLMM with a fixed and random effect will be implemented on a financial data set.

■ WD-20

Wednesday, 14:30-16:00

RB-2113

Financial Optimization 3

Stream: Financial Optimization

Invited session

Chair: *Ayşe Arik*, actuarial science, hacettepe university, Beytepe Campus, Cankaya, Ankara, Turkey, aysearik@hacettepe.edu.tr

1 - Performance measurement of online algorithms using geometric Brownian motion and quantile regression

Esther Mohr, Information and Technology Management, Saarland University, P.O. Box 151150, 66041, Saarbrücken, Germany, em@itm.uni-sb.de, *Robert Dochow*, *Günter Schmidt*

We investigate the problem of estimating the independent risk and return represented by standard deviation and expected return of a known online conversion algorithm. The question is whether these parameters should be estimated by a theoretical price model or by an empirical procedure through experiments. To avoid data-snooping bias we present a hybrid of the theoretical and the empirical approach with 3 steps. The problem is formulated as a linear function of parameters, and solved by linear programming. Our results generalize former works.

2 - Optimal Dynamic Tax Evasion: A Portfolio Approach

Francesco Menoncin, Economics, Brescia University, Via S. Faustino, 74/B, 25122, Brescia, Italy, menoncin@eco.unibs.it, *Rosella Levaggi*

An agent invests on both a risk-less and a risky asset (following a GBM) and chooses how much of the latter to declare. A fine (Poisson jump process) must be paid on evasion if caught. Main results are: (i) inter-temporal consumption is higher with evasion, (ii) evasion is affected neither by the return nor by the volatility of the risky asset, (iii) evasion increases the investment in the risk-less asset, (iv) against evasion high fine is more effective than frequent controls, (v) for a sufficiently high level of taxation on the risk-less asset evasion is zero.

3 - Optimal Cash Management Using Impulse Control

Peter Lakner, IOMS, New York University, 44 West 4th St., Suite 8-61, 10012, New York, NY, United States, plakner@stern.nyu.edu, *Joshua Reed*

We solve the optimization problem of a manager who controls the amount of cash on hand by occasionally moving funds back and forth between his/her reserves and the cash on hand. The cash on hand process without any managerial intervention is assumed to follow a Levy process. The manager is charged fixed plus proportional costs for any specific adding to or withdrawing from the reserves and there are opportunity costs for keeping too little or too much cash on hand. The manager's objective is to minimize the expected total discounted costs over an infinite horizon.

4 - The Lee Carter Method and Poisson Log-Bilinear Model: An Application To Turkish Census Data

Ayşe Arık, actuarial science, Hacettepe university, Beytepe Campus, Cankaya, Ankara, Turkey, aysearık@hacettepe.edu.tr, *Basak Bulut*, *Erengül Özkök*, *Meral Sucu*

We present Lee-Carter (LC) and Poisson log-bilinear model, suggested by Brouhns et al. (2002), for modelling Turkish mortality rates. After estimating the LC parameters then we re-estimated the parameters under the Poisson log-bilinear model using bootstrap method. Projections are also made by using the estimated parameters obtained from these two methods and are compared with the actual mortality rates. References: Brouhns et al. (2002), A Poisson log-bilinear regression approach to the construction of projected life tables. *Insr Math Econ* 31:373-393.

■ WD-21

Wednesday, 14:30-16:00

RB-2115

Capital Asset Pricing Models

Stream: Numerical Methods in Finance

Invited session

Chair: *Fabian Lutzenberger*, FIM Research Center Finance & Information Management, University of Augsburg, Universitätsstr. 12, 86159, Augsburg, Germany, fabian.lutzenberger@googlemail.com

1 - Testing the Capital Asset Pricing Model (CAPM) on the Central and South-East European Emerging Securities Markets

Zdravka Aljinovic, Faculty of Economics, University of Split, Matice hrvatske 31, 21000, Split, Croatia, zdravka.aljinovic@efst.hr, *Josipa Dzaja*

The paper examines if the Capital Asset Pricing Model (CAPM) is adequate for capital asset valuation on the Central and South-East European emerging securities markets using monthly stock returns for nine countries for the period of January 2006 to December 2010. Precisely, it is tested if beta, as the systematic risk measure, is valid on observed markets by analysing are high expected returns associated with high levels of risk, i.e. beta. Also, the efficiency of market indices of observed countries is examined.

2 - Risk Sensitive Approach to Inventory Management

Müge Tekin, Industrial Engineering, Koc University, Rumelifeneri Yolu, Koc Universitesi, 34450, Istanbul, – Select –, Turkey, mtekin@ku.edu.tr, *Suleyman Ozekici*

Newsboy models are one of the core models in inventory management literature. The classical newsboy model aims to maximize the expected profit and the risk caused by demand uncertainty is disregarded. However, the inventory managers may prefer less gain but more stable outcomes. We follow a mean-variance approach to the newsboy problem and take care of risk. We also aim to incorporate supply randomness into our model, as well. In the second part, supposing the randomness is correlated with financial markets the newsboy invests in a portfolio of financial instruments and hedges the risk.

3 - Valuation — Liquidity (Risk) and Cost of Equity

Michael Ludwig, FIM Research Center Finance & Information Management, University of Augsburg, Germany, michael.richard.ludwig@email.de, *Stefan Stöckl*, *Dennis Diepold*

While several empirical studies could find a significant impact of liquidity (risk) on asset returns, its effect on valuation has not been investigated yet. Therefore, we examine whether the market value of a company can be estimated more exactly when cost of equity are used that do explicitly account for liquidity (risk) and all other variables (e.g. cash flows) being equal. We find that estimated company values are significantly closer to the actually observed market capitalization, when the cost of equity are calculated with the liquidity-adjusted CAPM instead of the CAPM.

4 - Multiperiod valuation and the CAPM

Fabian Lutzenberger, FIM Research Center Finance & Information Management, University of Augsburg, Universitätsstr. 12, 86159, Augsburg, Germany, fabian.lutzenberger@googlemail.com, *Stefan Stöckl*, *Vasko Isakovic*

This paper compares different applications of the Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM) to the valuation of assets with stochastic cashflows in more than one periods ahead using STOXX Europe 600 data. We show that the cross-section of market capitalizations can be explained best by taking into account time-varying CAPM-based discount rates with time-varying beta coefficients, market risk premiums and risk free rates. Since discount rates are usually assumed to be constant over time, we make an important contribution to making better multiperiod investment decisions.

■ WD-22

Wednesday, 14:30-16:00

RB-2117

Fuzzy Systems in Geopolitics and Disaster Management

Stream: Fuzzy Optimization - Systems, Networks and Applications

Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: *Alexis Pasichny*, Students' Science Association, National Technical University of Ukraine, 37, Peremohy av., 03056, Kiev, Ukraine, alexis.pasichny@gmail.com

1 - Preparation of Complex Landslide Simulation Results with Spatial Data Mining Methods for Decision Support

Erik Kropat, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de, *Eva Nuhn*, *Wolfgang Reinhardt*, *Stefan Pickl*

Recent catastrophic landslide events caused large human and material damages. In order to improve protection against such kinds of natural hazards a new approach for early warning systems for landslide events is pursued where the results of complex finite element simulations of landslides are coupled with geoinformation systems. This allows a detailed investigation of unstable slopes with sophisticated crisp and fuzzy spatial data mining methods as well as a user friendly preparation of the complex simulation results for decision support.

2 - Fuzzy civilization-state model for system analysis of world geopolitics

Alexis Pasichny, Students' Science Association, National Technical University of Ukraine, 37, Peremohy av., 03056, Kiev, Ukraine, alexis.pasichny@gmail.com

Proposed study is based on development of fuzzy representation for the global cultures' distribution across world countries'. Several original methods for construction of fuzzy world civilization structure using different types of expert data are proposed. Given model allows to define formal procedures for identification of world civilizations' core states and fault lines for testing of S. Huntington's 'clash of civilizations' concept.

3 - A concurrent neuro-fuzzy inference system for automotive service industry

Fehmi Evren Dinç, Industrial Engineering, Kocaeli University, 41000, Kocaeli, Turkey, fevren41@hotmail.com, *Yildiz Yulugkural*, *Zerrin Aladag*

Automotive post purchase service network and its quality can be effective on consumers' purchasing consideration as much as product and service themselves. In this article, an intelligent model is developed to determine the motor, transmission and power unit problems of specific vehicle model. A Concurrent Neuro-Fuzzy Inference System has been generated with Self-Organized Map (SOM) and Adaptive Neural Fuzzy Inference System (ANFIS) for the detection and estimation of the vehicles' malfunctions. SOM which takes part in model structure, has been positioned as ANFIS's antecedent input feeder.

■ WD-23

Wednesday, 14:30-16:00

RB-Delta

Recent Advances in Convex Optimization

Stream: Convex Optimization
Invited session

Chair: *Aharon Ben-Tal*, Industrial Engineering and Management, Technion-Israel Institute of Technology, Technion City, 32000, Haifa, Israel, abental@ie.technion.ac.il

Chair: *Attila Gilanyi*, Faculty of Informatics, University of Debrecen, Pf. 12, 4010, Debrecen, Hungary, gilanyi@math.klte.hu

1 - Iterative solution methods for a canonical dc programming problem

Syuuji Yamada, Graduate School of Science and Technology, Niigata University, 8050 Ikarashi-2nocho, 9502181, Niigata, Japan, yamada@math.sc.niigata-u.ac.jp, *Tamaki Tanaka*, *Tetsuzo Tanino*

In this talk, we consider a canonical dc programming problem (CDC) to minimize a linear function over the difference between a compact convex set and an open bounded convex set. For (CDC), many global optimization algorithms have been proposed. However, since the volume of data necessary for executing such algorithms increases in proportion to the number of iterations, such algorithms are not effective for large scale problems. Hence, to calculate an approximate solution of a large scale (CDC), we propose new iterative solution methods by utilizing polar coordinates.

2 - Revisiting the construction of gap functions for variational inequalities via conjugate duality

Liana Cioban, Babes-Bolyai University, Cluj Napoca, Romania, *Mihail Kogalniceanu*, nr. 1, 400084, Cluj Napoca, Romania, lianacioban@yahoo.com, *Ernö Robert Csetnek*

Based on conjugate duality we construct gap functions for general variational inequalities formulated by a perturbation function. In convex setting and if a regularity condition is fulfilled, these become gap functions. By particularizing the perturbation function we rediscover several gap functions from literature. We characterize the solutions of the general variational inequalities by the properties of the convex subdifferential. If no regularity condition is fulfilled, we give necessary and sufficient sequential characterizations for the solutions.

3 - Database for Convex Optimization

Shriguru Nayak, IT, IIIT-B, IIIT-B, 26/C, Electronic City, 560100, Bangalore, Karnataka, India, shrigurunayak@gmail.com, *Neha Bhatia*, *G. N. Srinivasa Prasanna*

Convex optimization methods rely on efficient representation of high dimensional convex constraints, both linear and non-linear. Vertex only and facet only representations of the feasible region are suboptimal in terms of storage. Extending work on 3D polytope representations, we propose a hybrid of vertex and facet representation to efficiently represent convex polytopes and general convex bodies. Efficient query algorithms are presented, including membership of a point in the convex body, its volume, and generation of information equivalent convex bodies.

4 - An iterative algorithm for the reflexive optimal approximation solutions of matrix equations $AXB+CYD=E$

Heming Sun, College of Science, Hohai University, 1 Xi Kang Road, 210098, Nan Jing, China, sunheminghl@msn.com

In this paper, we consider the following 3-steps optimization problem. First step, define matrices X and Y as reflexive (anti-reflexive) matrices. Second step, minimize the Frobenius norm of $AXB+CYD-E$. Third step, find the nearest matrices to two given matrices among the solutions of second step. General optimization problem is two-steps optimization problem. We present an iterative algorithm to solve the above 3-steps optimization problem by making use of the hybrid steepest descent method (HSMD).

■ WD-24

Wednesday, 14:30-16:00

CC-A11

OR and the Arts

Stream: OR and the Arts
Invited session

Chair: *Vitaly Podobedov*, Computational Mathematics and Cybernetics, Moscow State University, Vorobievsky Gory, MSU, 119992, Moscow, Russian Federation, vetix@or-art.org

1 - OR and Abstract Painting

Vitaly Podobedov, Computational Mathematics and Cybernetics, Moscow State University, Vorobievsky Gory, MSU, 119992, Moscow, Russian Federation, vetix@or-art.org

Local optimization algorithms and deterministic chaos are the main creative subjects of a new style of mathematical art — the abstract determinism painting. Compared to fractal art, abstract determinism expands the creative possibilities of chaos by obscuring a mathematical nature of its paintings; even a discerning spectator can hardly say who made it — a computer or an artist-person? Software for generating the test functions and the domains of attraction of local optima are presented. Numerous illustrations, allowing the aesthetic and semantic interpretations are provided.

2 - Optimization of inner operation of a museum to enhance the educational impact on visitors

Katarina Simoncicova, Institute of History and Theory of Architecture and Monument Restoration, Slovak university of technology, Faculty of architecture, Slovakia, katka.simoncicova@gmail.com, *Eva Kralova*

This paper develops the process of creation of interior operation, which is important part of securing the fluency of education. It will be showed on example of conversion of a former heat plant to a poly-functional museum of technology that will mediate the history of industry. The ethic approach is in the sensitization of the relations between visitors and architectural heritage and education of ecology and sustainability. The aim of this project is to evaluate efficient interior operation and necessity of changing perceptions throughout the visitor's path.

3 - Composing counterpoint musical scores with variable neighborhood search

Dorien Herremans, Operations Research Group ANT/OR, University of Antwerp, Dolfijnstraat 82, 2018, Antwerpen, Belgium, dorien.herremans@ua.ac.be, *Kenneth Sörensen*

In this research a variable neighborhood search (VNS) algorithm is developed that can generate musical fragments of arbitrary length. The objective function of the algorithm is based on a quantification of existing fifth species counterpoint rules. A thorough parametric analysis of the VNS reveals the significance of the algorithm's parameters on the quality of the composed fragment, as well as their optimal settings. The VNS algorithm has been implemented as a user-friendly software environment for composition, called *Optimuse*.

4 - Ball motion inside symmetric surfaces, described by using special diagrams

Lina Otradnova, Department of Mechanics and Mathematics, Lomonosov MSU, GSP-1, Leninskie Gory, 119991, Moscow, Russian Federation, otradnova.lina@gmail.com

Problems of ball motion between two parallel planes, inside a sphere or a circular cylinder, and also disk motion between two parallel lines and inside the angle, by inertia in the absence of gravity are considered. During the impact, an instant constraint is imposed, and a condition of rolling without slipping is satisfied. Two cases of impacts are given: absolutely elastic and not absolutely elastic. Diagrams illustrating this effect are presented. Such model with impacts can be found in everyday life, namely in sport: pole vault, or table tennis.

■ WD-25

Wednesday, 14:30-16:00
CC-A23

Simulation Based Decision Support

Stream: Simulation Based Decision Support
Invited session

Chair: *Guido Siestrup*, Business Information Systems, Hochschule Furtwangen University, Robert-Gerwig-Platz 1, 78120, Furtwangen, Germany, sig@hs-furtwangen.de

1 - Simulation approach for measuring benefits of cutting stock optimization with usable leftovers

Mihael Cesar, Business Informatics, Faculty of Economics, Kardeljeva pl. 17, 1000, Ljubljana, mcesar@gmail.com, *Luka Tomat*, *Miro Gradisar*

We present a method for one-dimensional cutting stock optimization with usable leftovers (UL). All leftovers longer than t are returned back to stock and reused in future orders. The question is how to set t . Lower t produces more UL in stock and therefore higher trim-loss in future orders. If it is too high, too many leftovers become trim-loss. With hundreds of simulations we found the optimal number of leftovers in stock for various stock-to-order size ratios. The proposed method minimizes trim-loss and at the same time maintains optimal number of UL in stock.

2 - A risk management approach for logistics agglomerations

Guido Siestrup, Business Information Systems, Hochschule Furtwangen University, Robert-Gerwig-Platz 1, 78120, Furtwangen, Germany, sig@hs-furtwangen.de, *Claudia Breuer*, *Hendrik Wildebrand*, *Hans-Dietrich Haasis*

Logistics agglomerations play an important role within today's logistics networks. At the same time, they represent critical infrastructures. This means that a serious disturbance may lead to severe consequences. Consequently, there is a need for short-term decision support to identify possibilities of compensation for e.g. capacity failure in case of disruption. Methodically, we focus on decision matrices. These are integrated in a multi-agent-based distributed simulation environment. The empirical background is based on two freight villages representing a type of logistics agglomerations.

■ WD-26

Wednesday, 14:30-16:00
CC-A24

Multi-Criteria Decision Making and Applications 2

Stream: Multi-Criteria Decision Making and Environmental Management
Invited session

Chair: *King-Wah Pang*, Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, Hong Kong, lgtapang@polyu.edu.hk
Chair: *Mikhail Kuznetsov*, Moscow Institute of Physics and Technology, Russian Federation, mikhail.kuznecov@phystech.edu

1 - Multi-criteria Internet Shopping Optimization Problem

Jedrzej Musial, Computer Science and Communications Research Unit, University of Luxembourg, Luxembourg, jedrzej.musial@ext.uni.lu, *Jacek Blazewicz*, *Pascal Bouvry*

Internet Shopping Optimization Problem answers the question of how to manage a multiple-item shopping list over several shopping locations. ISOP problem is also very interesting from the practical point of view since it concerns shopping optimization for all the users of the Internet.

Multi-criteria ISOP introduces a model within a wider class of problems including additional variables and characteristics (e.g. expiration dates, product priorities). Computational experiments with greedy algorithms were conducted to check their applicability.

2 - A hybrid decision making model for labor flexibility

Erdem Aksakal, Industrial Engineering, Gazi University, Gazi University Faculty of Engineering, Maltepe, 06570, Ankara, Turkey, eaksakal@gazi.edu.tr, *Metin Dagdeviren*, *Ihsan Yüksel*

Globalization forces firms to consider the flexibility in human resources. Labor flexibility plays an important role in organizations in all parts. As a result of including the labor requirements in market requirements, labor flexibility and its factors become a considered cost value to the firms. Without labor flexibility, firms cannot take efficient and competent decisions. Under labor flexibility, 4 criteria will be examined and tried to find out that which one is the most affecting on labor flexibility.

3 - A knowledge based decision support system for warehousing management to improve operating efficiency

King-Wah Pang, Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, Hong Kong, lgtapang@polyu.edu.hk

Data mining approaches have been applied in information extraction for applications such as customers relationship management. In retailing industry, this technique is used to extract consumers buying behavior when customers frequently order similar products together, thus it is beneficial to store these correlated products nearby to reduce the order picking operating time and cost. We present a knowledge based decision support system for the storage location assignment that minimizes the total travel distances for both put-away and order picking operations.

■ WD-27

Wednesday, 14:30-16:00

CC-A25

Applications in Decision Making & Decision Analysis

Stream: Decision Support Systems

Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, Toulouse University, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

Chair: *Fatima Dargam*, SimTech Simulation Technology, Ries Strasse 120, 8010, Graz, Austria, F.Dargam@SimTechnology.com

1 - A decision making framework for a Colombian business group

Julián Benavides, Finance, Universidad Icesi, Cra 89 10-80, 760032, Cali, Valle, Colombia, jbenavid@icesi.edu.co, *Felipe Henao*

We develop a 7-steps framework to facilitate decision-making. It emerges from an ongoing project where different sources of data were gathered in order to identify the group's needs in decision-making. It combines approaches of strategic management, Soft OR and decision analysis. Activities such as problem formulation, definition of goals and SWOT add to define relevant criteria. Alternatives are ranked using scenario planning. 3 major corporate decisions have been successfully undertaken: Portfolio prioritization, partner selection for a new venture, and disposal of a failed initiative.

2 - Development of a territorial vulnerability indicator framework for cross-border risk analysis

Tina Comes, Institute for Industrial Production (IIP), Karlsruhe Institute of Technology (KIT), Hertzstr. 16, 76187, Karlsruhe, Germany, comes@kit.edu, *Marjorie Vannieuwenhuysse*, *Frank Schultmann*

To reduce vulnerability against natural disasters, decision makers must implement adequate risk management strategies. Since risks ignore national borders, the need for a transnational risk management arises: cooperation in cross-border areas must be reinforced, resources should be cumulated. By identifying key drivers and weaknesses, vulnerability analysis is the first step to an efficient risk management. We present an indicator framework for regional vulnerability analysis at cross-border scale and show how it is used as the basis for cross-border risk management.

3 - Requirements analysis and conceptual design of data warehouse

Dragana Becejski-Vujaklija, Faculty of Organizational Sciences, University of Belgrade, Jove Ilica 154, 11000, Belgrade, Serbia, draganab@fon.rs, *Milena Panovic*

The subject of paper is requirement analysis and conceptual design of data warehouses and proposal of general method for requirement analysis and conceptual design, which should be a methodological framework in implementing these phases within the overall data warehouse design. The general method for requirement analysis and conceptual design that combines current approaches is presents. Based on the research, the general steps that should be applied to specific projects in order to ensure a higher level of longevity as well as acceptance of the users are identified and described.

■ WD-28

Wednesday, 14:30-16:00

CC-A27

Seismic Modeling with OR

Stream: Recent Advances in Earthquake Studies

Invited session

Chair: *Aysegul Askan*, Civil Engineering, Middle East Technical University, Inonu Bulvari, 06531, Ankara, Turkey, aaskan@metu.edu.tr

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Ensemble methods for classification of volcano - seismic signals

Cindy Mora-Stock, Institut für Geowissenschaften, Christian-Albrechts-Universität, Otto-Hahn-Platz 1, 24118, Kiel, Schleswig-Holstein, Germany, cindy@geophysik.uni-kiel.de, *Cristian Bravo*

Volcanoes present different types of seismic activity depending on the source origin, such as tremors, long-period, and volcano-tectonic events. In Chile, Villarrica and Llaima are two of the most active volcanoes, constantly presenting seismicity that can be classified into these different types. To obtain a faster and reliable classification of future activity, pattern recognition ensemble methods were constructed using neural networks and support vector machines. The usefulness of the procedure applied to a real-life data set with 18 months of data from these volcanoes is presented.

2 - An integrated model for disaster mitigation and response decisions

Alper Döyen, Industrial Engineering, Bogazici University, Department of Industrial Engineering, Bogazici University, Istanbul, Turkey, doyenalper@gmail.com, *Necati Aras*, *Gülşay Barbarosoglu*

We propose a two-stage stochastic integer programming model for pre-disaster planning of mitigation and response decisions in an integrated manner. The mitigation decisions involve both building and transportation infrastructure retrofitting. The objective is to minimize the total cost of retrofitting, transportation and shortage of relief item demand. The deterministic equivalent of the model is formulated as an MILP and solved by Lagrangean heuristics. Test results show that the proposed heuristics show good performance for a wide range of problem instances.

3 - A data mining approach for modeling high-frequency spectral decay of ground motions for Northwestern Turkey

Fatma Nurten Sisman, Civil Engineering, Middle East Technical University, METU Üniversiteler Mah. Dumlupınar Blv. No:1,06800 Çankaya, Ankara, Turkey, fnsisman@metu.edu.tr, *Onur Pekcan*, *Aysegul Askan*

In this study, we use data mining methods on 114 strong ground motion records with different magnitudes, source-to-site distances, and site classes. We use both traditional regression techniques and data mining approaches to describe the relationships between kappa values and the aforementioned independent variables. We then compare the outcomes of data mining techniques with those of traditional methods to better highlight the important characteristics of the ground motion dataset. We express a regional Kappa model for Northwestern Turkey.

4 - Waveform tomography with numerical optimization techniques

Aysegul Askan, Civil Engineering, Middle East Technical University, Inonu Bulvari, 06531, Ankara, Turkey, aaskan@metu.edu.tr, *Volkan Akcelik*, *Jacobo Bielak*, *Omar Ghattas*

In this study, we present a recent waveform inversion method, based on least-squares optimization for solving the nonlinear full waveform inverse problem of determining the crustal velocity and intrinsic attenuation properties of sedimentary valleys in seismically active regions. The inverse problem of retrieving the crustal velocity is formulated as a constrained optimization problem. We present the method with inversions for sedimentary models of the San Fernando Valley in California, under SH-wave propagation. Finally, we discuss the sensitivity of the method to various model parameters.

■ WD-29

Wednesday, 14:30-16:00

CC-A29

Optimization and Data Mining (II)

Stream: Optimization and Data Mining

Invited session

Chair: *Minyoung Cho*, Korea University, Korea, Republic Of, needskyblue@korea.ac.kr

1 - The application of neural networks and linear programming discriminant models on the file fragment classification problem

Erich Wilgenbus, School of Computer, Statistical and Mathematical Sciences, North West University Potchefstroom Campus, Internal box 107, Private Bag X6001, North-West University Potchefstroom Campus, 2520, Potchefstroom, South Africa, erichfw@gmail.com, *Hennie Kruger*, *Tiny Du Toit*

The file fragment classification problem is of importance in network and computer forensics. This classification problem requires prediction of the correct file type to which a given file fragment belongs. Several approaches have been proposed in literature. This paper compares the use of neural networks and linear programming discriminant models to solve this binary classification problem. This multi-class problem is solved using a sequence of binary neural network and linear programming classification models. The results of empirical experimentation will be presented.

2 - Clustering anthropometric data addressed to the clothing industry

Teresa Leon, Statistics and OR, Universitat de Valencia, Dr. Moliner 50, 46100, Burjassot, Spain, teresa.leon@uv.es, *Guillermo Vinue*, *Guillermo Ayala*, *Sandra Alemany*, *Juan Domingo*

A 3D anthropometric survey of the female population was conducted in Spain by the Spanish Ministry of Health. Its aim was to generate anthropometric data addressed to the clothing industry. A sample of 10,415 Spanish females from 12 to 70 years old randomly selected was measured using a 3D body scanner and 95 anthropometric measures were obtained. We explore this dataset using cluster analysis techniques. We use a dissimilarity measure based on McCulloch et al's. We modify the original measure, which is merely based on the sum of squared discrepancies over each individual feature, by taking into account the user's opinion, using an OWA operator.

3 - Fault Classification using Data Mining Technique for Semiconductor Process Monitoring

Minyoung Cho, Korea University, Korea, Republic Of, needskyblue@korea.ac.kr, *Jonghyuck Park*, *Jun Seok Kim*, *Sung-Shick Kim*, *Jun-Geol Baek*

Process control is essential to operating in the semiconductor process efficiently. This paper considers fault classification of semiconductor cyclic signal for process control and monitoring. In general, process signal usually take the different pattern depending on different causes of fault. Fault classification by causes of faults could improve the process control through a rapid diagnosis. This paper proposes the method that can classify fault causes as each one class. Data-Mining Technique such as Neural-network, SVM, Average distance, k-NNDD, Hotelling T2 are used to perform the method.

■ WD-31

Wednesday, 14:30-16:00

CC-A33

OR and Ethics II

Stream: OR and Ethics

Invited session

Chair: *Cristobal Miralles*, Depto. Organización de Empresas, Universidad Politecnica de Valencia, Cami de Vera s/n, 46022, Valencia, Spain, cmiralles@omp.upv.es

1 - Identifying the upper age limit to extend screening for breast cancer in england and wales

Rachid Rafia, HEDS, University of Sheffield, ScHARR, Regent court, 30 Regent street, S14DA, Sheffield, United Kingdom, r.rafia@sheffield.ac.uk, *Alan Brennan*, *Jason Madan*, *Lynda Wyld*, *Karen Collins*

A mathematical model that allows the impact of screening policies on breast cancer diagnosis and subsequent management to be assessed was constructed to evaluate the optimal upper age for a breast cancer screening policy. The model has two parts - a natural history model of the progression of breast cancer up to discovery, and a post-diagnosis model of treatment, recurrence and survival. This study suggests that an extension of the current NHSBSP upper age limit for invitations from 69 to 78 would represent a cost-effective use of NHS resources.

2 - Multi-criteria decision making with criteria values estimated from survival data: a case study in heart failure

Jing Zhao, Department of Epidemiology, University Medical Center Groningen, PO Box 30.001, 9700 RB, Groningen, Netherlands, j.zhao.5@student.rug.nl, *Douwe Postmus*, *Hans Hillege*

Clinical decision making is often based on assessing the patient's absolute risk of experiencing a disease event. When more than one event is considered, the problem is complicated by dependencies between different events and criteria value trade-offs. The stochastic multi-criteria acceptability analysis method enables to take into account the inter-criteria dependencies and identify the value trade-offs through Monte Carlo simulation. In this presentation, we show how a multi-criteria decision model can be constructed with the measurements estimated from a survival analysis.

3 - Complexity of decision making with multiple stakeholders: a case study.

Cristobal Miralles, Depto. Organización de Empresas, Universidad Politecnica de Valencia, Cami de Vera s/n, 46022, Valencia, Spain, cmiralles@omp.upv.es, *Alysson Costa*, *Maria Antónia Carravilla*

Complexity theory has been used extensively in the field of strategic management to understand how organizations or firms adapt to their environments. Complementary, the CSR paradigm brings a wider perspective of the decision making process where different stakeholders should be considered. Starting from a typical optimization problem, this case study aggregates pieces of information that consecutively increase the complexity of decision making; analyzing carefully those variables that influence the decision and the stakeholders and values in conflict. Thanks to: CORSARI MAGIC DPI2010-18243.

■ WD-32

Wednesday, 14:30-16:00

CC-A34

DEA and Performance Measurement: Applications 7

Stream: DEA and Performance Measurement (contributed)

Contributed session

Chair: *Hanns de la Fuente*, Facultad de Ciencias Económicas y Administrativas, Pontificia Universidad Católica de Valparaíso, Avenida Brasil 2950, 6 Piso, 2340025, Valparaíso, Valparaíso, Chile, hanns.delafuente@ucv.cl

1 - Measuring the efficiency and productivity change in Global Telecom Operators

Chrysovaladis Prachalias, Economics Department, Athens University, Proairesiou 8, 11636, Athens, Greece, valadisp@gmail.com, *Rajiv Banker*

The Liberalization of Telecommunications Markets in combination with the globalization of economies created new operational conditions of former state owned telecommunications operators, challenges and enterprising occasions. The aim of this paper is to assess the efficiency and productivity change in Global Telecom Operators after their transformation. The input oriented Data Envelopment Analysis is applied to the data of former public telecommunication operators for the period of 2002-2007.

2 - Returns to Scale and Incentive Regulation in Brazil Electricity Distribution Industry

Ana Lopes, CEPEAD, Federal University of Minas Gerais - UFMG, Brazil, av. Antonio Carlos, 6627, Face Sala 4042, 31270901, Belo Horizonte, Minas Gerais, Brazil, analopes.ufmg@gmail.com, *Rajiv Banker*

We address the empirical question of maintaining returns to scale assumption when using DEA models in incentive regulation. Although the complete specification of a production relationship between all inputs, outputs and environmental variables may exhibit NDRS or CRS for a local monopoly, we prove that the estimated production function will necessarily exhibit VRS with a region of decreasing returns in the simpler empirical abstraction. Data from 28 Brazilian electricity distribution companies also statistically rejects the NDRS assumption proposed by the regulator.

3 - Performance measurement in the marketing productivity in services. An application to the U.S. financial sector using stochastic frontier models

Hanns de la Fuente, Facultad de Ciencias Económicas y Administrativas, Pontificia Universidad Católica de Valparaíso, Avenida Brasil 2950, 6 Piso, 2340025, Valparaíso, Valparaíso, Chile, hanns.delafuente@ucv.cl

The literature on marketing productivity shows the absence of measurements, especially in the case of quantitative measures and in the measurement of the influence of marketing assets. This paper applies the Theoretical Model of Marketing Productivity (MTPM) in the case of U.S. financial sector. The results show decreasing technical efficiency levels, and demonstrate the positive influence of total assets, administrative staff and sales growth on the productivity of marketing and a negative influence of investments in marketing and labor costs on the productivity of marketing.

4 - Efficiency evaluation and analysis of Third Party Logistics in Brazil

Mariana Almeida, Production engennig, Escola de Engenharia de Sao carlos, Avenida Trabalhador Sãoocarlense, 400 - Centro, 13566-590, Sao Carlos, Sao Paulo, Brazil, almeidamariana@yahoo.com, *Luis Oliveira*

This paper deals with the efficiency evaluation and analysis of 44 Third Party Logistics working in Brazil, using Data Envelopment Analysis — DEA for this purpose. The DEA model used considers variable returns to scale, since the analyzed companies have diversified sizes, and oriented to maximize their outputs. The use of variable selection techniques was critical to reach a subset of variables with greater representativeness for the system. As the main practical result, it was possible to identify the best players, regarding the efficiency of production processes and the returns to scale.

■ WD-33

Wednesday, 14:30-16:00

CC-A37

Optimization Modeling II

Stream: Software for OR/MS

Invited session

Chair: *Bjarni Kristjansson*, Maximal Software, Ltd., Boundary House, Boston Road, W7 2QE, London, United Kingdom, bjarni@maximalsoftware.com

Chair: *Robert Fourer*, Industrial Engineering and Management Sciences, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu

1 - Alternatives for Scripting in Conjunction with an Algebraic Modeling Language for Optimization

Robert Fourer, AMPL Optimization, 2521 Asbury Avenue, 60201-2308, Evanston, IL, United States, 4er@ampl.com

Optimization modeling languages are fundamentally declarative, yet successful languages also offer ways to write scripts or programs. What can scripting in a modeling language offer in comparison to modeling in a general-purpose scripting language? Some answers will be suggested through diverse examples in which the AMPL modeling language is applied to parametric analysis, solution generation, heuristic optimization, pattern enumeration, and decomposition. Concluding comments will touch on the complexity of scripts seen in practical applications, and on prospects for further improvements.

2 - CMPL - Coliop|Coin Mathematical Programming Language

Mike Steglich, University of Applied Sciences Wildau, Germany, mike.steglich@th-wildau.de

CMPL is a mathematical programming language and a system for mathematical programming and optimization of linear optimization problems. CMPL is a COIN-OR project initiated by the Technical University of Applied Sciences Wildau and the Institute for Operations Research and Business Management at the Martin Luther University Halle-Wittenberg. This talk will begin with an overview about the language, followed by the description of some advanced modelling techniques. Finally, we will present the interaction between CMPL and selected solvers.

■ WD-35

Wednesday, 14:30-16:00

CC-A41

Recent Advances in Statistics

Stream: Computational Statistics

Invited session

Chair: *Pakize Taylan*, Mathematics, Dicle University, 21280, Diyarbakır, Turkey, ptaylan@dicle.edu.tr

Chair: *Elcin Kartal Koc*, Statistics, Middle East Technical University, Department of Statistics, No:234, 06800, Ankara, Turkey, kartalelcin@gmail.com

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - A simulation study to compare conditional and normalized residuals in diagnostic checking

Mehmet Güray Ünsal, Statistics, Gazi University, Gazi University Science Faculty, Statistics Department, 06100, Ankara, Turkey, mgunsal@gazi.edu.tr, *Resat Kasap*

In this study, a simulation study has been done for comparing the conditional and normalized residuals in diagnostic checking in Box-Jenkins Modelling Process. Firstly, it was given basic information about different types of residuals then a simulation study has been given to show different decision cases when the conditional and normalized residuals were considered in diagnostic checking.

2 - Statistical Analysis of Narrative Sequences

Fatma Selcen Phelps, ABEMIS, Westminster College, 501 Westminster Ave, 65251, Fulton, MO, United States, fsphelps@yahoo.com, *William Guinee*, *Eugene Johnson*

This cross-disciplinary study extends the benefits of analytics to the realm of research in the social sciences, specifically the detection of an underlying "narrative grammar" in Alcoholics Anonymous meetings. Binomial distributions, and distributions estimated by simulating a large number of meetings with the same parameters as those that were observed, allow us to test the hypothesis that there is an underlying narrative sequence in AA speeches, which allows the audience to vicariously experience giving up alcohol repeatedly, as a turbulent story with a satisfactory resolution.

■ WD-36

Wednesday, 14:30-16:00

CC-A43

Technological change and productivity: permanent features of population health

Stream: Occupational Health & Wellbeing

Invited session

Chair: *M. Harvey Brenner*, School of Public Health, Department of Behavioral and Community Health, University of North Texas Health Science Center, 3500 Camp Bowie Blvd., EAD-711A, 76107, Fort Worth, TX, United States, harvey.brenner@unthsc.edu

Chair: *Elena Andreeva*, Berlin University of Technology, ACK-185, Ackerstr. 76, 13355, Berlin, Germany, elan@ifg.tu-berlin.de

1 - Large-scale organisational downsizing and workers' health during the global crisis of the last decade

Elena Andreeva, Berlin University of Technology, ACK-185, Ackerstr. 76, 13355, Berlin, Germany, elan@ifg.tu-berlin.de

During the recent global economic crisis, enterprises have introduced a variety of strategies for managing the "surplus" employees. This paper addresses the issues of identifying and understanding the consequences of such strategies, first of all, with respect to health responses of workers affected by the large scale downsizing. We consider the current information needs in occupational health research and discuss factors which can potentially modify the patterns of health responses in the European context.

2 - Macroeconomic influences on life expectancy in advanced industrialized countries

M. Harvey Brenner, School of Public Health, Department of Behavioral and Community Health, University of North Texas Health Science Center, 3500 Camp Bowie Blvd., EAD-711A, 76107, Fort Worth, TX, United States, harvey.brenner@unthsc.edu

Macroeconomic policy is a crucial component in the health of industrialized countries. Key findings are: GDP per capita in purchasing power parity is the most important predictor of increased life expectancy in industrialized countries. The damaging effect of income inequality can be seen only in age groups under 45. The replacement of manufacturing employment by services employment is the second most important factor beneficially influencing life expectancy. Decreased labor force participation is a significant source of increased mortality in middle age.

3 - Health policy amidst financial austerity — the case of Hungary

Péter Mihályi, University of Pannonia (Veszprém) and Institute of Economics, Hungarian Academy of Sciences, 8200, Budapest, Hungary, peter@mihalyi.com

In early 2009, WHO advised governments not to cut health expenditures during the global financial crisis. When the present Hungarian government took office in mid-2010, its programme didn't envisage any major change. However, in the context of the Bismarckian social insurance reform, the policies aimed at cutting pension expenditures at the end resulted in totally unexpected cuts in health expenditures as well as in drastic health policy shifts. The paper will describe in details how the model implanted in 1992 was replaced by the NHS model within a few months without any policy discussion.

■ WD-37

Wednesday, 14:30-16:00

CC-Act

Operations Research in Health Care II

Stream: Health Care Management

Invited session

Chair: *Sally Brailsford*, University of Southampton, School of Management, SO17 1BJ, Southampton, United Kingdom, s.c.brailsford@soton.ac.uk

1 - Combining Discrete Event, Agent Based and System Dynamics Simulation to explore the Health and Social Care implications of Age Related Macular Degeneration

Joe Viana, School of Social Science, University of Southampton, University Road, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, J.Viana@soton.ac.uk, *Andrew Amos Channon*, *Sally Brailsford*

Age Related Macular degeneration (ARMD) causes sight loss, a new treatment requiring monthly injections has increased the demand on Ophthalmology departments (OD), which is compounded by the UK's ageing population. A Discrete Event Simulation (DES) model of an OD has been produced to evaluate performance. An Agent Based model has been combined with the DES model, representing the need and receipt of social care of individuals. An agent's sight is captured by a System Dynamics (SD) model of each eye. The purpose of the models is to explore how social and health care interact.

2 - Modelling the dental workforce in Sri Lanka

Sally Brailsford, University of Southampton, School of Management, SO17 1BJ, Southampton, United Kingdom, s.c.brailsford@soton.ac.uk, *Dileep de Silva*

This talk presents a system dynamics simulation model of the supply and demand for dental care in Sri Lanka. The model represents the flows of dentists through the complex recruitment and career progression phases through to retirement. This is augmented by a demand model, which combines empirical data on the time required to carry out various dental procedures with secondary clinical and demographic data to project the future incidence of different dental conditions. The overall supply-demand model enables policy-makers to test various policies for staffing, training and recruitment.

3 - Managing limited bed capacity at hospitals

Burhaneddin Sandikci, Booth School of Business, University of Chicago, 5807 South Woodlawn Avenue, 60637, Chicago, IL, United States, burhan@chicagobooth.edu, *Tom Best*, *Don Eisenstein*, *David Meltzer*

To address adverse effects of limited inpatient bed capacity, an academic medical center received government dispensation to partition its inpatient beds into mini-hospitals or wings. Each wing has a specific designation of the types of patients it can admit, and the number of beds it is allocated. A patient requesting hospital services can be admitted only if a bed is available in the appropriate wing. We present a model to help hospital administrators make wing formation decisions and a novel approach to solve the hard problem of forming wings along with a rich set of numerical results.

■ WD-38

Wednesday, 14:30-16:00

HH-Colombus

Multiobjective Optimization and Water Management

Stream: Multiobjective Optimization

Invited session

Chair: *Javier Cano*, Rey Juan Carlos University, Spain, javier.cano@urjc.es

Chair: *Angel Udias*, Rey Juan Carlos University, Spain, angelluis.udias@urjc.es

1 - Pareto Data Mining based decision for Global Water Restoration Decision Process

Angel Udias, Rey Juan Carlos University, Spain, angelluis.udias@urjc.es, *Andrés Redchuk*, *Javier Cano*, *Lorenzo Lgalbiati@gencat.cat*

Sustainability of water resources has become a challenging problem worldwide. We present a hydroinformatics management tool designed to find an optimal Program of Measures (PoMs) to achieve Water Framework Directive objectives. It combines 1) a water quality model (to simulate effects of PoMs) 2) a Multi-Objective Evolutionary Algorithm to identify efficient trade-offs between PoMs' costs and water quality 3) data-mining of the Pareto optimal set to extract knowledge from optimal decisions in a usable form. We have applied our methodology in inner Catalan watersheds with promising results.

2 - A decision support system for the multiobjective management of the Kwanza river

Kiombo Jean Marie, Universidad Rey Juan Carlos, 28943, madrid, Spain, k_jean_marie@yahoo.com.br, *Javier Cano*, *David Rios-Insua*

Water management has become a challenging problem worldwide, especially in developing countries, due to the growing scarcity of natural water resources; a demographic explosion in many urban settlements; and the inherent increase in the demand of energy and natural fresh water. We provide a model for the multiobjective management of the Kwanza River, taking into account uncertainty in various involved processes, and the need to plan over a long period of time, and the presence of several conflicting interests. We describe also a decision support system implementing our model.

3 - Role of carbon capture technologies in the Spanish industry in 2030 under a CO2 reduction scenario using the TIMES-Spain energy optimisation model

Diego García, Energy System Analysis Unit, CIEMAT, Av. Complutense 40, E28040, Madrid, Madrid, Spain, diego.garcia@ciemat.es, *Helena Cabal*, *Machteld Van Den Broek*, *Yolanda Lechón*, *Antonio Alonso-Ayuso*

In this work, a techno-economic assessment of CO2 capture technologies for relevant industrial sectors (cement, steel, and oil refineries) is presented. Main capture techniques are described, such as pre-combustion, oxyfuel combustion, and postcombustion. Introducing these technologies in the TIMES-Spain energy optimization model results show that, under a CO2-reduction scenario (20% by 2020 and 30% by 2030 below 1990 levels), emissions in the cement sector decrease 73% comparing to the BaU scenario at the end of the period. Nevertheless, there is no CO2 capture in the other sectors.

■ WD-39

Wednesday, 14:30-16:00

HH-Cousteau

Graph and Digraph Searching Games

Stream: Graph Searching

Invited session

Chair: *Nancy Clarke*, Mathematics and Statistics, Acadia University, 12 University Avenue, B4P2R6, Wolfville, Nova Scotia, Canada, nancy.clarke@acadiau.ca

1 - On Constructive Characterization of Forbidden Minors for k-Searchable Graphs

Oznur Yasar Diner, Informations Technology, Kadir Has University, Cibali Kampusu, Balat, 34083, Istanbul, Turkey, oznur.yasar@khas.edu.tr

Edge searching is a pursuit evasion game played on graphs. The aim is to find a search strategy which ensures that all edges of the graph are secure. The least number of searchers needed is the edge search number of the graph, denoted $s(G)$. A major problem is to characterize the k -searchable graphs, those graphs G such that $s(G)$ is at most k . We can characterize the k -searchable graphs by giving the complete list of forbidden minors. Such sets are only known when k is less than four. In this talk we discuss how clique sum operations give rise to constructively obtain some forbidden minors.

2 - LIFO-search on digraphs

Paul Hunter, Department of Computer Science, University of Oxford, Wolfson Building, Parks Road, OX1 3QD, Oxford, United Kingdom, paul.hunter@cs.ox.ac.uk

Graph searching games on digraphs are notoriously badly behaved. Different notions of connectivity lead to different parameters, monotonicity is rare and tight min-max theorems are even rarer. We present a searching game that characterizes the cycle-rank of a digraph - a measure that has been around for several decades - and show that all standard variations of the game (invisible/visible, monotone/non-monotone, strongly-connected/directed paths) coincide, yielding an exact min-max theorem for cycle-rank.

3 - Eternal Domination- being ever watchful

Stephen Finbow, St Francis Xavier University, Canada, sfinbow@stfx.ca

Consider a network under constant surveillance thru a noisy channel. Searchers are stationed throughout the network so that they may be quickly dispersed to investigate any suspicious activity. To investigate a searcher is presumably moved out of position and hence the other searchers may also have to move to ensure any additional activity on the network can be inspected. When the searchers are able to respond indefinitely, the network is said to be eternally dominated. We will focus on recent results and conjectures regarding grid graphs.

■ WD-40

Wednesday, 14:30-16:00

HH-Livingstone

Modelling sustainable production systems

Stream: SD Modelling in Sustainable Development

Invited session

Chair: *Francois Guerrin*, UPR Recyclage & Risque, Inra & Cirad, Station de la Bretagne - BP 20, 97408, Saint-Denis, France, francois.guerrin@cirad.fr

1 - Modeling and prioritizing requirements for designing sustainable supply chains

Anjali Awasthi, CIISE, Concordia University, H3G 1M6, Montreal, Quebec, Canada, awasthi@ciise.concordia.ca, *ZhongHua Zhang*

We present a technique called Sustainable Function Deployment developed on the concept of Quality Function Deployment to model customer and technical requirements, establish relationship between them and prioritize them for developing sustainable supply chains. The customer requirements for sustainable supply chains are obtained through Voice of the Customer surveys and the technical requirements using systematic literature review. In addition, priority matrix and cause-and-effect diagram techniques are applied to screen the requirements. Numerical application is provided.

2 - A fuzzy farming efficiency estimation model for agricultural development

Tomas Balezentis, Lithuanian Institute of Agrarian Economics, Lithuania, tomas@laei.lt, *Alvydas Balezentis*

Reaching an economic efficiency is the foremost objective of agricultural development. The paper focuses on development of the multi-criteria benchmarking of farming efficiency across different farming types in Lithuania. In this study time series data from the FADN were analyzed. The fuzzy MULTIMOORA method was applied on the selected indicators identifying farming efficiency in terms of land, labour, and capital exploitation. The most efficient as well as least efficient farming types were identified. Such analysis provides a rationale for strategic decision making.

3 - Integrating multidisciplinary knowledge into simulation models to organize organic wastes recycling in agriculture

Francois Guerrin, UPR Recyclage & Risque, Inra & Cirad, Station de la Bretagne - BP 20, 97408, Saint-Denis, France, francois.guerrin@cirad.fr, *Moussa NDienor*, *Heriniaina Ramahefarison*, *Virginie Parnaudeau*, *Jean-Marie Paillat*

Substituting chemical fertilizers by organic wastes is a way to improve agriculture sustainability. It requires designing new management scenarios of agricultural production systems based on the knowledge available on their biophysical and managerial components. Simulation models representing those systems as productive units spread over a territory together with data from agronomical experiments are jointly used to assess the performances of the scenarios against agronomical and environmental criteria. This approach is illustrated on two examples in periurban areas of Senegal and Madagascar.

■ WD-41

Wednesday, 14:30-16:00

HH-Heyerdahl

Applications of Control Theory in Dynamical Systems

Stream: Control Theory & System Dynamics (contributed)

Contributed session

Chair: *Ioan Radu Morar*, Automation Dept, Technical University of Cluj-Napoca, Ghe Baritiu Street 26-28, room 350, 400027, Cluj-Napoca, Cluj, Romania, radu.morar@gmail.com

1 - A model to particles flow composed by two metastable potentials

Elso Drigo Filho, Department of Physics, Sao Paulo State University, Rua Cristovao Colombo 2265, 15054-000, Sao Jose do Rio Preto, Sao Paulo, Brazil, elso@ibilce.unesp.br, *Marcelo Tozo de Araujo*

A fluid flow through a tube can promote a sedimentation of particles which reduces the diameter of the tube. This phenomenon is particularly important to oil transport which induces the deposition of paraffin in the inner wall of the tube. In order to simulate this process, we suggest a model that involves two time dependent metastable potentials. The solution of a Fokker-Planck equation for each potential is the input to describe the time dependence of the total flow. Numerical results for different values of parameters are presented.

2 - The mechatronic system optimization with use of genetic programming

Marian Klucik, Institute of Control and Industrial Informatics, Slovak University of Technology, Ilkovičova 3, 812 19, Bratislava, Slovakia, klucik2@gmail.com, *Ladislav Jurisica*, *Anton Vitko*, *Peter Paszto*, *Jaroslav Hanzel*

The aim of this article are the desired properties of mechatronic systems, and the desired properties of mechatronic systems design. In the design process is essential to develop the method for search the optimal system structure and parameters, which ensures sufficient synergy between system components. One means of solving this difficult problem is to use genetic programming. With this method it is possible to solve the optimization problem with consideration of the large number of criteria. In the conclusion is proposed one case of control system optimization of mechatronic system.

3 - Fault-tolerant Control Systems in Stability and Recovery control Of Damaged Aircraft

M. Navabi, Dynamics and Control, Shahid Beheshti University, GC, 123, thr, Iran, Islamic Republic Of, sciences.edu@gmail.com, *M. Radaei*

In the emergency cases where conventional flight controls are lost, an alternative means of control is needed to maintain a certain level of stability and performance to avoid potential crashes and accidents. In this paper two classified inter-control-disciplinary of fault-tolerant control systems are introduced: 1) passive fault-tolerant control based on robust control techniques, and 2) active fault-tolerant control using direct and indirect adaptive control, reconfigurable control, and eigenstructure assignment technique for different damage scenarios. Simulation results are discussed.

4 - Modeling an Unmanned Aerial Vehicle (Quadrotor)

Ioan Radu Morar, Automation Dept, Technical University of Cluj-Napoca, Ghe Baritiu Street 26-28, room 350, 400027, Cluj-Napoca, Cluj, Romania, radu.morar@gmail.com, *Ioan Nascu*

In this paper the authors describe the process of obtaining a model for an Unmanned Aerial Vehicle (UAV) designed by the Parrot, called AR.Drone. The aim of this process is to find a simple model that can approximate as good as possible the non-linear dynamics of the real model. A simulator was designed in computational software and tested, with a purpose of developing control techniques and strategies. Simulation results are presented at the end of the paper

ACKNOWLEDGMENT: TUCN, research supported by the project POSDRU/107/1.5/S/78534

■ WD-42

Wednesday, 14:30-16:00

BW-Amber

Stochastic Modelling in Computational Biology and Environmental Sciences

Stream: Stochastic Modeling and Simulation in Engineering, Management and Science

Invited session

Chair: *Erik Kropat*, Department of Computer Science, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577, Neubiberg, Germany, erik.kropat@unibw.de

Chair: *Zeev (Vladimir) Volkovich*, Ort Braude Academic College, Yehiam 6, 21823, Karmiel, Israel, zeev@actcom.co.il

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Earthquake Scenario Reduction by Symmetry Reasoning

Steven Prestwich, Computer Science, Cork Constraint Computation Centre, University College, Cork, Ireland, s.prestwich@cs.ucc.ie

A recently identified problem is that of finding an optimal investment plan for a transportation network, under the assumption that an earthquake or other disaster may destroy each link in the network with a given probability. A network based on the Istanbul highway system has a billion scenarios, but it has been found that sampling a million scenarios gives reasonable results. In this work we use symmetry reasoning to reduce the number of scenarios to a few thousand, and Under an additional but realistic assumption we further reduce this number to a few hundred.

2 - Modelling the meteorological effects on air temperature for Konya city in Turkey: the approaches of quantile regression and quantile regression neural networks

İlkay Altındag, Statistics, Selçuk University, Selcuk University Science Faculty Department of Statistics Kampus Selcuklu/KONYA, Konya, Turkey, ialtindag@selcuk.edu.tr, *Nimet Yapici Pehlivan*

Globalization forces firms to consider the flexibility in human resources. Labor flexibility plays an important role in organizations in all parts. As a result of including the labor requirements in market requirements, labor flexibility and its factors become a considered cost value to the firms. Without labor flexibility, firms cannot take efficient and competent decisions. Under labor flexibility, 4 criteria will be examined and tried to find out that which one is the most affecting on labor flexibility.

3 - Stochastic optimization methods in change-point detection

Tatiana Polushina, NTNU, Norway, tvpolushina@inbox.ru, *Georgiy Sofronov*

The change-point problem arises in a wide variety of fields, including speech and image processing, seismology, industry and financial mathematics. Multiple change-point models are also important in many biological applications and, particularly, in analysis of DNA sequences. In this talk, we consider various stochastic optimization methods to change-point detection, using Monte Carlo simulation to find estimates of change-points as well as parameters of the process on each segment. We also demonstrate the methods for a realistic problem arising in computational biology.

4 - A randomness test based on the Minimal Spanning Tree approach

Zeev (Vladimir) Volkovich, Ort Braude Academic College, Yehiam 6, 21823, Karmiel, Israel, zeev@actcom.co.il

A stochastic model intended to evaluate the relative randomness of two given texts is offered. Pairs of samples, drawn from different texts, are compared. The relative randomness is measured via the resemblance of the samples in the pooled one when the mixture quality is represented by the total number of edges connecting points from different samples in the constructed minimal spanning tree. Under the homogeneity hypothesis, this amount is normally distributed. Numerical experiments exhibit the ability of the method to distinguish texts generated by different random sources.

■ WD-43

Wednesday, 14:30-16:00

BW-Granite

Emerging applications in finance and insurance

Stream: Stochastic Programming
Invited session

Chair: *Giorgio Consigli*, Mathematics, Statistics and Computer Sciences, University of Bergamo, Via dei Caniana 2, 24127, Bergamo, Italy, giorgio.consigli@unibg.it

1 - An application of institutional asset-liability management to a large P&C insurance company

Giorgio Consigli, Mathematics, Statistics and Computer Sciences, University of Bergamo, Via dei Caniana 2, 24127, Bergamo, Italy, giorgio.consigli@unibg.it, *Vittorio Moriggia*, *Gaetano Iaquina*, *Angelo Uristani*

Recent trends in the insurance sector have highlighted expansion of large insurance firms into asset management. In addition to their historical liability exposure, the growth of investment divisions has caused increasing exposure to market fluctuations. This has led to stricter risk management requirements as reported in the Solvency II 2010 study by the European Commission. We present an ALM model tested on a real-world case study, combining in a dynamic framework an optimal strategic asset allocation problem with risk capital and P&C business constraints for a large insurer.

2 - Multistage strategic asset allocation with alternative investments

Angelo Uristani, Mathematics, University of Bergamo, 20149, Bergamo, Italy, angelo.uristani@unibg.it, *Giorgio Consigli*, *Vittorio Moriggia*

In recent years, due to increasing market risk and low expected returns, investors are expanding their investment universe. The so-called alternative investments have become increasingly interesting since they provide good diversification benefits, despite their poor liquidity. In this work we present an ALM multi-stage problem which includes private equity and real estate along with more common investment classes such as stocks and bonds. The complex model specification and its numerical implications are analysed in detail.

3 - An Alternative Approach for Exponential Smoothing Method

Ali Sabri Taylan, Market Oversight, Turkish Derivatives Exchange, Vadeli Islem ve Opsiyon Borsasi A.S., Akdeniz Cd. Birsal Is Mrk. No:14 Kat:6, 35210, Izmir, Turkey, staylan@turkdex.org.tr, *Güçkan Yapar*

The original exponential smoothing has performed well in numerous empirical studies, and it is well established as an accurate and optimal forecasting method. However, there are two main problems about choosing the smoothing constant and starting value in exponential smoothing theory. In this study, we suggest an alternative method for smoothing constant and starting value. The modified method gives more weights than the classical method to most recent observations. The forecasting error is compared to the error in forecasts obtained by the original.

4 - Quadrangle Concept in Classification and Online Trading Algorithms

Stan Uryasev, Director of Risk Management and Financial Engineering Lab, University of Florida, FL 32611-6595, Gainesville, 303 Weil Hall, Florida, United States, Uryasev@ufl.edu, *Peter Tsyurmasto*

Quadrangle Concept in Risk Management provides a convenient tool for building new numerical approaches involving decision making in uncertain environment. We use Quadrangle for the development of new classification algorithms with application to the intraday trading strategies. We are interested in a simple trading strategy: "buy low and sell high" on daily basis. The position is closed in the end of the day. We are planning to use for solving the classification problem the CVaR-based Support Vector Machine implemented with Portfolio Safeguard (PSG) software.

■ WD-44

Wednesday, 14:30-16:00

BW-Marble

Information and Intelligent Systems II

Stream: Information and Intelligent Systems
Invited session

Chair: *Igor Kabashkin*, Transport and Telecommunication Institute, Lomonosova iela 1, Riga, Latvia, kiv@tsi.lv

Chair: *Hans Georg Zimmermann*, Corporate Technology CT T, Siemens AG, Otto-Hahn-Ring 6, 81730, München, Germany, Hans_Georg.Zimmermann@siemens.com

1 - E-Commerce & m-Commerce: A Specific Integrated Platform

David L. La Red Martínez, Informática, Universidad Nacional del Nordeste, 9 de julio 1449, (3400), Corrientes, Corrientes, Argentina, laredmartinez@gigared.com, *Valeria E. Uribe*, *Sofia J. Vallejos*

In recent years, the evolution of technology has given great leap. Internet, combined with telephone, becomes a means of social interaction that is currently present in all areas of daily life. One of the many applications of this integration occurs between the e-commerce and m-commerce, even with little development in the Argentina (except mobile banking sector). The developed platform supports e-commerce and m-commerce for a pharmaceutical entity, manages information about the client and the marketing of products and over-the-counter medications.

2 - Text mining and visualization with self-organizing maps

Pavel Stefanovič, Vilnius University, Institute of Mathematics and Informatics, Akademijos str. 4, LT-08663, Vilnius, Lithuania, pavel.stefanovic@mii.vu.lt, *Olga Kurasova*

The aim of the research is text mining and visualization with self-organizing maps. Text to Matrix Generator toolbox was used to construct term-document matrices from text collections. The influence of different options has been investigated. A self-organizing map has been used for text clustering and graphical representation (visualization). A comparative analysis has been made with 40 different articles from four areas: artificial neural network, bioinformatics, optimization and self-organizing maps. The quantization and topographic errors have been measured to estimate the SOM quality.

3 - Design of architecture of embedded system for optimal reliability of complex system

Igor Kabashkin, Transport and Telecommunication Institute, Lomonosova iela 1, Riga, Latvia, kiv@tsi.lv

The digital systems provide higher productivity and greater flexibility, but it is also accepted that they cannot be fault-free. The role of built in test embedded system in electronics has grown in prominence with the advances in system complexity. The architecture of an embedded system is an abstraction, that typically doesn't show detailed information such as software source code or hardware circuit design. Our paper describes the approach for design of optimal architecture of embedded system with minimal cost of reliability identification during life cycle of complex systems.

4 - Selecting Ore for an Iron Ore Mine

Jim Everett, Centre for Exploration Targeting, University of Western Australia, 49 Goldsmith Rd, 6009, Nedlands, WA, Australia, jim.everett@uwa.edu.au

Interpolated drilling data provide assay estimates for each block in the modeled mine, identifying it as ore or waste, depending on its iron and contaminants (such as silica, alumina and phosphorus). Industry practice accepts a block as ore if its grade lies within a quadrant, above a cut-off in iron and below cut-off in each contaminant. A composite cut-off function is shown preferable to quadrant selection. The method maximizes the yield of ore of required product grade and matches marginal cost to marginal value, optimizing the resource net value. It can apply to other mine types.

3 - An efficient way to find an optimal power series for charging electric vehicles

Jacint Szabo, Business Optimization, IBM Research Lab, Zurich, Säumerstrasse 4, 8803, Rüschlikon, Switzerland, jsz@zurich.ibm.com, *Olivier Gallay*, *Olle Sundstrom*

The charging of electric vehicles (EV) is usually managed by charging service providers, who buy electric power from the retailer to satisfy the demand of the EV pool in such a way that the forecasted consumption profiles of the EV's are respected, and power grid load constraints are taken into account. In this contribution we present an efficient way to calculate an optimal power series over the considered time horizon.

4 - Multi-Period Production Planning Under Non-Compliance Risk

Marco Laumanns, IBM Research - Zurich, 8803, Rueschlikon, Switzerland, mlm@zurich.ibm.com, *Alwin Haensel*, *Ban Kawas*, *Eleni Pratsini*, *Steven Prestwich*, *Catalin Stefan Tiseanu*

We address a production planning setting for pharmaceutical companies under the risk of failing quality inspections undertaken by the regulatory authorities. After reviewing the single-period problem of maximizing the worst-case revenue and the worst-case expectation, different stochastic programming and dynamic programming formulations for the multi-period version are discussed. We show how decision-dependent probabilities, which are due to risk transfer between products of the same site, can be handled by solving a MINLP for each state in the multi-period dynamic program.

■ WD-45

Wednesday, 14:30-16:00

BW-Water

IBM Research Applications

Stream: IBM Research Applications
Invited session

Chair: *Marco Laumanns*, IBM Research - Zurich, 8803, Rueschlikon, Switzerland, mlm@zurich.ibm.com

1 - Planning under Uncertainty — Case Study: Energy Cost Minimization for a Water Treatment and Distribution Network.

Susara van den Heever, Research, IBM, Ireland, susarava@ie.ibm.com, *Niall Brady*, *Olivier Verscheure*, *Kate Lehane*

We address the problem of planning under uncertainty where the planning decisions are represented by binary variables. As a case study, we consider the minimization of energy costs due to pumping for a water treatment and distribution network, where energy prices vary during the day due to factors such as wind. The actual prices are only known several days after the planning decisions have been made. We present a Mixed Integer Linear Programming model, as well as two approaches to capture the uncertainty, namely a stochastic programming approach and a heuristic scenario hedging approach.

2 - Nonlinear optimization for decision problems in water distribution networks under uncertainty

Martin Mevissen, IBM Research Dublin, IBM Technology Campus, Damastown Industrial Park, Mulhuddart, 15, Dublin, Ireland, martmevi@ie.ibm.com

Decision problems in water distribution networks are challenging due to both, nonlinearity in the hydraulic models and demand uncertainty over the network. We propose an approach for pressure optimization and optimal design decisions over the network, which is based on a novel quadratic model for the nonlinearity and constructs demand uncertainty sets from given sampled data. We use convex optimization and MINLP methods to obtain an optimal solution, which is robust with respect to demand uncertainty and based on an accurate approximation for a real world water distribution network.

Wednesday, 16:30-17:30

■ WE-01

Wednesday, 16:30-17:30

RB-Alfa

IFORS Distinguished Lecture: Professor Ralph E. Gomory

Stream: Keynote, Tutorial and Plenary Lectures
Plenary session

Chair: *Dominique de Werra*, EPFL, 1015, Lausanne,
dewerra@gmail.com

1 - Forty Years of Corner Polyhedra

Ralph E. Gomory, Stern School, New York University, 260
Douglas Road, 10514, Chappaqua, New York, United States,
gomory@sloan.org

This talk will discuss the evolution of corner polyhedra from their beginnings in the study of Stock Cutting problems. We will discuss both their practical and theoretical aspects. We will see that corner polyhedra are by themselves the simplest integer programs and therefore might be expected to be more amenable to analysis than the more complex I.P. s of which they are always a part. This expectation is fulfilled by some theoretical insights gained from corner polyhedra. The practical linkage stems from the fact that cutting planes for corner polyhedra are cutting planes for the complex practical problems of which they are a part. No knowledge of corner polyhedra is assumed in this talk and historical and personal aspects will be included throughout.

Actuarial Sciences and Stochastic Calculus

Invited

Ricardo Josa-Fombellida
Universidad de Valladolid
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Juan Pablo Rincon-Zapatero
Universidad Carlos III de Madrid
jrincon@eco.uc3m.es

Track(s): 19
3 sessions

Advanced Inventory Control and Pricing Strategies

Invited

Alf Kimms
University of Duisburg-Essen
alf.kimms@uni-due.de

Robert Klein
Universität Augsburg
robert.klein@wiwi.uni-augsburg.de

Track(s): 45
3 sessions

Analytic Hierarchy Process, Analytic Network Process

Invited

Josef Jablonsky
University of Economics Prague
jablon@vse.cz

Y. Ilker Topcu
Istanbul Technical University
ilker.topcu@itu.edu.tr

Track(s): 41
6 sessions

Applications of Location Analysis

Invited

Sibel A. Alumur
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Ioannis Giannikos
University of Patras
I.Giannikos@upatras.gr

Mercedes Landete
University Miguel Hernández of Elche
landete@umh.es

Track(s): 17
5 sessions

Arc Routing

Invited

Stefan Irnich
Johannes Gutenberg University Mainz
irnich@uni-mainz.de

Claudia Bode
Johannes Gutenberg University Mainz
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Track(s): 11
2 sessions

Boolean and Pseudo-Boolean Optimization

Invited

Endre Boros
Rutgers University
Endre.Boros@rutcor.rutgers.edu

Track(s): 8
4 sessions

Business Excellence in Logistics

Invited

Martin Josef Geiger
Helmut-Schmidt-University
m.j.geiger@hsu-hh.de

Track(s): 3
3 sessions

Combinatorial Optimization

Invited

Silvano Martello
University of Bologna
silvano.martello@unibo.it

Paolo Toth
University of Bologna
paolo.toth@unibo.it

Track(s): 4
7 sessions

Commodities and Financial Modeling

Invited

Rita Decclesia
Sapienza University of Rome
rita.decclesia@uniroma1.it

Ronald Hochreiter
WU Vienna University of Economics and Business
ronald.hochreiter@wu.ac.at

Yeliz Yolcu Okur
Middle East Technical University
yyolcu@metu.edu.tr

Track(s): 19
2 sessions

Computational Biology, Bioinformatics and Medicine

Invited

Jacek Blazewicz
Poznan University of Technology
jblazewicz@cs.put.poznan.pl

Metin Turkyay
Koc University
mturkay@ku.edu.tr

Giovanni Felici
Consiglio Nazionale delle Ricerche
giovanni.felici@iasi.cnr.it

Track(s): 37
4 sessions

Computational Statistics

Invited

Pakize Taylan
Dicle University
ptaylan@dicle.edu.tr

Gerhard-Wilhelm Weber
Middle East Technical University
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Track(s): 35
2 sessions

Container Terminal Operations

Invited

Iris F.A. Vis
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Christian Bierwirth
Martin-Luther-University Halle-Wittenberg
christian.bierwirth@wiwi.uni-halle.de

Ceyda Oguz
Koc University
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Track(s): 12
2 sessions

Continuous Location

Invited

Emilio Carrizosa
Universidad de Sevilla
ecarrizosa@us.es

Track(s): 18
3 sessions

Control Theory & System Dynamics (contributed)*Contributed**Richard Hartl*University of Vienna
richard.hartl@univie.ac.at**Track(s): 41****1 session****Convex Optimization***Invited**Aharon Ben-Tal*Technion-Israel Institute of
Technology
abental@ie.technion.ac.il*Marc Teboulle*Tel Aviv University
teboulle@math.tau.ac.il*Attila Gilanyi*University of Debrecen
gilanyi@math.klte.hu**Track(s): 23****4 sessions****Cooperative Game Theory***Invited**Mariana Rodica Branzei*"Alexandru Ioan Cuza" University
branzeir@info.uaic.ro*Sirma Zeynep Alparslan Gok*Faculty of Arts and Sciences,
Suleyman Demirel University
zeynepalparslan@yahoo.com**Track(s): 34****7 sessions****Cutting and Packing***Invited**José Fernando Oliveira*University of Porto
jfo@fe.up.pt*A. Miguel Gomes*INESC TEC, Faculdade de
Engenharia, Universidade do Porto
agomes@fe.up.pt**Track(s): 9 10****7 sessions****Data Confidentiality***Invited**Jordi Castro*Upc
jordi.castro@upc.edu*Juan José Salazar González*Universidad de La Laguna (Tenerife)
jjsalaza@ull.es**Track(s): 30****2 sessions****Data Mining and Decision Making***Invited**Lai-Soon Lee*Universiti Putra Malaysia
lee@math.upm.edu.my*Hsin-Vonn Seow*University of Nottingham- Malaysia
Campus*Hsin-**Vonn.Seow@nottingham.edu.my***Track(s): 24****1 session****Data Mining in Early Warning Systems***Invited**Inci Batmaz*Middle East Technical University
ibatmaz@metu.edu.tr*Gulser Koksall*Middle East Technical University
koksall@ie.metu.edu.tr*Antonio Rodrigues*University of Lisbon
ajrodrigues@fc.ul.pt**Track(s): 24****1 session****Data Mining in the Financial Sector***Invited**Vadim Strijov*Russian Academy of Sciences,
Computing Center
strijov@ccas.ru**Track(s): 20****4 sessions****Data Mining, Knowledge Discovery and Artificial Intelligence***Contributed**Vincent Mousseau*Ecole Centrale Paris
vincent.mousseau@ecp.fr**Track(s): 31****4 sessions****DEA and Performance Measurement***Invited**Dimitris Despotis*University of Piraeus
despotis@unipi.gr*Ozren Despic*Aston University
o.despic@aston.ac.uk*Meryem Duygun Fethi*University of Leicester
m.fethi@le.ac.uk*Ana Camanho*Universidade do Porto
acamanho@fe.up.pt*Vania Sena*Aston University
v.sena@aston.ac.uk**Track(s): 36****6 sessions****DEA and Performance Measurement (contributed)***Contributed**Elena Fernandez*Technical University of Catalonia
e.fernandez@upc.edu**Track(s): 29 30 32 35****8 sessions****Decision Making Modeling and Risk Assessment in the Financial Sector***Invited**Cristinca Fulga*Gheorghe Mihoc-Caius Iacob
Institute of Mathematical Statistics
and Applied Mathematics of
Romanian Academy
fulga@csie.ase.ro**Track(s): 20****5 sessions**

Decision Processes*Invited**Ahti Salo*

Aalto University School of Science
and Technology
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Alec Morton

London School of Economics
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Jeffrey Keisler

University of Massachusetts Boston
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Track(s): 27**8 sessions****Decision Support Systems***Invited**Pascale Zaraté*

Toulouse University
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Fatima Dargam

SimTech Simulation Technology
F.Dargam@SimTechnology.com

Rita Ribeiro

Uninova - CA3
rita.a.ribeiro@gmail.com

Track(s): 27**4 sessions****Demand and Supply in
Consumer Goods and Retailing***Invited**Heinrich Kuhn*

Catholic University of
Eichstaett-Ingolstadt
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Winfried Steiner

Clausthal University of Technology,
Institute of Management and
Economics
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Rob Broekmeulen

TU Eindhoven
r.a.c.m.broekmeulen@tue.nl

Track(s): 35**1 session****Discrete Optimization,
Geometry & Graphs
(contributed)***Contributed**Silvano Martello*

University of Bologna
silvano.martello@unibo.it

Track(s): 5**7 sessions****Dynamic Programming***Invited**Lidija Zadnik Stirn*

University of Ljubljana
lidija.zadnik@bf.uni-lj.si

Track(s): 39**2 sessions****Dynamical Systems and Game
Theory***Invited**Alberto A. Pinto*

University of Porto
aapinto1@gmail.com

Track(s): 6**3 sessions****Dynamical Systems and
Mathematical Modelling in OR***Invited**Selma Belen*

CAG University
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Gerhard-Wilhelm Weber

Middle East Technical University
gweber@metu.edu.tr

Track(s): 41**1 session****Emerging Applications in
Finance and Logistics***Invited**Norbert Trautmann*

University of Bern
norbert.trautmann@pqm.unibe.ch

Track(s): 30**3 sessions****Emerging Applications of Fat
Tail Models in Financial
Modeling and Engineering***Invited**Audrius Kabasinskas*

Kaunas University of Technology
audrius.kabasinskas@ktu.lt

Track(s): 30**1 session****Emerging Aspects of
Production Planning in
Continuous Process Industries:
Theory, Optimization, and
Practice***Invited**Krystsina Bakhrankova*

SINTEF - Technology and society
krystsina.bakhrankova@sintef.no

Track(s): 30**3 sessions****Emissions Trading and Energy***Invited**Magnus Fröhling*

Karlsruhe Institute of Technology
(KIT)
magnus.froehling@kit.edu

Track(s): 32**2 sessions****Energy, Environment and
Climate 1***Contributed**Peter Letmathe*

RWTH Aachen University
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Track(s): 25**2 sessions****Energy, Environment and
Climate 2***Invited**Wolf Fichtner*

Kit
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Costas Pappis

University of Piraeus
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Track(s): 25 35**3 sessions****Engineering Optimization***Invited**Wolfgang Achtziger*

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Helder Rodrigues

Technical University of Lisbon, UTL
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Track(s): 35**1 session****Environmental Issues in
Operations Management***Invited**Grit Walther*

Bergische Universität Wuppertal
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Track(s): 25**2 sessions****EURO Doctoral Dissertation
Award (EDDA 2012)***Invited***Track(s): 42****1 session**

EURO Excellence in Practice Award 2012*Invited**Michel Bierlaire*

École Polytechnique Fédérale de Lausanne (EPFL)

michel.bierlaire@epfl.ch

Track(s): 42**2 sessions****EURO/ROADEF Challenge***Invited**H. Murat Afsar*

University of Technology of Troyes

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Christian Artigues

Cnrs

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Eric Bourreau

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University of Nottingham

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Marc Sevaux

Université de Bretagne Sud - UEB

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Track(s): 3 9**5 sessions****Experimental Economics and Game Theory***Invited**Ulrike Leopold-Wildburger*

Karl-Franzens-University

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Stefan Pickl

Universität der Bundeswehr München

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Gerhard-Wilhelm Weber

Middle East Technical University

gweber@metu.edu.tr

Track(s): 22**1 session****Financial Mathematics and OR***Invited**Gerhard-Wilhelm Weber*

Middle East Technical University

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Mustafa Pinar

Bilkent University

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Track(s): 21**6 sessions****Financial Modelling & Risk Management (contributed)***Contributed**Stein W. Wallace*

Lancaster University Management

School

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Track(s): 18**4 sessions****Financial Optimization***Invited**Gautam Mitra*

Brunel University

gautam.mitra@brunel.ac.uk

J. E. Beasley

Brunel University & JB Consultants

john.beasley@brunel.ac.uk

Track(s): 20**3 sessions****Forecasting***Invited**Aris Syntetos*

University of Salford

a.syntetos@salford.ac.uk

Antonio Rodrigues

University of Lisbon

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Sven F. Crone

Lancaster University Management

School

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Track(s): 24**4 sessions****Fuzzy Optimization - Systems, Networks and Applications***Invited**Erik Kropat*

Universität der Bundeswehr München

erik.kropat@unibw.de

Track(s): 22**3 sessions****Fuzzy Sets and Soft Computing***Invited**Mikael Collan*

Lappeenranta University of

Technology

mikael.collan@lut.fi

Track(s): 12 22**4 sessions****Fuzzy Systems, Neural Networks & Artificial Intelligence***Invited**Heinrich Rommelfanger*

J. W. Goethe University

rommel@wiwi.uni-frankfurt.de

Track(s): 12**2 sessions****Game Theory and Logistics***Invited**Ignacio García-Jurado*

Coruna University

igjurado@udc.es

Ana Meca

Universidad Miguel Hernández

ana.meca@umh.es

Track(s): 24**2 sessions****Game Theory and Social Networks***Invited**Juan Tejada*

Complutense University of Madrid

jtejada@mat.ucm.es

Track(s): 31**2 sessions****Generalized Differentiation and Optimization***Invited**Boris Mordukhovich*

Wayne State University, Detroit

boris@math.wayne.edu

Alexander Kruger

University of Ballarat

a.kruger@ballarat.edu.au

Gerhard-Wilhelm Weber

Middle East Technical University

gweber@metu.edu.tr

Juan Enrique Martínez-Legaz

Universitat Autònoma de Barcelona

JuanEnrique.Martinez.Legaz@uab.cat

Track(s): 23**5 sessions**

Geometric Clustering*Invited*

Andreas Brieden
 Universität der Bundeswehr München
 andreas.brieden@unibw.de

Peter Gritzmann
 TU München
 gritzman@ma.tum.de

Track(s): 13**1 session****Global Optimization***Invited*

Herman Mawengkang
 The University of Sumatera Utara
 mawengkang@usu.ac.id

Track(s): 17**2 sessions****Graph Searching***Invited*

Boting Yang
 University of Regina
 boting@cs.uregina.ca

Anthony Bonato
 Ryerson University
 abonato@ryerson.ca

Nancy Clarke
 Acadia University
 nancy.clarke@acadiau.ca

Track(s): 39**2 sessions****Graphs and Networks***Invited*

Dominique de Werra
 Epfl
 dominique.dewerra@epfl.ch

Track(s): 9**3 sessions****Health Care Management***Invited*

Sally Brailsford
 University of Southampton
 s.c.brailsford@soton.ac.uk

Teresa Melo
 Saarland University of Applied
 Sciences
 teresa.melo@htw-saarland.de

Stefan Nickel
 Karlsruhe Institute of Technology
 (KIT)
 Stefan.Nickel@kit.edu

Marion Rauner
 University of Vienna
 marion.rauner@univie.ac.at

Track(s): 37**2 sessions****Hub Location***Invited*

James Campbell
 University of Missouri-St. Louis
 campbell@umsl.edu

Ivan Contreras
 Concordia University
 icontr@encs.concordia.ca

Track(s): 17**2 sessions****IBM Research Applications***Invited*

Eleni Pratsini
 IBM Zurich Research Lab
 pra@zurich.ibm.com

Track(s): 45**1 session****Information and Intelligent Systems***Invited*

Zuzana Oplatkova
 Tomas Bata University in Zlin
 oplatkova@fai.utb.cz

Gerhard-Wilhelm Weber
 Middle East Technical University
 gweber@metu.edu.tr

Track(s): 44**2 sessions****Innovative Software Tools for MCDA***Invited*

Patrick Meyer
 Telecom Bretagne
 patrick.meyer@telecom-bretagne.eu

Vincent Mousseau
 Ecole Centrale Paris
 vincent.mousseau@ecp.fr

Track(s): 39**2 sessions****Inventory Management***Invited*

Dolores Romero Morales
 University of Oxford
 dolores.romero-
 morales@sbs.ox.ac.uk

Track(s): 13**2 sessions****Iterative Methods for Economic Models***Invited*

Adriana Gnudi
 University of Bergamo
 adriana.gnudi@unibg.it

Elisabetta Allevi
 University of Brescia
 allevi@eco.unibs.it

Igor Konnov
 University of Kazan
 Igor.Konnov@ksu.ru

Track(s): 31**1 session****Keynote, Tutorial and Plenary Lectures***Invited*

Marielle Christiansen
 Norwegian University of Science and
 Technology
 marielle.christiansen@iot.ntnu.no

Leonidas Sakalauskas
 Institute of Mathematics &
 Informatics
 sakal@ktl.mii.lt

Track(s): 1**15 sessions**

Linear and Conic Programming*Invited**Miguel Anjos*Ecole Polytechnique de Montreal
anjos@stanfordalumni.org*Tibor Illés*Budapest University of Technology
and Economics
illes@math.bme.hu**Track(s): 16****4 sessions****Logistics, Transportation,
Traffic***Contributed**Elena Fernandez*Universitat Politecnica de Catalunya
e.fernandez@upc.es**Track(s): 3****3 sessions****Long Term Financial Decisions***Invited**Thomas Burkhardt*Universitaet Koblenz-Landau
tburkha@uni-koblenz.de**Track(s): 21****3 sessions****Long Term Planning in Energy,
Environment and Climate***Invited**Nadia Maïzi*MINES ParisTech
nadia.maizi@mines-paristech.fr**Track(s): 25****3 sessions****Lot-sizing and Related Topics***Invited**Christian Almeder*European University Viadrina
Almeder@europa-uni.de*Bernardo Almada-Lobo*Faculty of Engineering of Porto
University
almada.lobo@fe.up.pt*Alistair Clark*University of the West of England
Alistair.Clark@uwe.ac.uk**Track(s): 13****4 sessions****Machine Learning and its
Applications***Invited**Vadim Strijov*Russian Academy of Sciences,
Computing Center
strijov@ccas.ru*Sureyya Ozogur-Akyuz*Bahcesehir University
sureyya.akyuz@bahcesehir.edu.tr**Track(s): 44****6 sessions****Manufacturing and
Warehousing***Invited**Martin Grunow*Technische Universität München
martin.grunow@tum.de**Track(s): 13****2 sessions****Maritime Transportation***Invited**Henrik Andersson*Norwegian University of Science and
Technology

Henrik.Andersson@iot.ntnu.no

Track(s): 5 9**6 sessions****Mathematical Models in Macro-
and Microeconomics***Invited**Murat Kirdar*Middle East Technical University
kirdar@metu.edu.tr*Ludmilla Koshlai*Institute of Cybernetics
koshlai@ukr.net*Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr**Track(s): 22****3 sessions****Mathematical Programming***Invited**Florian Potra*University of Maryland
potra@umbc.edu*Tamas Terlaky*Lehigh University
terlaky@lehigh.edu*Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr*Goran Lesaja*Georgia Southern University
goran@georgiasouthern.edu*Sandor Zoltan Nemeth*The University of Birmingham
nemeths@for.mat.bham.ac.uk**Track(s): 23****3 sessions****Matheuristics***Invited**Vittorio Maniezzo*University of Bologna
vittorio.maniezzo@unibo.it*Stefan Voss*University of Hamburg
stefan.voss@uni-hamburg.de**Track(s): 6****1 session****MCDAs: New Approaches and
Applications***Invited**Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr**Track(s): 39 40****10 sessions****Metaheuristics***Invited**Marc Sevaux*Université de Bretagne Sud - UEB
marc.sevaux@univ-ubs.fr*Kenneth Sörensen*University of Antwerp
kenneth.sorensen@ua.ac.be*Andreas Reinholz*German Aerospace Center (DLR)
andreas.reinholz@gmx.de**Track(s): 6****7 sessions**

Methodology of Societal Complexity*Invited*

Dorien DeTombe
Chair Euro Working Group
detombe@nosmo.nl

Track(s): 36
2 sessions

Mixed-Integer Non-Linear Programming*Invited*

Sonia Cafieri
Ecole Nationale d'Aviation Civile
sonia.cafieri@enac.fr

Claudia D'Ambrosio
CNRS - Ecole Polytechnique
dambrosio@lix.polytechnique.fr

Track(s): 29
7 sessions

Models of Embodied Cognition*Invited*

Susie Vrobel
The Institute for Fractal Research
Susanne.Vrobel@t-online.de

Track(s): 28
2 sessions

Multi-Criteria Decision Making and Environmental Management*Invited*

Vadim Strijov
Russian Academy of Sciences,
Computing Center
strijov@ccas.ru

Track(s): 26
3 sessions

Multiobjective Optimization*Invited*

José Rui Figueira
Technical University of Lisbon
figueira@ist.utl.pt

Kaisa Miettinen
University of Jyväskylä
kaisa.miettinen@jyu.fi

Christiane Tammer
Martin-Luther-University
Halle-Wittenberg
christiane.tammer@mathematik.uni-halle.de

Track(s): 38 41
13 sessions

Network and Discrete Location*Invited*

Francisco Saldanha-da-Gama
University of Lisbon
fsgama@fc.ul.pt

Alfredo Marín
University of Murcia
amarin@um.es

Stefan Nickel
Karlsruhe Institute of Technology (KIT)
Stefan.Nickel@kit.edu

Track(s): 18
4 sessions

Network Optimization*Invited*

Bernard Fortz
Université Libre de Bruxelles
bfortz@euro-online.org

Luis Gouveia
University of Lisbon
legouveia@fc.ul.pt

Walid Ben-ameur
Telecom SudParis
walid.benameur@it-sudparis.eu

Track(s): 8
4 sessions

New Trends in Vehicle Routing*Invited*

Jorge E. Mendoza
Université Catholique de l'Ouest
jorge.mendoza@uco.fr

Track(s): 7
3 sessions

Nonconvex Programming: Local and Global Approaches*Invited*

Tao Pham Dinh
INSA Rouen
pham@insa-rouen.fr

Hoai An Le Thi
University of Lorraine
hoai-an.le-thi@univ-lorraine.fr

Track(s): 17
3 sessions

Nonlinear Programming*Invited*

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Lino Costa
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Isabel Espírito Santo
Minho University
iapinho@dps.uminho.pt

Simone Göttlich
University of Mannheim
goettlich@uni-mannheim.de

Track(s): 15 19
4 sessions

Nonsmooth Optimization*Invited*

Adil Bagirov
University of Ballarat
a.bagirov@ballarat.edu.au

Albert Ferrer
Technological University of Catalonia
alberto.ferrer@upc.edu

Antonio Fuduli
Università della Calabria
antonio.fuduli@unical.it

Peter Recht
TU Dortmund
peter.recht@tu-dortmund.de

Track(s): 16
3 sessions

Numerical Methods in Finance*Invited*

Ömür Ugur
Middle East Technical University
ougur@metu.edu.tr

Track(s): 21
3 sessions

Occupational Health & Wellbeing*Invited*

Elena Andreeva
Berlin University of Technology
elan@ifg.tu-berlin.de

Track(s): 36
1 session

Operational Research and Quantitative Models in Banking*Invited*

Constantin Zopounidis
 Technical University of Crete
 kostas@dpem.tuc.gr

Track(s): 19
2 sessions

Operations/Marketing Interface*Invited*

Kathryn E. Stecke
 University of Texas at Dallas
 KStecke@utdallas.edu

Xuying Zhao
 University of Notre Dame
 xzhao1@nd.edu

Track(s): 35
1 session

Optimal Control*Invited*

Ekaterina Kostina
 University of Marburg
 kostina@mathematik.uni-marburg.de

Gernot Tragler
 Vienna University of Technology
 tragler@eos.tuwien.ac.at

Erik Kropat
 Universität der Bundeswehr München
 erik.kropat@unibw.de

Gerhard-Wilhelm Weber
 Middle East Technical University
 gweber@metu.edu.tr

Track(s): 4
2 sessions

Optimization and Data Mining*Invited*

Emilio Carrizosa
 Universidad de Sevilla
 ecarrizosa@us.es

Theodore Trafalis
 University of Oklahoma
 ttrafalis@ou.edu

Renato De Leone
 Università di Camerino
 renato.deleone@unicam.it

Track(s): 29
4 sessions

Optimization for Sustainable Development*Invited*

Herman Mawengkang
 The University of Sumatera Utara
 mawengkang@usu.ac.id

Gerhard-Wilhelm Weber
 Middle East Technical University
 gweber@metu.edu.tr

Track(s): 34
3 sessions

Optimization in Public Transport*Invited*

Leo Kroon
 Erasmus University Rotterdam
 lkroon@rsm.nl

Anita Schöbel
 Georg-August University Goettingen
 schoebel@math.uni-goettingen.de

Track(s): 3 4 12
9 sessions

OR and Environmental Management*Invited*

Marion Steven
 Ruhr-University Bochum
 marion.steven@rub.de

Track(s): 25 26
2 sessions

OR and Ethics*Invited*

Cristobal Miralles
 Universidad Politecnica de Valencia
 cmiralles@omp.upv.es

Fred Wenstøp
 BI Norwegian School of Management
 fred.wenstop@bi.no

Track(s): 31
2 sessions

OR and Real Implementations*Invited*

Ben Lev
 Drexel University
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Belarmino Adenso-Diaz
 Universidad de Oviedo
 adenso@epsig.uniovi.es

Istvan Maros
 Imperial College London
 i.maros@imperial.ac.uk

Track(s): 35
1 session

OR and the Arts*Invited*

Vitaly Podobedov
 Moscow State University
 vetix@or-art.org

Track(s): 24
1 session

OR Applications in Industry*Invited*

Geir Hasle
 Sintef Ict
 geir.hasle@sintef.no

Jens Wollenweber
 Dr. Staedtler Transport Consulting
 j.wollenweber@staedtler-logistik.de

Track(s): 35
1 session

OR Applications in the Automotive Industry*Invited*

Thomas Spengler
 Technische Universität Braunschweig
 t.spengler@tu-bs.de

Thomas Volling
 Technische Universität Braunschweig
 t.volling@tu-bs.de

Track(s): 13
3 sessions

OR for Development and Developing Countries*Invited**Elise del Rosario*Orsp
elise@jgdelrosario.com*Honora Smith*University of Southampton
honora.smith@soton.ac.uk*Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr*Subhash Datta*Institute of Management Technology
subhash.datta@gmail.com*Leroy White*University of Bristol
leroy.white@bris.ac.uk*Alexander Makarenko*National Technical University of
Ukraine "KPI"
makalex@i.com.ua*Francoise Summers*Middle East Technical University
fsummers@metu.edu.tr*Youssef Masmoudi*Hight School of Commerce of Sfax
youssef.masmoudi@gmail.com**Track(s): 33****8 sessions****OR for Sustainable Development***Invited**Leonidas Sakalauskas*Institute of Mathematics &
Informatics
sakal@ktl.mii.lt*Edmundas Kazimieras Zavadskas*Vilnius Gediminas Technical
University
edmundas.zavadskas@vgtu.lt*Tatjana Vilutiene*Vilnius Gediminas Technical
University
tatjana.vilutiene@vgtu.lt*Vida Maliene*School of the Built Environment,
Liverpool John Moores University
v.maliene@ljmu.ac.uk**Track(s): 33****3 sessions****OR in Agriculture, Forestry and Fisheries***Invited**Lluís Pla*University of Lleida
lpla@matematica.udl.es*Victor M. Albornoz*Universidad Tecnica Federico Santa
Maria
victor.albornoz@usm.cl**Track(s): 26****4 sessions****OR in Health & Life Sciences (contributed)***Contributed**Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr**Track(s): 37****6 sessions****OR in Human Resources***Invited**Bo Hu*Universität der Bundeswehr München
bo.hu@unibw.de**Track(s): 24****1 session****OR in Industry and Software for OR (contributed)***Contributed**Mikael Rønnqvist*Département de génie mécanique
mikael.ronnqvist@nhh.no**Track(s): 35****1 session****OR in Military, Safety and Security Applications***Invited**Ana Isabel Barros*Tno
ana.barros@tno.nl**Track(s): 28****3 sessions****OR in Quality Management***Invited**Ipek Deveci Kocakoç*Dokuz Eylul University Faculty of
Economics and Administrative
Sciences
ipek.deveci@deu.edu.tr*Gulser Koksall*Middle East Technical University
koksall@ie.metu.edu.tr**Track(s): 28****2 sessions****OR in Sports***Invited**Sigrid Knust*University of Osnabrück
sigrid@informatik.uni-osnabrueck.de*Dirk Briskorn*University of Siegen
dirk.briskorn@uni-siegen.de*Alexandra Newman*Colorado School of Mines
newman@mines.edu**Track(s): 35****1 session****OR in the Oil and Gas Sectors***Invited**Irina Dolgoplova*Middle East Technical University
irina.dolgoplova@gmail.com**Track(s): 26****2 sessions****OR in Water Management***Invited**Halil Önder*Middle East Technical University
onde@metu.edu.tr*Elcin Kentel*Metu
ekentel@metu.edu.tr**Track(s): 26****1 session****Pioneers in Operations Research***Invited**Graham Rand*Lancaster University
g.rand@lancaster.ac.uk*Jakob Krarup*University of Copenhagen
krarup@diku.dk**Track(s): 24****1 session**

Preference Learning*Invited**Krzysztof Dembczynski*Poznan University of Technology
kdembczynski@cs.put.poznan.pl*Willem Waegeman*Ghent University
willem.waegeman@ugent.be*Roman Slowinski*Poznan University of Technology
roman.slowinski@cs.put.poznan.pl**Track(s): 40****5 sessions****Production and the Link with Supply Chains***Invited**Lionel Amodeo*University of Technology of Troyes
lionel.amodeo@utt.fr*Farouk Yalaoui*University of Technology of Troyes
farouk.yalaoui@utt.fr**Track(s): 10****3 sessions****Production Management & Supply Chain Management (contributed)***Contributed**Elena Fernandez*Universitat Politecnica de Catalunya
e.fernandez@upc.es**Track(s): 10****6 sessions****Project Management and Scheduling***Invited**Rainer Kolisch*Technische Universitaet Muenchen
rainer.kolisch@wi.tum.de**Track(s): 2****4 sessions****Quantitative Approaches in Managerial and Financial Accounting***Invited**Matthias Amen*University of Bielefeld
Matthias.Amen@web.de**Track(s): 45****1 session****Quantitative Models for Performance and Dependability***Invited**Markus Siegle*Universitaet der Bundeswehr
Muenchen
markus.siegle@unibw.de**Track(s): 36****2 sessions****Realistic Production Scheduling***Invited**Ruben Ruiz*Universidad Politecnica de Valencia
rruiz@eio.upv.es**Track(s): 11****3 sessions****Recent Advances in Earthquake Studies***Invited**Aysegul Askan*Middle East Technical University
aaskan@metu.edu.tr*Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr**Track(s): 28****1 session****Revenue Management***Invited**Ayse Kocabiyikoglu*Bilkent University
aysekoca@bilkent.edu.tr*Yuri Levin*Queen's University
ylevin@business.queensu.ca*Tatsiana Levina*Queen's University
tlevin@business.queensu.ca*Joern Meissner*Kuehne Logistics University
joe@meiss.com**Track(s): 40 44 45****6 sessions****Scheduling***Invited**Erwin Pesch*University of Siegen
erwin.pesch@uni-siegen.de*Vitaly Strusevich*University of Greenwich
sv02@gre.ac.uk**Track(s): 2****8 sessions****Scheduling under Resource Constraints***Invited**Joanna Jozefowska*Poznań University of Technology
jjozefowska@cs.put.poznan.pl*Jan Weglarz*Poznan University of Technology
jan.weglarz@cs.put.poznan.pl**Track(s): 14****6 sessions****SD Modelling in Sustainable Development***Invited**Pierre Kunsch*Vrije Universiteit Brussel
pkunsch@vub.ac.be*Erik Pruyt*Delft University of Technology
E.Pruyt@tudelft.nl**Track(s): 40****2 sessions****Semi-Infinite Optimization***Invited**Vladimir Shikhman*RWTH Aachen University
shikhman@mathc.rwth-aachen.de*Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr*Shunsuke Hayashi*Kyoto University
shunhaya@amp.i.kyoto-u.ac.jp**Track(s): 15****2 sessions****Simulation***Invited***Track(s): 42****1 session****Simulation Based Decision Support***Invited**Miroljub Kljajic*University of Maribor
miroljub.kljajic@fov.uni-mb.si*Viveca Asproth*Mid Sweden University
viveca.asproth@miun.se**Track(s): 25****1 session**

Simulation in Management Accounting and Management Control*Invited**Friederike Wall*Alpen-Adria-Universitaet Klagenfurt
friederike.wall@uni-klu.ac.at*Stephan Leitner*Alpen-Adria-Universität Klagenfurt
stephan.leitner@uni-klu.ac.at**Track(s): 45****2 sessions****Simulation Methods in Finance***Invited**Aysegul Iscanoglu Cekic*Selcuk University
iaysegul@selcuk.edu.tr*Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr**Track(s): 19****3 sessions****Soft OR and Problem Structuring Methods***Invited**Giles Hindle*Hull University Business School
giles.hindle@hull.ac.uk**Track(s): 32****6 sessions****Software for OR/MS***Invited**Robert Fourer*

4er@iems.northwestern.edu

*Bjarni Kristjansson*Maximal Software, Ltd.
bjarni@maximalsoftware.com**Track(s): 33 35****2 sessions****Stochastic Modeling and Simulation in Engineering, Management and Science***Invited**Erik Kropat*Universität der Bundeswehr München
erik.kropat@unibw.de*Devin Sezer*Middle East Technical University,
Institute of Applied Mathematics
devin@metu.edu.tr*Basak Tanyeri*Bilkent University
basak@bilkent.edu.tr*Zeev (Vladimir) Volkovich*Ort Braude Academic College
zeev@actcom.co.il*Gerhard-Wilhelm Weber*Middle East Technical University
gweber@metu.edu.tr**Track(s): 42****8 sessions****Stochastic Modelling in Logistical Networks***Invited**El-Houssaine Aghezzaf*Ghent University
ElHoussaine.Aghezzaf@UGent.be**Track(s): 45****3 sessions****Stochastic Programming***Invited**Jitka Dupacova*Charles Univ, Faculty of Math. and
Physics
dupacova@karlin.mff.cuni.cz*Georg Pflug*University of Vienna
georg.pflug@univie.ac.at*Andras Prekopa*Rutgers University
prekopa@rutcor.rutgers.edu*Alexander Shapiro*Georgia Institute of Technology
ashapiro@isye.gatech.edu*Stein W. Wallace*Lancaster University Management
School
stein.w.wallace@lancaster.ac.uk*Giorgio Consigli*University of Bergamo
giorgio.consigli@unibg.it*Abdel Lisser*Universite de Paris Sud
lisser@lri.fr*Asgeir Tomasgard*Sintef Technology and society
asgeir.tomasgard@sintef.no**Track(s): 43 44****12 sessions****Structured Optimization and Applications***Invited**Vladimir Shikhman*RWTH Aachen University
shikhman@mathc.rwth-aachen.de**Track(s): 28****4 sessions****Supply Chain Management***Invited**Steef van de Velde*RSM Erasmus University
svelde@rsm.nl**Track(s): 10****2 sessions**

Supply Chain Planning*Invited*

Moritz Fleischmann
University of Mannheim
Moritz.Fleischmann@bwl.uni-mannheim.de

Herbert Meyr
University of Hohenheim
H.Meyr@uni-hohenheim.de

Track(s): 7 8
4 sessions

Sustainable Living: Cognitive, Social, Economical, Ecological and World View*Invited*

Annette Hohenberger
Middle East Technical University (METU)
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Pedamallu Chandra Sekhar
Dana-Farber Cancer Institute
pcs.murali@gmail.com

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Claudia Rave
National University of Colombia
claudia.rave@gmail.com

Track(s): 34
1 session

Sustainable Transport Planning*Invited*

Bülent Çatay
Sabanci University
catay@sabanciuniv.edu

Tolga Bektas
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Track(s): 3
2 sessions

System Dynamics Modeling and Simulation*Invited*

Markus Schwaninger
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Markus Schwenke
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Track(s): 41
1 session

Timetabling and Rostering*Invited*

Dario Landa-Silva
University of Nottingham
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Nysret Musliu
Vienna University of Technology
musliu@dbai.tuwien.ac.at

Timothy Curtois
University of Nottingham
tim.curtois@nottingham.ac.uk

Track(s): 14
5 sessions

Transportation and Logistics*Invited*

Maurizio Bielli
Institute of Systems Analysis and Informatics
bielli@iasi.cnr.it

Track(s): 11
5 sessions

Transportation Planning*Invited*

Herbert Kopfer
University of Bremen
kopfer@uni-bremen.de

Frank Schultmann
Karlsruhe Institute of Technology (KIT)
frank.schultmann@kit.edu

Track(s): 11
1 session

Uncertainty and Perturbations in Optimization and in Environmental and Energy Modelling*Invited*

Jerzy Filar
Flinders University
jerzy.filar@flinders.edu.au

Julia Piantadosi
University of South Australia
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Track(s): 16
5 sessions

Variable Neighborhood Search*Invited*

José A. Moreno-Pérez
University of La Laguna
jamoreno@ull.es

Nenad Mladenovic
Brunel University
Nenad.Mladenovic@brunel.ac.uk

Track(s): 6
1 session

Variational Inequalities and Bi-Level Problems*Invited*

Stephan Dempe
Technische Universität Freiberg
dempe@math.tu-freiberg.de

Yury Kochetov
Novosibirsk State University
jkochet@math.nsc.ru

Oleg Khamisov
Institute of Energy Systems
mis@isem.sei.irk.ru

Track(s): 15
3 sessions

Vector and Set-Valued Optimization*Invited*

Vicente Novo
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Bienvenido Jiménez
Uned
bjimenez@ind.uned.es

César Gutiérrez
Universidad de Valladolid
cesargv@mat.uva.es

Track(s): 15
3 sessions

Vehicle Routing and Logistics Optimization*Invited*

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6 sessions

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Artigues, Christian	WA-02, TD-09, WD-09	Balestrassi, Pedro Paulo	TD-29	Bekiaris, Michail	MA-18
Asbjørnslett, Bjørn Egil	MA-05	Balezentis, Alvydas	WD-40	Bektas, Tolga	TD-03
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Cheaitou, Ali	MA-05	Consigli, Giorgio	WD-43	Dangerfield, Brian	WB-41
Chelouah, Rachid	TA-06, TA-31	Consiglio, Andrea	MC-18	Danilkina, Alexandra	TD-36
Chen, An	TA-19	Constantino, Miguel	WA-37	DanisOncul, Selmin	WB-14
Chen, Bo	MA-34	Contardo, Claudio	WC-18	Dao Thi, Thu Ha	TC-36
Chen, Chie-bein	MC-39	Contreras, Ivan	TB-17	Daou Pulido, Amir José	MD-25
Chen, Frank Y	TB-10	Contreras, Javier	TB-16	Dargam, Fatima	WC-27
Chen, JongChen	MC-15, TB-31	Cookson, Emily	MA-44	Darlay, Julien	WB-03, WB-35
Chen, Pei-Ting	MD-39	Corbett, Charles	TB-25	Dasaklis, Tom	TC-25, TB-37
Chen, Sheu-Hua	WB-27, WC-44	Cordeau, Jean-François	MD-05	Dasgupta, Bhaskar	MA-37
Chen, Vivien Y.C.	MA-40, MD-40	Cordeiro, Clara	TD-24	Daskalaki, Sophia	TB-20, WA-24
Chen, Yuh-Wen	TC-37	Cordeiro, Isabel	TC-20	Datta, Subhash	MB-33
Cheng, Chun-Yuan	TC-45	Cornejo, Oscar	WC-11	de Araujo, Silvio	TD-10
Cheng, Weiwei	WB-40	Corominas, Albert	WC-41	De Asmundis, Roberta	WC-29
Chernichovsky, Dov	TB-36	Coronado-Hernandez, Jairo	MC-45	De Baets, Bernard	WA-40
Chiang, Naiyuan	TD-43	Correia, Gonçalo	MA-04	de Carvalho, J. M. Valério	WC-07
Chiang, Yu-Min	MB-40, MC-40	Correia, Isabel	MA-17, TB-17	De Causmaecker, Patrick	TC-14
Chien, Hung-ju	MA-40	Cortazar, Gonzalo	MB-20	De Cosmis, Sonia	WA-29
Chilcott, Jim	TA-32	Cortinhal, Maria	TD-11, TA-17	De Cuyper, Eline	TC-45
Chin, Yang-Chieh	TA-31, TD-31	Cosgun, Ozlem	MB-26	de Freitas Rodrigues, Rosiane	WC-11
Chiwiacowsky, Leonardo	TC-06	Coskun, Semih	TC-03	de Graaf, Gimón	TA-37
Cho, Minyoung	WD-29	Costa, Alysson	WD-31	de Joode, Jeroen	MA-26
Choi, Yuran	WD-18	Costa, Anabela	MA-21, TB-21	de Kok, Ton	WA-43
Choo, Eng	MD-41	Costa, Fabricio	TD-10	de la Fuente, Hanns	WD-32
Chou, Chun An	MA-37	Costa, João Paulo	MA-38	de la Torre, Rocio	MD-30
Chou, Ying-Chyi	MC-40	Costa, Julian	MA-24	De Leone, Renato	MD-16, WA-29
Choudhary, Rekha	TA-28	Costa, M. Fernanda P.	MD-15, TA-15	de los Santos, M. Antonia	TD-02, MD-11
Chowdhury, S.M. Atiqur Rahman	WC-16	Costa, Marie-Christine	MA-08	de Miranda Borba, Leonardo	WC-03
Christensen, Tue	TB-04	Costa, Sueli	MD-09	De Rosa, Vincenzo	TD-35
Christiansen, Marielle	MA-06, WC-09	Coti, Camille	WA-03		
Christie, Marc	WB-25	Couellan, Nicolas	WB-29		

FarajiDavar, Nazli	TA-44	Fodstad, Marte	MA-26	Garín, María Araceli	WA-43
Farid, Suzanne	TB-30	Fondacci, Rémy	TA-29	García Alvarado, Marthy Stivaliz	MD-10
Fasano, Giorgio	MB-09	Fonseca, Carlos M.	TB-06	García Quiles, Sergio	WB-18
Fasth, Tobias	TD-27	Forjaz, Maria	WD-15	García Sipols, Ana Elizabeth	TD-42
Fathi, Masood	TD-07	Forsgren, Malin	WA-12	García, Diego	WD-38
Fattahi, Ali	TC-03, TB-11	Fortemps, Philippe	TD-40	García, María D.	TD-18
Faulin, Javier	WA-07, MB-16	Fortz, Bernard	MA-08	García-Jurado, Ignacio	MB-24
Fayzur Rahman, Dewan	MA-25	Fotopoulos, Christos	MB-10	García Centeno, Maria Del Carmen	TA-39
Fedotova, Kristine	WA-33	Fourer, Robert	WD-33	García Lopez, Juan Manuel	WC-41
Fedrizzi, Mario	MB-22	Fourneau, Jean-Michel	TC-36	García-Flores, Rodolfo	MA-17
Fedrizzi, Michele	MD-12	Frédéric, Dambreville	WD-17	García-Laguna, Juan	MD-10
Feillet, Dominique	MD-06	Fröhling, Magnus	TD-32	García-Sabater, José P.	MC-45
Felici, Giovanni	WC-08	Framinan, Jose M.	TD-02, WB-11, MC-14	García_Perez, Fernando	TB-09
Felix, Bastian	TC-32	França, Felipe	MA-16	Gardi, Frédéric	WB-03, MA-35, WB-35, MC-42
Fellag, Hocine	MD-33	Franc, Vojtech	WA-23	Garfinkel, Robert	TC-30
Felletti, Daniele	MB-19	Francfort, Stanislas	MA-08, MC-08	Gargallo, Pilar	MD-18
Fenerci, Kübra	TC-19	Franco, L. Alberto	MA-27, MA-32, MB-32	Gass, Saul	MD-24
Ferhat, Arezki	MD-34	Frangioni, Antonio	TC-30	Gastaldi, Massimiliano	MB-11
Fernández Barberis, Gabriela	TA-39	Frankowicz, Marek	TD-33	Gaudutis, Ernestas	WA-33
Fernandes, Edite M.G.P.	MD-15, TA-15, TD-19	Frankowska, Helene	MD-04	Gavalec, Martin	MB-12, TC-13, MA-22
Fernandes, Luís	WD-15	Frazzon, Enzo	WD-10	Gavranovic, Haris	WB-03, WA-05
Fernandez, Elena	TB-17	Frei, Oleksandr	WB-44	Gawiejnowicz, Stanislaw	MD-14, TA-14
Fernandez, Jose	TB-18	Freixas, Josep	MC-34	Gawron, Piotr	WC-03, MB-37
Fernandez, Pascual	TC-18, TD-18	Friedman, Lea	TA-36, TB-36	Gebhard, Marina	TD-35
Fernandez-Viagas Escudero, Victor	MC-14	Fries, Carlos Ernani	WB-30	Gee, Deborah	TA-16
Ferreira Filho, Virgilio Jose Martins	WB-42	Frisk, Mikael	WA-13, MD-42	Gehring, Hermann	MA-11
Ferreira, Carlos	TD-11	Fukuda, Yutaka	TA-04	Geiger, Martin Josef	MB-03, MC-03
Ferreira, Luis	WB-06, WC-06	Fukushima, Masao	TB-15, 16	Geipele, Ineta	MA-33, WA-33, WB-33
Ferreira, Pedro	TB-24	Fulga, Cristinca	TB-20	Geipele, Sanda	WA-33, WB-33
Ferreira, Ubirajara	WC-38	Furems, Eugenia	TA-20	Geissler, Bjoern	TB-29
Ferrer, Albert	MB-16, MC-16	Furió, Salvador	TC-35	Gel, Yulia	MD-16
Ferretti, Valentina	TC-27	Furmans, Kai	TC-07, WB-13	Geldermann, Jutta	MC-13, TC-25, WC-25, WB-39
Fertig, Emily	TC-43			GenÇ, Aşır	WB-19
Fescioglu-Unver, Nilgun	MA-42, TD-42	G		Gendreau, Michel	WC-07, WA-43
Fetta, Angelico	TB-42	G. Hernandez-Diaz, Alfredo	TC-06	Gendron, Bernard	TB-04
Fiala, Petr	WC-45	G. Nejad, Mohammad	MD-27	Genova, Krassimira	WB-27
Fichtner, Wolf	TB-35	Gabay, Michaël	TB-02, WA-03	Genovesse, Andrea	WC-41
Fidelis, Krzysztof	MD-37	Gabor, Adriana F.	WA-07	Gentile, Claudio	TC-30
Fiems, Dieter	TC-45	Gabriel, Steven	TA-25, WA-26	Georgiadis, Michael	WD-02, TA-25
Fiestras-Janeiro, M ^a Gloria	MB-24	Güler, M. Güray	TC-10	Geraldo, Diego	MC-36
Figueira, Gonçalo	MA-13	Günther, Elisabeth	TB-12	Gerdessen, J.c.	MB-13
Figueiredo, Rosa Maria	MB-37	Günther, Markus	MD-27	Geroliminis, Nikolas	TD-18
Filar, Jerzy	TC-16	Güran, Celal Barkan	WA-20	Gesteira, Claudio	MA-16
Filippi, Carlo	TB-04, MA-06	Gürbüz, Tuncay	MB-40	Gestrelus, Sara	WA-12
Finbow, Stephen	WD-39	Gaertner, Thomas	TD-31	Gevezes, Theodoros	MB-37
Finke, Gerd	TB-02	Gökçen, Hadi	MC-17	Ghattas, Omar	WD-28
Finta, Lucian	WA-03	Gönsch, Jochen	WA-45	Ghiani, Gianpaolo	TD-13
Fioole, Pieter	TD-12	Gössinger, Ralf	WC-42	Ghodsi, Reza	WB-13
Firat, Murat	MB-02	Göttlich, Simone	MB-15	Ghosh, Diptesh	MC-06
Firmansyah, Firmansyah	TC-34	Gaidamaka, Yuliya	TD-36	Giandomenico, Monia	MA-29
Fischer, Frank	WC-05	Galafassi, Cristiano	TC-06	Gianfreda, Angelica	MB-19
Fischetti, Matteo	WB-01	Galindo, Gina	TA-18	Giannikos, Ioannis	TA-17
Flatberg, Truls	TC-12, TA-30	Gallay, Olivier	WD-45	Giannopoulou, Maria	WC-45
Fliedner, Malte	MD-02	Gallegos, David	MD-11	Giffhorn, Edilson	TB-32
Fliedner, Thomas	WC-02	Galli, Laura	MA-29	Gil-Lafuente, Ana Maria	TB-19
Flier, Holger	TB-03	Gallien, Jérémie	MC-42	Gila Arrondo, Aranzazu	TB-18
Flisberg, Patrik	WA-13, MD-42	Gallivan, Steve	WC-37	Ginda, Grzegorz	TA-14
Flor, Guerrero	WB-21	Gallo, Giorgio	TD-32	Ginestar, Concepción	MD-26
Florentino, Helenice	TD-10	Gallo, Mariano	WB-12	Glass, Celia	TA-02
Flores, Ramon	MB-31	Galvão Dias, Teresa	WD-03, MD-36		
Floudas, Christodoulos	MC-29	Gamboia, Dorabela	TD-06		
Flynn, James	MD-10	Gamrath, Gerald	WC-05		
		Ganas, Ioannis	MC-06		
		Ganobjak, Michal	MB-25		

Glazebrook, Kevin	TB-42, MA-44	Granot, Daniel	MA-24	H	
Glorie, Kristiaan	WA-28	Grasas, Alex	MB-16, TA-35	Haase, Knut	WA-16
Gnudi, Adriana	MC-31	Grass, Dieter	MC-04	Haasis, Hans-Dietrich	WD-12, WD-25
Goberna, Miguel	TA-15, TB-15	Grebennik, Igor	WC-05	Habenicht, Walter	MA-38
Goddard, Wayne	TD-05	Gregory, Amanda	TB-32	Hadzi-Purić, Jelena	WA-37
Godfrey, Patrick	MD-32	Gribkovskaia, Irina	TA-05, WC-09	Hadad, Yossi	WB-24, TA-36, TD-37
Godinho, Maria Teresa	TC-04	Griebisch, Susanne	MB-18	Hadjiconstantinou, Eleni	TD-04, TC-21
Goel, Asvin	MA-07	Griffiths, Jeff	WA-37	Haensel, Alwin	WD-45
Goeppel, Mathias	MA-04	Grigorenko, Olga	WB-22	Hübner, Ruth	MB-29
Goerdts, Andreas	WA-08	Grimaud, Frédéric	TB-45	Hüllermeier, Eyke	WB-40
Goerigk, Marc	TB-12	Grinshpoun, Tal	WB-14	Hörmann, Wolfgang	MC-18
Gogos, Christos	TD-09	Grisar, Catherine	MD-45	Höschl, Cyril	MD-12
Goldengorin, Boris	WA-17	Gritzmann, Peter	TB-13	Haftendorn, Clemens	MA-26
Golikova, Victoria	TA-22	Grmusa, Jeca	WA-37	Hagiwara, Motohiro	MA-18
Gollmer, Ralf	MD-29	Groenevelt, Harry	TB-10	Hain, Vladimir	TD-33
Gollowitzer, Stefan	TB-04	Groissböck, Markus	MA-25	Hakanen, Jussi	TD-38
Gomes Júnior, Silvio	WC-32	Gromicho, Joaquim	MA-09	Halabi Echeverry, Ana	WD-12
Gomes, A. Miguel	MA-09, MB-09, MD-09	Gronalt, Manfred	TC-26	Halfoune, Nadia	TA-31
Gomes, Christina	MC-37	Grossmann, Ignacio	MA-01	Hall, Nicholas	WA-35
Gomes, Gastão	MC-37	Grothey, Andreas	MD-30	Halme, Merja	TD-29
Gomes, Luiz F. Autran M.	TA-20	Grothmann, Ralph	WA-24	Halskau, Oyvind	WC-09
Gomes, Marta Castilho	WB-26	Gruber, Aritanan	WC-08	Hamann, Joern	TD-26
Gomes, Rui	WD-03	Grunewald, Martin	WB-13, WC-13	Hamouma, Moumen	MD-08
Gomez Gonzalez, Daniel	MA-31	Grunow, Martin	TA-13	Hamzadayi, Alper	MC-06, MD-39, WC-42
Gomez Padilla, Alejandra	WB-32, WC-40	Grzybowski, Jerzy	MA-23	Han, Do Hee	MA-44
Gomez, Arthur	WB-04, TC-06, WA-06	Guajardo, Mario	WA-13, MB-26	Hanáček, Tomás	MD-33
Gomory, Ralph E.	WE-01	Guarracino, Mario	WC-29	Hanaf, Said	MB-02, WA-06, WC-07, TD-09
Gonçalves, Graça	TA-26	Gucumengil, Alper	WB-11	Hanczar, Pawel	TC-08
Gonçalves, José Fernando	TA-09	Guegan, Dominique	MC-21	Hans, Erwin	WB-37
Gondzio, Jacek	TB-07, WC-16	Guenther, Hans-Otto	MA-05, MA-13	Hansen, Klaus Reinholdt Nyhuus	TA-13
Gontis, Vygtintas	MD-18	Guere, Emmanuel	TD-09, WD-09	Hansmann, Ronny	MA-06
Gonul, Mustafa Sinan	TC-24	Gueret, Christelle	MA-07	Hanya, Kherchi	WA-42
González Alastrué, José Antonio	TD-30	Guerrero, Fernando	TD-07	Hanzel, Jaroslav	TB-09, WD-41
González-Arangüena, Enrique	MA-31, MB-31	Guerrin, Francois	WD-40	Harmand, Jérôme	MC-15
González-Császár, Eduardo	TB-10	Gueye, Serigne	WD-18	Harper, Paul	TB-37, TB-42
Gonzaga, Clovis	WB-16	Guignard-Spielberg, Monique	WD-04	Hart, Diane	MA-32
Gonzalez-Araya, Marcela	TD-26	Guillen, Montserrat	TB-19	Hartikainen, Markus	TA-38
Gonzalez-Brevis, Pablo	WC-16	Guimarães, Luis	MD-13	Hartl, Richard	WA-02, WD-02, WA-07, TA-45
Gonzalez-R, Pedro L.	TC-37	Guimaraes, Paula	MD-35	Hartmann, Jens	WD-10
Goos, Peter	WD-07, WA-14	Guimaraes, Thiago	TB-03, TB-09	Harvey, Nigel	TC-24
Goossens, Dries	MB-18	Guinee, William	WD-35	Haselmann, Tobias	WB-02
Gorczyca, Mateusz	TC-02	Guinzbourg, Anna	MB-28	Hashemkhani Zolfani, Sarfaraz	WC-33
Gordini, Angelo	MD-42	Guivarch, Céline	TD-25	Hashimoto, Hideki	TD-09
Gorelik, Viktor	WB-04	Guleria, Sanjeev Kumar	WC-14	Haspesslagh, Stefaan	TC-14
Gori, Stefano	MD-11	Guliashki, Vassil	WB-27	Hassan, Mehedi	MC-37
Gorobetz, Mikhail	MD-38	Gulserin, Meltem	TC-31	Hassanababdi, Morteza	TD-17
Gorokhovik, Valentin	MB-23	Gultekin, Hakan	WB-11	Hassanpour-ezatti, Majid	WD-06
Goto, Yusuke	MC-45	Gunalay, Yavuz	MD-26	Hasuike, Takashi	WA-10, TA-45
Gotthardt, Benjamin	WA-24	Gunay, Elif Elcin	MB-28	Hauge, Kristian Milo	TA-07
Goumoto, Kensuke	TB-15	Gundogdu, I.Bulent	WC-44	Haurie, Alain	TD-16
Gouveia, Luis	TC-04, MA-08, TA-26	Gungor, Askiner	TC-03	Hayashi, Shunsuke	TB-15
Gouveia, Maria	MD-36	Gunkel, David	TC-32	Haythorpe, Michael	TC-16
Goverde, Rob	TC-12	Guo, Xuezhen	MC-26	Heggedal, Ane Marte	TC-43
Grace, Adam	TA-42	Guo, Yike	TB-43	Heinimann, Hans Rudorf	MD-26
Grad, Sorin-Mihai	MB-38	Gupta, Ashish	TA-44	Heipcke, Susanne	MA-30
Gradisar, Miro	WD-25	Gurevich, Gregory	WB-24	Heismann, Olga	WD-04
Gröflin, Heinz	TC-02	Gurrieri, Massimo	TD-40	Hellingrath, Bernd	TA-07
Gram, Markus	WA-10	Gurvich, Vladimir	WB-08	Helmberg, Christoph	WC-05, WA-16
Granado, Bertrand	TA-06	Guschinsky, Nikolai	TD-13	Helmedag, Fritz	WA-21
Grandjean, Arnaud	MC-44	Gutiérrez Fernández, Milagros	TA-39		
Granichin, Oleg	WA-42	Gutiérrez, César	TD-15, WA-15		
		Gutiérrez-Jarpa, Gabriel	WD-03		
		Gutjahr, Walter	WC-02		
		Guzman Castillo, Maria	WC-37		
		Gwiggner, Claus	TA-04, TC-42		

Hemmelmayer, Vera	WC-18	Hsiung, Liang-Yuan	MD-39	Jamall, Mohammad	TD-05
Hena, Felipe	WD-27, MA-32	Hsu, Chin-Min	MD-35	James, Tabitha	TD-06
Henkel, Charlotte	WB-43	Hsu, Chiung-Wen	MC-40	Jancauskas, Vytautas	WA-17
Herczeg, Gábor	TC-25	Hsu, Chung-Chian	TB-31	Janiak, Adam	TC-02, MD-14, TB-14
Hermosilla, Cristopher	WB-23	Hsu, Pi-Fang	MB-39, 40	Janiak, Wladyslaw	MD-14
Hernández-Jiménez, Beatriz	TC-15	Hu, Yike	TC-10	Janilionis, Vytautas	TD-37
Hernández-Pérez, Hipólito	WA-07	Huang, Kwei-Long	TC-37	Jarboui, Bassem	WD-09
Herranz, Patricia	WB-21	Huerga, Lidia	TD-15	Jarus, Mateusz	MA-02
Herremans, Dorien	WD-24	Hugues, Paul	TD-25	Jazbec, Anamarija	MC-41
Herrmann, Frank	TA-24	Huisman, Dennis	TD-12	Jaškowski, Wojciech	WC-03
Herron, Rebecca	MA-32	Humpola, Jesco	TB-29	Jean Marie, Kiombo	MD-33, WD-38
Hertz, Alain	MD-06	Hung, Rose	MB-40	Jeanjean, Antoine	MD-03, MC-42
Hervet, Cédric	MA-08, MC-08	Hungerländer, Philipp	WA-16	Jelinek, Herbert	TB-31
Herzog, Florian	MB-20	Hunjak, Tihomir	MC-41	Jensen, Rune	MD-05
Heskes, Tom	WA-40	Hunjet, Dubravko	MD-36	Jeon, Jeasu	MC-35
Hesse, Martina	WB-39	Hunter, Paul	WD-39	Jerman Blazic, Borka	TA-21
Heuberger, Daniel	TC-29	Huppmann, Daniel	MA-26	Jiang, Hao-Ping	TB-03
Heydari, Somayeh	MA-25	Hurink, Johann	WB-37	Jimenez-Lopez, Mariano	MA-12
Hezarkhani, Behzad	MA-14	Hurkens, Cor	MB-02	Jin, Jianyong	MB-06
Hezer, Seda	TC-02	Huynh, Nha-Nghi	WC-10	Jin, Shunfu	WC-44
Hidayati, Hidayati	TA-34	Hvattum, Lars Magnus	MD-05	Jochem, Patrick	TB-35
Hielscher, Kai-Steffen	TC-13	Hwu, Tian-Jong	MB-27, MA-33	Jofre, Alejandro	MD-08
Higgins, Andrew	MA-17	Hyde, Matthew	TA-06	Johnsen, Eugene	WD-35
Hilbert, Andreas	WB-45			Johnson, Trond A. V.	MA-05
Hildenbrandt, Achim	MD-03	I		Johnson, Andrew	MA-36
Hildmann, Marcus	MB-20	Iaquinta, Gaetano	WD-43	Joncour, Cédric	TD-13
Hillege, Hans	WD-31, TD-37	Ibacache, Pablo	WD-03	Jones, Dylan	MA-07
Hiller, Benjamin	TC-29	Ibarra-Rojas, Omar	WD-03	Jongen, Geert	WC-25
Hilliard, Casey	MB-11	Ide, Jonas	WA-38	Jongen, Hubertus Th.	TA-15, MD-28
Hindle, Giles	MD-32, TB-32	Ignatavičius, Česlovas	WA-33	Jorgensen, Bjorn	TC-01
Hinojosa, Yolanda	WC-18	Imura, Takuya	MD-28	José Nogueira Medeiros, Wesley	TB-03
Hirsch, Patrick	TC-26, WC-37	Ijzerman, Hans	TC-28	Jost, Vincent	MD-03
Hiziroglu, Abdulkadir	TC-22	Ikem, Precious	TA-33	Jozefowska, Joanna	MA-02, MA-14
Hnich, Brahim	TA-24, TC-45	Ilani, Hagai	WB-14	Juan, Angel A.	MB-16
Ho, Chia-Huei	MA-39	Illés, Tibor	TD-14, WD-16	Juan, Angel, A.	WA-07, MB-16, MC-16
Hoang, Le	WB-04	Ilsen, Rebecca	TD-32	Juan, Pin-Ju	MB-39
Hobbesland, Kirsti	MD-05	Imai, Haruo	WB-34	Judice, Joaquim	WD-15
Hochreiter, Ronald	MA-19	Imanirad, Raha	WA-27	Jules, Sadefo Kamdem	MB-12
Hocine, Megloul	WC-40	Inci, A. Can	WB-21	Jung Grant, Susan	TC-21
Hoehener, Daniel	MD-04	Inkaya, Alper	MB-19	Junqueira, Leonardo	MA-09
Hoff, Arild	MC-07	Inoue, Ayaka	WB-29	Juristica, Ladislav	TB-09, WD-41
Hoffman, Karla	WD-01	Ioannou, George	TD-04	Jurun, Elza	TC-33
Hofmann, Ulla	TD-21	Irnich, Stefan	TC-11	Justel, Claudia	TB-05
Hohenberger, Annette	TC-28	Irzhavski, Pavel	TC-05	Juutinen, Artti	MD-38
Hohzaki, Ryusuke	WB-28	Isakovic, Vasko	TD-21, WD-21		
Hoji, Eduardo	TB-32	Iscanoglu Cekic, Aysegul	WB-19	K	
Holden, Phil	TD-16	Isenberg, Marc-André	WD-10	Kabak, Özgür	MB-03
Holeček, Pavel	MB-22	Isguder, Hanifi Okan	MC-06, MD-39, WC-42	Kabashkin, Igor	WD-44
Holler, Justus	TD-24			Kabasinskas, Audrius	MA-30
Holnicki, Piotr	TD-32	Ishikawa, Hiroshi	TD-08	Kabyl, Kamal	TD-05
Holschemacher, Klaus	WA-33	Isik, Mine	TC-31	Kaczmarczyk, Waldemar	TB-08
Hombach, Laura	TB-25	Ismayilov, Elviz	WC-22	Kadima, Hubert	TA-06, TA-31
Hon, Cheng-Chuang	MC-39	Isomaki, Hannakaisa	TD-38	Küfer, Karl-Heinz	MC-38
Hong, Seongtae	TD-34	Ivakhnenko, Andrey	WB-44	Köbis, Elisabeth	WA-38
Hooker, John N.	TA-27	Ivanov, Dmitry	TA-07	Köker, Michaela	WB-13
Horbach, Andrei	MB-02	Ivorra, Benjamin	MC-15	Kämpf, Uwe	TD-28
Horiguchi, Masayuki	TC-16	Iyigun, Cem	WB-24, WC-35	Körez, Muslu Kazım	WB-19, WC-19
Horta, Isabel	MD-36	Izbirak, Gokhan	WA-32	Kahl, Fredrik	TD-08
Hossein Mirzaei, Ali	TB-08			Kahraman, Cengiz	WC-22
Hotta, Keisuke	TC-20	J		Kakeneno, Joe	TA-32
Hou, Jiang-Liang	MB-40, MC-40	Jablonsky, Josef	MB-41	Kakouris, Iakovos	MD-19
Houda, Michal	MB-43	Jacobs, Neil	WA-04, WC-04	Kaletka, Mariusz	MD-04, MA-20
Housos, Efthymios	TD-09	Jacobson, Sheldon	WC-35	Kalinina, Maria	WC-38
Howard, John	WB-06	Jaehn, Florian	TA-02	Kalsyte, Zivile	MA-30
Hrd, Venkata	MA-36	Jäkel, Manuel	TA-28		
Hsiao, Yuan-Du	MD-39	Jakubiak, Michal	TC-07		

Kaluzny, Michael	WC-42	Kibzun, Andrey	TD-43	Kotlowski, Wojciech	WB-40
Kamanli, Mehmet	TC-31	Kidd, Martin	WA-04, WC-04	Kotsialos, Apostolos	MA-16
Kamp, Michael	TD-31	Kiesling, Elmar	MD-27	Kouedeu, Annie Francie	TB-45
Kan, Tang-Chung	MD-39, MA-40, MD-40	Kijima, Masaaki	MD-19	Koukoumialos, Stelios	MB-10
Kana Zeumo, Vivien	TC-27	Kilby, Philip	TB-07	Kouvela, Anastasia	TC-09
Kang, Chao-Chung	WC-30	Kilci, Firat	MB-17	Kovacevic Vujcic, Vera	WB-09
Kanudia, Amit	TD-16	Kilic, Erdem	TB-21	Kovalev, Sergey	TA-02
Kaparis, Konstantinos	MA-29, MB-29	Kim, Jun Seok	WD-29	Kovalyov, Mikhail Y.	MA-02, TA-02, MD-14, TB-14
Kara, Bahar Yetis	MB-17	Kim, Sang Won	MD-44	Kowalski, Dawid	MA-02
Kara, Yakup	TC-02	Kim, Sung-Shick	WD-29	Koyuncuoğlu, Mehmet Ulaş	WC-12
Karacapilidis, Nikos	TC-25	Kinoshita, Eizo	WA-36, TB-41	Kozan, Erhan	WC-12, MD-14
Karadayı, Neriman	WD-19	Kirilov, Leoneed	WB-27	Kraemer, Christian	TA-28
Karakoca, Aydın	WC-19	Kirytopoulos, Konstantinos	MC-14	Kralova, Eva	WD-24, MB-25, TD-33, WC-36
Karaman, Kayhan	TC-10	Kis, Tibor	WB-10, MD-18	Krarup, Jakob	MD-24, MC-30
Karaoglan, Ismail	WC-18, TD-23	Kittler, Josef	TA-44, TB-44	Krass, Dmitry	TA-18
Karelkina, Olga	WA-15, TA-38	Klabjan, Diego	MD-13, WC-45	Kratica, Jozef	WB-09
Karimov, Azar	TB-21	Klamroth, Kathrin	WA-38	Kraus, Sarit	WD-13
Karray, Salma	MA-45	Klein, Sulamita	WA-05	Krawczyk, Jacek	TB-16
Karsu, Ozlem	TA-27	Kleindorfer, Paul	WC-07	Kriett, Phillip	TA-13
Kartal Koc, Elcin	WB-24, WC-35	Kleniati, Polyxeni-Margarita	WC-15	Krislock, Nathan	MA-29
Kasap, Resat	WD-35	Klibi, Walid	TA-45	Kristensen, Anders Ringgaard	MC-26
Kaschub, Thomas	TB-35	Klimentova, Xenia	WA-37	Kristianto, Yohanes	WA-10
Kaspar, Ralf	WB-39, TA-41	Klingelhöfer, Heinz Eckart	WA-21	Kristjansson, Bjarni	WB-35
Kaspi, Moshe	MD-14	Klucik, Marian	TB-09, WD-41	Kritikos, Manolis	TD-04
Kasprzak, Marta	MB-37	Klucik, Miroslav	TD-44	Kroeller, Alexander	WB-17
Kassay, Gabor	TA-23	Klumbyt, Egl	WB-33	Kronborg, Morten Tolver	TA-19
Katin, Igor	WC-06	Kneib, Thomas	TB-29	Kroon, Leo	TD-12
Katina, Joana	WC-06	Knight, Vincent	WD-06, TB-37, WA-37, TB-42	Kropat, Erik	WD-22, TB-23
Katris, Chris	TB-20	Knippel, Arnaud	TD-13	Kruger, Alexander	TA-23
Katsev, Ilya	WA-34	Koç, Çağrı	TD-23	Kruger, Hennie	WD-29, TA-31
Katsifou, Argyro	MB-35	Koberstein, Achim	TC-43	Krumke, Sven	MB-02
Kaulakys, Bronislovas	MD-18	Kobylarczyk, Justyna	TD-34	Krushinsky, Dmitry	WA-17
Kaur, Parmjit	MC-32	Kobylkin, Konstantin	WB-44	Krysiak, Tomasz	TC-02, MD-14
Kaut, Michal	TC-12, MA-26	Koch, Marco K.	MD-25	Kubat, Gözde	MC-24, TD-34
Kawamura, Márcio	MC-13	Koch, Sebastian	WA-45	Kubiak, Wieslaw	MA-14
Kawano, Hiroyuki	TD-03	Koch, Thorsten	TB-29	Kubicka, Ewa	TD-05
Kawas, Ban	WA-42, WD-45	Koiliias, Christos	WB-37	Kubicki, Grzegorz	TD-05
Kaya, C Yalcin	MD-23	Kojic, Jovana	TC-34	Kucher, Vlad	WC-22
Kaya, Onur	MC-03	Kok, Gurhan	MB-24	Kucuk, Mahide	MA-23
Kayaci Çodur, Merve	MB-12	Koksal, Gulser	MA-28	Kucuk, Yalcin	MA-23
Kayakutlu, Gulgun	MA-03, MD-30, TC-31	Koksalan, Murat	MA-03	Kuefer, Karl-Heinz	MC-38
Kazancoglu, Yigit	TC-40	Kolisch, Rainer	WC-02	Kuehlwein, Daniel	WA-40
Kazina, Irina	MC-24	Komenda, Izabela	WA-37	Kuhn, Daniel	WB-42, TB-43
Kaňková, Vlasta	MB-43	Komiya, Toru	WC-28	Kuhn, Heinrich	MB-35
Keisler, Jeffrey	MC-27	Konarzewska-Gubala, Ewa	TD-20	Kuhn, Kenneth	TB-12
Kellerer, Hans	TB-02	Kong, Jiehong	TC-08	Kuhpfahl, Jens	MC-02
Kenne, Jean-Pierre	TB-45	Konnov, Igor	MC-31	Kuik, Roelof	MD-10
Kennedy, Deanna	WC-14	Kononovicius, Aleksejus	MD-18	Kuimova, Anastasia	WA-39
Kennedy, Jonathan	MC-35	Konstantaras, Ioannis	MC-06	Kula, Erhun	MD-26
Kentel, Elcin	TA-26	Kopa, Milos	TB-43	Kula, Ufuk	MB-28, TC-33, TB-45
Kentrait, Ausrä	TA-21	Kopanos, Georgios	WD-02, TA-25	Kulak, Osman	MA-05, TC-07, WC-12
Keren, Baruch	TA-36, TD-37	Kopfer, Heiko	MA-11	Kulak, Ozgur	MD-09
Kergosien, Yannick	TB-14	Kopfer, Herbert	MA-11	Kumar, Kundan	MA-10
Kern, Walter	WB-38	Kopytov, Rostislav	MC-24	Kundakci, Nilsen	MC-41
Keropyan, Aras	TB-19	Korhonen, Pekka	TD-29, WA-32, TB-39, MA-41, TC-41	Kunsch, Pierre	WC-40
Keshvari, Abolfazl	WA-32	Kornafel, Marta	MD-23	Kunter, Marcus	MA-45
Keskin, M. Emre	MC-08	Koronakos, Gregory	MB-36	Kunz, Friedrich	TC-32
Khachay, Michael	WB-44	Korviny, Petr	MA-22	Kuosmanen, Timo	WB-30, MA-36
Khadraoui, Djamel	WB-17	Koshlai, Ludmilla	TA-22	Kurasova, Olga	MB-07, WD-44
Khenchaf, Ali	WD-17	Kostina, Ekaterina	MC-04	Kurc, Wieslaw	MD-14
Khmelnitskaya, Anna	MB-31	Kostoglou, Vassilis	WB-37	Kuroiwa, Daishi	TC-38
Khokhar, Ashfaq	MA-37	Kostrzewska, Marta	TB-22	Kurz, Sascha	MC-34
Khoshgam, Zahra	MC-04	Kostyukova, Olga	TA-15	Kus, Coskun	WB-19, WC-19, WD-19
Khosravi, Somayeh	TB-15	Kothari, Ravi	MC-06	Kusanovic, Tino	TC-33

Kusunoki, Yoshifumi	WA-44	Lechevalier, Steve	WB-25	Lin, Shin-Yi	MB-39
Kuter, Semih	WC-35	Lee, Dong Myong	MA-44	Lin, Shu-Yu	MB-39
Kuyzu, Gultekin	MC-03	Lee, Gregory	MC-24	Lin, Ya-Han	MB-39
Kuznetsov, Mikhail	WB-26	Lee, Gue Myung	TC-38	Lin, Yao-Chang	MC-40
Kuznetsov, Nikita	TD-28	Lee, Hansuk	TD-34	Linck, Iris	WB-04
Kuzytutin, Denis	WC-06	Lee, Hong Tau	WB-27, WC-44	Linden, Isabelle	WC-27
Kydland, Finn	ME-01	Lee, Hwi Young	MD-45	Lindsey, Christopher	WC-45
Kylinger, Martin	MB-26	Lee, In-Young	TD-34	Lindstad, Haakon	WD-12
Kyriakidis, Thomas	WD-02	Lee, Jinwook	MB-21	Lino, M.Pilar	MC-14
Kinacı, İsmail	WC-19, WD-19	Lee, Mooyeob	MB-21	Liou, James	MB-41
Kıran, Mustafa Servet	TD-23	Leggate, Alexander	TD-14	Liour, Yuanchau	MC-39
Kıvrak, Abdulkadir	MB-26	Legillon, François	WC-03	Lipara, Carmen	TD-20
		Lehane, Kate	WD-45	Lisboa, Adriano	WB-21, MA-40
L		Lehmann, Thomas	TB-29	Lisser, Abdel	TD-43
La Red Martínez, David L.	WD-44	Lehuédé, Fabien	MA-17	Listes, Ovidiu	TD-07
La Spada, Simone	MD-11	Leitner, Markus	TC-04	Liu, Fuh-Hwa	MB-36
Labbé, Martine	TB-04, MA-08	Leitner, Stephan	MD-45	Liu, Jiyin	MB-05
Labriet, Maryse	TD-16	Lemarié, Bernard	WC-07	Liu, Mei-Ling	TC-45
Lachout, Petr	MB-43	Leme, Rafael C	TD-29	Liu, Shaofeng	WC-27
Lackes, Richard	TD-10	Lenté, Christophe	TB-14	Liu, Wenrong	TC-25
Løkketangen, Arne	MB-06, MC-07	Leon, Teresa	WD-29, MA-36	Liu, Xiaoming	WD-05
Lê, Minh	TC-36	Leonhardt, Alexander	TA-21	Liu, Yu-Cheng	MB-36
Löhne, Andreas	MB-38	Leopold, Ulrich	MA-03	Lium, Arnt-Gunnar	TC-12, MA-26
López Sánchez, Ana Dolores	TC-06	Leopold-Wildburger, Ulrike	TD-22	Liuzzi, Giampaolo	MB-29
López, Diana	MB-15	Lepin, Victor	TC-05	Ljubic, Ivana	TB-04, TC-04
López, Julio	WB-23, WC-23	Lerida, Josep Lluís	MD-43	Llamazares, Bonifacio	WB-26
López-Cerdá, Marco A.	TA-23	Leroux, Christian	MA-17	Llerena, Francesc	MD-34
López-Ibáñez, Manuel	MA-41	Leskovar-Špacapan, Gabrijela	MC-24	Llorente, Miguel Angel	MB-16
López-Redondo, Juana	TB-18	Letchford, Adam	WC-16, MA-29, MB-29	Lo, Mei-Chen	TA-20, MB-27, MA-33
Létocart, Lucas	WD-04	Leurent, Fabien	WB-12	Lobato, Marcus	WB-21, MA-40
Laganà, Demetrio	TC-11, TD-13	Levêque, Christèle	WC-07	Lodi, Andrea	MC-29
Lai, Mu-Hui	MD-39	Levaggi, Rosella	WD-20	Loeffler, Andreas	TC-21
Lai, Yi-Chiuann	MD-35	Levchenkova, Anatoly	MD-38, WB-38	Lonc, Zbigniew	WA-08
Lakhdar, Sais	TD-10	Levin, Genrikh	MA-10, TD-13	Lopes, Ana	WD-32
Lakner, Peter	WD-20	Levin, Yuri	TA-40, MA-44	Lopes, Carlos	MC-08
Lal, A.k.	WC-14	Levina, Tatsiana	TA-40	Lopes, Maria João	MA-08
Lambert, Amélie	MC-29	Levy, Marc	MC-21	Lopes, Rui Borges	TD-11
Lami, Isabella	TC-27	gencat.cat, Lorenzo	WD-38	Lopez, Pierre	WA-02
Lamorgese, Leonardo	WA-12	Li, Olga	MD-35	Lopez, Ruben	WA-15
Landete, Mercedes	MD-17	Li, Qing	MB-44	Lopez, Susana	MB-31
Landsman, Zinovi	TA-19	Li, Qing	MB-44	Lopez-Pascual, Joaquin	MD-17
Lange, Jan	TD-14	Li, Weiqi	TB-07, MD-21, WA-39	Lorenzo, Leticia	MA-24
Langevin, André	TC-11	Li, Xiang	TC-29	Lorenzo-Freire, Silvia	MA-24, MA-35
Langton, Sebastian	MB-03	Li, Xin	WD-05	Lourenço, Helena Ramalhinho	MB-16, MC-16
Lansink, Alfons Oude	MC-26	Li, Yan	TD-38	Love, Ernie	TC-45
Lantz, Frederic	WA-39	Li, Yongjun	WC-30	Lovison, Alberto	TA-38
Lančinskis, Algirdas	TC-18	Li, Zhiyong	WC-30	Lozano, Sebastián	TC-35
Lapegue, Tanguy	WB-02	Lian, Zhaotong	WD-05	Lozovanu, Dmitrii	MD-04
Laporte, Gilbert	TD-03, TA-05	Liang, Chih-Chin	MC-39	Lu, Hua-An	TB-11
Larrañaga, Pedro	WC-29	Liberatore, Federico	MC-33	Lu, Jung-Ho	MA-39, MC-39
Larsen, Christian	TB-08, TA-10	Lichner, Ivan	WC-21, MB-25	Lu, Ming-Tsang	MC-39
Larsen, Jesper	TA-07	Lichtenstein, Maciej	TC-02	Lubis, Asrin	TB-34
Larsson, Aron	TD-27, WC-38	Lidbetter, Thomas	TB-18	Lucheroni, Carlo	MD-16
Laskova, Maya	TA-33, TD-35	Lidestam, Helene	TA-08	Ludwig, Michael	WD-21
Laugier, Alexandre	MB-02	Lieder, Alexander	MD-02	Luhandjula, Monga K	MA-12
Lauks, Gunars	TD-36	Liefvooghe, Arnaud	WC-03, MA-41	Lukas, Elmar	TC-43
Laumanns, Marco	WA-42, WD-45	Lienert, Judit	TB-27	Lukasiak, Piotr	MD-37
Lavor, Carlile	MB-37	Liesa, Francisco	MD-11	Luna, Henrique	MB-08, TC-17
Layter Xavier, Vinicius	MA-16	Liesiö, Juuso	TD-27, WC-30	Luna, Mônica M. M.	WB-30
Lazarev, Alexander	TD-02, WB-14, TA-33, TD-35	Lim, Gino	MC-37	Luque, Mariano	TB-38
Le Thi, Hoai An	WB-17, WC-17, WD-17	Lima, Priscila	MA-16	Lusa, Amaia	MD-30, WC-41
Le, Hoai Minh	WC-17	Lin, Chin-Tsai	MA-39	Luss, Ronny	WA-23
Leal, Nuno	TA-29	Lin, Dong	MB-11	Lutzenberger, Fabian	WD-21
Lechón, Yolanda	WD-38	Lin, Hsuan-Tien	TD-40	Luz, Carlos J.	WB-16
		Lin, Hung Lung	MB-40	Lydia, Maya Silvi	TD-17
		Lin, Jenn-rong	MA-04		

Lyons, Daniel	WC-05	Marins, Fernando	WC-38	Meissner, Joern	MA-44
Lyra, Christiano	TD-24, MA-25	Marmaras, Nicolas	MA-32	Melchior, Philipp	WC-02
M					
M, Ganesh Perumal	WC-34	Marmolejo, Antonio	MD-30	Melnikov, Andrey	WB-15
M. Costa, Alysso	TC-13, MC-26	Maroti, Gabor	TD-12	Melo, Teresa	MA-17
Ma, Meng	WC-21	Maroto, Concepcion	MD-26, TD-26	Melo, Valdir	TB-06
Maç, Elif	MA-40	Marques, Inês	MC-06	Meltzer, David	WD-37
Maïzi, Nadia	TD-25, WA-25, WB-25	Marques, Rui	WC-32	Memmedli, Memmedaga	WB-22
MacCarthy, Bart	WC-13	Martein, Laura	MC-23	Mendes, Armando	TA-31
Macedo, Rita	MB-02, WC-07	Martel, Alain	TA-45	Mendoza, Jorge E.	MA-07
Machado Cardoso Junior, Moacyr	WA-29	Martello, Silvano	MC-29	Meneguzzer, Claudio	MB-11
Machado, Maria Augusta	TA-20	Martin Caraballo, Ana M.	WB-21	Menezes, Mozart	WD-18
Machowiak, Maciej	MA-02	Martin, Alexander	TB-29	Menoncin, Francesco	TA-19, WD-20
Maculan, Nelson	MB-37, TC-44	Martin, Simon	TC-14	Mera Vazquez, Ana	MA-25
Madan, Jason	WD-31	Martin-Campo, F. Javier	TA-29	Merchant, Sue	MC-32
Maenhout, Broos	WA-02	Martinez Sykora, Antonio	MB-09	Merino, María	WA-43
Müller, Sven	WA-16	Martinez, Carme	MD-30	Merkuryeva, Galina	MC-03
Mäkelä, Marko M.	WA-15	Martinez, Luis	MA-04	Merlo, Angelo	TA-42
Mészáros, András	TC-36	Martinez-de-Albeniz, Javier	MD-34	Mesa, Juan A.	TD-12
Maggioni, Francesca	MA-43, TC-43	Martinez-Martin, Pablo	WC-29	Meshkinfam, E.	MD-15
Magirou, Evangelos	MB-05	Martins de Sá, Elisangela	TC-17	Messinger, Margaret-Ellen	WC-39
Maglaras, George	MB-10	Mas, Marta	MD-30	Mesyagutov, Marat	TA-09
Magnusson, Johan	WC-41	Masala, Elena	TC-27	Meterelliyo, Emre	MB-26
Magos, Dimitris	TC-09	Mashira, Hildah	TA-33	Metla, Nataliya	WC-17
Maheut, Julien	TC-35	Massol, Olivier	TA-25, MD-33	Mevissen, Martin	WD-45
Mahmassani, Hani	MC-11, WC-45	Masson, Renaud	WB-03	Meyer, Anne	WC-07
Maia, Fábio	TD-06	Masui, Michiharu	MA-31	Meyer, Matthias	MD-45
Maisiuk, Yauhen	TA-05	Matallin-Saez, Juan Carlos	MB-30	Meyer, Patrick	TC-39, TD-39
Maiza, Mohamed	TD-10	Matano, Yoshinori	TB-28	Meyerov, Iosif	WA-23
Majewska, Justyna	TD-43	Mateo, Jordi	MD-43	Meyers, Kris	MB-45
Makajic-Nikolic, Dragana	WB-09	Mateo, Manuel	MD-30	Meza, Sergio	TB-22
Makarenko, Alexander	TC-33	Mathiesen, Lars	TB-16	Mezei, József	MA-22
Makulska, Joanna M.	TB-23, MC-26	Matos Dias, Joana	TD-19	Mianabadi, Hojjat	MC-40
Makuschewitz, Thomas	WD-10	Matos, Henrique	WC-41	Michaels, Dennis	MD-29
Malapert, Arnaud	MC-08	Matos, Telmo	TD-06	Michallet, Julien	WB-03
Malassé, Olaf	TD-36	Matsushita, Yasuhiro	MA-18	Michel, Sophie	TD-13
Maldonado, Michelli	MB-13	Matthews, Jason	WA-04	Michel, Terraza	MB-12
Maldonado, Sebastian	WB-29	Mattik, Imke	MA-13	Michelon, Philippe	WD-18
Malhamé, Roland	TD-16	Maturana, Sergio	TC-26	Michnik, Jerzy	MB-27, MA-33
Malick, Jerome	MA-29	Matzke, Andreas	WC-13	Midthun, Kjetil	MA-26
Maliene, Vida	WB-33	Mavri, Maria	MA-18	Mietek, Arleta	TD-22
Malitsky, Yuri	WC-03	Mawengkang, Herman	TD-17, TA-34, TB-34, TC-34	Miettinen, Kaisa	MD-38, TA-38, TB-38, TD-38
Malo, Pekka	TB-38	Maya Duque, Pablo Andrés	WA-14	Miglierina, Enrico	TD-15, WA-15
Mammeri, Mohamed, Lounes	TD-39	Mayag, Brice	TC-40	Miguéis, Vera	TD-31
Maneia, Gian Mauro	TA-42	Mayston, David	TB-36	Miguez, Geraldo	TC-44
Mangaraj, Bijaya Krushna	WC-38	Mazalov, Vladimir	TD-22	Mihályi, Péter	WD-36
Manger, Robert	WB-05	Mazauric, Vincent	WA-25	Mihalak, Matus	TB-03
Manitz, Michael	MA-42	Mazzola, Marco	TA-42	Mika, Marek	MB-14
Manni, Emanuele	TD-13	Mbiydzennyuy, Gideon	MB-03	Mikhailau, Mikalai	TA-05
Mannini, Livia	MD-11	McBride, Tom	TB-27	Milanic, Martin	WB-08
Manon, Yvan	MC-08	McComb, Sara	WC-14	Milioni, Armando Zeferino	MC-36
Manuel, Conrado M.	MA-31, MB-31	McDowall, Richard	WB-41	Milostan, Maciej	MD-37
Mar-molinero, Cecilio	MA-18, WA-32	McGarraghy, Seán	MA-08	Minh Thuy, Ta	WB-17
Marín, Ángel	TD-12	McGill, Jeff	TA-40	Minnetti, Valentina	TC-40
Marín, Alfredo	MD-17, WB-18, WC-18	McHale, Ian	WA-35	Minoux, Michel	MB-45
Marangoni, Giacomo	MC-31	McKinnon, Ken	MD-30	Minty, R John	TB-37
Marasovic, Branka	WB-20, MA-21, MB-33	Meca, Ana	MB-24	Mirabi, Mehrdad	MC-40
Marentakis, Charis	MA-11, WC-45	Medaglia, Andres	MA-07	Miralles, Cristobal	TC-25, WD-31
Mareschal, Bertrand	TC-39	Medineckiene, Milena	WC-33	Miranda, Gilberto	MB-08, TC-17
Marianov, Vladimir	WD-03, TA-17, TB-17	Medori, Jean-robin	MB-45	Miranda, Joao	WC-41
Marinakos, George	WA-24	Meeyai, Sutthipong	TD-41	Mirchandani, Prakash	MD-44
		Megel, Romain	WB-03, WB-35	MirHassani, Ali	TD-17
		Meherrem, Shahlar	WB-16	Mirkov, Radoslava	TB-29
		Mehmet, Kabak	TD-33, MD-41	Misener, Ruth	MC-29
		Mehta, Deepak	WA-03	Misevicius, Alfonsas	WD-04
		Meier, Arne	WA-08	Mishina, Tsutomu	WB-32, WC-40

Miskiewicz, Michal	MA-02	Muñoz, Jose	WB-18	Nigro, Marialisa	MD-11
Missbauer, Hubert	TA-13	Mueller, Christian	TA-42	Nikitina, Mariya	WC-20
Miyamoto, Yuichiro	WB-29, WB-38	Mula, Josefa	MA-12	Niknejad, Ali	TA-36
Miyashiro, Ryuhei	WB-38	Munari, Pedro	TB-07, WC-16	Nikolaev, Alexander	WC-35
Miyazaki, Kenji	TD-33	Munavalli, Jyoti R.	TB-37	Nikolakopoulos, Athanassios	MC-06
Mladenovic, Marko	WA-06	Murray, Robert	TA-16	Nikolic, Nebojsa	WB-09
Mladenovic, Nenad	WA-06, WD-09	Musatova, Elena	WB-14, TA-33, TD-35	Nikulin, Yury	WA-15
Mockus, Jonas	WC-06	Musial, Jędrzej	WD-26	Niroomand, Sadegh	TB-11
Modliński, Piotr	MA-14	Musmanno, Roberto	TC-11	Nishide, Katsumasa	MD-19
Moeini, Mahdi	WB-17	Mustajoki, Jyri	WC-26	Nishihara, Michi	WC-20
Moench, Lars	MC-02, MA-09, TA-13	Myndyuk, Olga	MD-43	Nishimura, Nobuhiko	WA-26
Mohamad Doost, Faeghe	TA-08			Niu, Yi-Shuai	WD-17
Mohamed Sidi, Mohamed Ahmed	WD-05			Nogales, Amaya	TC-18
		N		Nogueira, Loana	WA-05
Mohammadipour, Mona	TA-24	Nabavi, Vahid	TC-41	Noll, Torsten	TD-10
Mohaupt, Michael	WB-45	Nadal, Esteve	MC-26	Nolz, Pamela	MD-06
Mohr, Esther	WD-20	Nadri Pari, Mahdi	TD-17	Nonås, Lars Magne	MA-05
Molho, Elena	TD-15, WA-15	Nørstebø, Vibeke	MA-26	Nonobe, Koji	TD-09
Molina, Elisenda	MA-31, MB-31	Nafi, Amir	WA-27	Noordkamp, Wouter	WA-28
Molina, Julian	TC-06	Nagamochi, Hiroshi	TC-05	Norikumo, Shunei	TB-41
Monacelli, Daniele	TB-11	Nagaoka, Sakae	TA-04, TC-42	Norkin, Vladimir	TD-43
Monaci, Michele	WB-01	Nagel, Andrea	MA-11	Norlund, Ellen Karoline	TA-05
Monkkonen, Mikko	MD-38	Nagurney, Anna	TC-23	Nossack, Jenny	TA-02
Monroy Licht, Ingrid Marcela	TC-11	Nagy, Adrienn	WD-16	Nouioua, Karim	WB-03, WB-35
Monsuur, Herman	WA-28, WC-28	Nahorski, Zbigniew	TD-32	Novaes, Antonio G.N.	WB-30
Montella, Bruno	WB-12	Naibaho, Tutiarny	WA-17	Novo, Vicente	TD-15, WA-15
Montero, Javier	MC-33	Naima, Hamadouche	TC-42	Novozhilova, Marina	MD-09
Montevechi, José Arnaldo	WC-38	Nait Belkacem, Salima	WA-04	Nowak, Maciej	MB-27, MA-33
Montibeller, Gilberto	MA-27, TD-42	Nakhai Kamalabadi, Isa	TB-08	Nowak, Thomas	TC-23
Montoya-Torres, Jairo	WD-12	Naroski, Pawel	WA-08	Nowak, Uwe	MC-38
Montvida, Olga	MA-38	Nascimento, Leonardo	MD-23, WB-42	Nuhn, Eva	WD-22
Mor, Baruch	WB-11	Nascu, Ioan	WA-37, WD-41	Nunes, Ana Catarina	TD-11
Mor-Yaroslavtsev, Andrew	WB-38	Nasrollahi, Mahdi	MD-40	Nunez, Marina	MD-34
Mora-Stock, Cindy	WD-28	Nasrollahi, Meisam	WB-13	Nykamp, Stefan	MA-25
Morabito, Reinaldo	MA-09, MD-13	Nasution, Azizah Hanim	TA-34	Němcová, Zuzana	TC-13
Moraes, Leonardo	WB-42	Natividade-Jesus, Eduardo Manuel	WB-27		
Morais, Paulo	TD-29			O	
Morar, Ioan Radu	WD-41	Naujokaitis, Darius	TD-37	Oberscheider, Marco	TC-26
Moreira, Attus	MD-35	Naumann, Marc	TC-43	Ocaktan, Beyazıt	TB-45
Moreno, Eduardo	WA-42	Naumov, Andrey	TD-43	Ochoa, Gabriela	TA-06
Moreno, Luis	MC-02, MC-15	Navabi, M.	MC-15, MD-15, TB-23, WD-41	Odegaard, Fredrik	MD-44
Moretti, Antônio	TA-09, TB-33			Oggioni, Giorgia	MC-31
Morgado, Miguel	MB-27	Navidi, Hamidreza	WD-06	Oghojafari, B.e.a.	MB-41
Morgan, Jacqueline	WD-15, TB-16	Nayak, Shriguru	WD-23	Ogiwara, Kei	WB-32
Mori, Ryota	TA-04	Nazarenko, Olga	MB-10	Oguz, Ceyda	MC-01
Moriggia, Vittorio	WD-43	NDienor, Moussa	WD-40	Ohazulike, Anthony	WB-38
Morozkov, Mikhail	WA-42	Nediak, Mikhail	TA-40, MA-44	Ohst, Jan Peter	WB-05
Morsi, Antonio	TB-29	Neiva, Rui	TD-29	Ohya, Takao	TB-41
Morton, Alec	TA-27	Nel, Hannelie	WA-04	Ojalehto, Vesa	TD-38
Morze, Michal	MA-02	Nenes, George	MA-28	Ojzyńska, Anna	TA-37
Moser, Albert	TA-28, TC-29	Neralic, Luka	MD-36	Okhrin, Irena	MD-13
Moser, Elke	MC-04	Nesterov, Yurii	MD-29	Oktay Firat, Seniye Ümit	MB-26
Mosheiov, Gur	WB-11	Neto, Jose	WD-05	Okuhara, Koji	WA-10, TA-45
Mosquera Rodríguez, Manuel Alfredo	MB-24	Neufeld, Janis Sebastian	MC-02	Okuno, Takayuki	TB-15
		Neumann, Ludmila	MC-36	Olabode, Adewoye	MD-21
Mostert, Erik	MC-40	Neves, Manuela	TD-24	Oliveira Moreira, Mayron César	TC-13
Motahhari, Seyyed Mahdia	TD-17	Ng, Chi To	MC-10		
Motrenko, Anastasia	TD-44	Nguyen Duc, Manh	WC-17, WD-17	Oliveira, Aurelio	MD-25
Mottl, Vadim	TB-22	Nguyen, Khanh	WB-21	Oliveira, José Fernando	MB-09, MC-09
Moulis, Frederic	MC-08	Nickel, Stefan	MC-17, TB-17	Oliveira, Luis	WD-32
Moura, Pedro	TC-04	Nicoloso, Sara	WA-09	Oliveira, Marisa	MA-09
Mourad, Amad	MD-08	Nielsen, Jens Perch	TB-19	Oliveira, Ricardo	WC-32
Mourão, Cândida	TD-11	Nielsen, Lars Relund	TA-10	Oliveira, Sandra Cristina	MC-21
Mourtos, Yiannis	TC-09	Niemann, André	MD-25	Olsson, Leif	TD-27
Mousseau, Vincent	TD-39, TC-40	Nieto-Gallardo, Gracia M.	TC-15	Olteanu, Alexandru-Liviu	TC-39
Moustapha, Diaby	MB-45				

Onel, Selis	TC-43	Paiva, Anderson Paulo	TD-29	Pennings, Clint	TA-24
Onn, Shmuel	MD-29	Paixão, José	MA-21, TB-21	Pensa, Stefano	TC-27
Onoda, Takashi	WA-44	Paksoy, Turan	TD-23	Perau, Eugen	MD-25
Onsel, Sule	MB-03	Palacio, Antonio	TC-35	Perea Olabarria, Eugenio	MA-25
Onucyildiz, Mustafa	TA-26	Palka, Piotr	WB-06	Pereira, Ana I.	MD-15, TA-15
Oorni, Anssi	TB-39	Pallas, Sabine	MD-25	Pereira, António	MB-37
Opolchenov, Daniil	WC-30	Palomo Zurdo, Ricardo	TA-39	Pereira, Javier	TA-21
Oppen, Johan	MC-07, MC-11	Pan, Jason Chao-Hsien	MA-39	Pereira, Luis Gustavo	TB-03
Oprime, Pedro	MB-28	Pan, Quan-Ke	WA-11	Pereverza, Kateryna	WC-41
Or, Ilhan	TC-19	Panagioutidou, Sofia	MA-28	Perez Gonzalez, Paz	TD-02, WB-11
Oral, Evrim	WB-19, WC-19	Pando, Valentín	MD-10	Perez Valdes, Gerardo	MA-26
Orlov, Alexej	WA-41	Pang, King-Wah	MB-05, WD-26	Perez, Gloria	WA-43
Orlovich, Yuriy	TC-05	Pankratov, Alexander	MB-09	Perez, Juan	MD-08
Orlovs, Pavels	MA-38	Pankratova, Yaroslavna	WC-06	Perez-Marin, Ana Maria	TB-19
Ortega Riejos, Francisco A.	TD-12, MD-17	Pankratz, Giselher	MA-11	Perić, Tunjo	MC-45
Ortigosa, Pilar M.	TB-18	Panovic, Milena	WD-27	Perraudin, Xavier	MA-17
Ortobelli, Sergio	TC-19	Panteli, Antiopi	TA-17	Pervukhina, Elena	TA-22
Ortuño, M. Teresa	MC-33	Papadimitriou, Dimitri	MB-08	Pesch, Erwin	MA-02, TA-02, MD-14
Ossadnik, Wolfgang	WB-39	Papadopoulos, Thanos	MB-32	Peska, Ladislav	TD-41
Osswald, Christophe	WD-17	Papamichail, K. Nadia	MB-27	Pesneau, Pierre	TC-04
OSullivan, Barry	WA-03	Papayanopoulos, Lee	WD-04	Pessoa, Luciana	MB-16
Osuna-Gómez, Rafaela	TC-15	Pappis, Costas	TC-25, TB-37	Peters, Georg	WB-22
Otradnova, Lina	WD-24	Paquet, Marc	MD-10	Petersen, Hanne	TC-06
Otto, Alena	TC-13	Paradi, Joseph	MC-18	Petrelli, Marco	TA-11
Oubraham, Aichouche	WC-12	Pardalos, Panos	WA-17	Petrovic, Slavica P.	WA-36
Ouelhadj, Djamila	TC-14	Paredes, Fernando	TA-21	Petrucci, Vinicius	WB-03
Oulamara, Ammar	TB-14	Pareja, Paloma	MC-19	Peypouquet, Juan	WC-23
Ouyang, Liang-yuh	MA-39	Park, Jonghyuck	WD-29	Pfeiffer, Dominik	TA-07
Ovchinnikov, Anton	TA-40	Park, Young Woong	WC-45	Pflug, Georg	MA-43
Owadally, Iqbal	TA-19	Parkes, Andrew J.	TA-06	Pfossier, Stefan	TD-21
Owen, Guillermo	MB-31	Parnaudeau, Virginie	WD-40	Pham Dinh, Tao	WB-17, WC-17, WD-17
Oxley, Tim	TD-32	Parpaillon, Jean	MC-08	Pham, Viet Nga	WD-17
Oyatoye, Emmanuel O.	MB-41	Parreno, Francisco	MA-09, MC-09	Phelps, Fatma Selcen	WD-35
Oyola, Jorge	MC-07	Paschenko, Yuriy	MB-10	Phillips, Antony	WC-14
Ozaydin, Ozay	MB-03	Pash, David	TD-14	Piantadosi, Julia	MD-16
Ozbudak, Ferruh	WC-42	Pasichny, Alexis	WD-22	Piccolo, Carmela	TA-18
Ozceylan, Eren	TD-23	Paslowski, Jerzy	MB-33	Pichl, Lukas	MA-21
Ozdemir, Ozer	WB-22	Passarella Freire, Wilhelm	MD-23	Pichler, Alois	MA-43
Ozdemir, Ozge	MA-26	Passerini, Andrea	WA-40	Pickl, Stefan	WD-22
Ozekici, Suleyman	WD-21	Paszto, Peter	TB-09, WD-41	Pidani, Fariba	WD-16
Ozener, Okan	MC-03	Patek, M.t.	MB-13	Pietropaoli, Ugo	WA-09
Ozgur, Leyla	TC-03	Paterson, Colin	TB-42	Pigden, Tim	MA-07
Ozkok, Erengul	WD-20	Pato, Margarida	MC-06, TA-26	Pillac, Victor	MA-07
Ozogur-Akyuz, Sureyya	TC-44	Paucar-Caceres, Alberto	MA-32	Pillon Torralba Fernandes, Jéssica	WC-25
Ozpeynirci, Ozgur	WA-14, TC-40	Paul, Anand	WC-02	Pilvar, Rahman	MC-11
Ozpeynirci, Selin	TC-40	Paul, Rahul	MA-10	Pilz, Kay	MB-18
Ozturk, Gurkan	TB-07, MC-16, WA-29	Pavlov, Alexander	TA-07	Pimentel, Carina	MA-13
Ozturkkal, Belma	TD-42	Pavlovic, Ljiljana	TC-05	Pindoria, Sandip	WB-35
Oğcu, Gamze	MB-26	Pawlak, Grzegorz	MA-02	Pinheiro, Sofia	TB-05
P					
P. Fernandes, Florbela	MD-15, TA-15	Peña, Gloria	MC-02	Pinho de Sousa, Jorge	WD-03, TD-07
Pacheco, Maria F	WB-16	Pecaric, Mario	TC-33	Pini, Rita	TD-15
Pacino, Dario	WC-03, MD-05	Pechinkin, Alexandr	TD-36	Pino, José L.	TD-18
Pacqueau, Rémi	WB-04	Pechlivanos, Lambros	WC-45	Pinson, Eric	TA-07
Püster, Johannes	TD-24	Pedraza Martinez, Alfonso	WC-10	Pinto Ferreira, M ^a Eduarda	MA-09
Paetz, Alexandra-Gwyn	TB-35	Pedraza-Martinez, Alfonso	WC-10	Pinto_Varela, Tânia	TA-30
Pérez Perales, David	TC-08	Pedro, Isabel	WC-32	Pires, José	MA-08
Pérez, M. Angeles	MC-14	Pedroso, Joao Pedro	MA-25, WA-37	Pirlot, Marc	TA-20
Péton, Olivier	MA-17	Peeters, An	TD-24	Pisciella, Paolo	TA-43
Pagel, Christina	WC-37	Pekár, Juraj	MD-03	Pisinger, David	MC-05, WC-09
Pahikkala, Tapio	TD-40	Pekcan, Onur	WD-28	Pistikopoulos, Efstratios	TA-25, MC-29
Paias, Ana	MA-08	Pekgör, Ahmet	WC-19	Pitzer, Erik	MC-03
Paillat, Jean-Marie	WD-40	Pelegrin, Blas	TC-18, TD-18	Piunovskiy, Alexei	TC-16
		Pelizzari, Cristian	MA-19	Pivac, Snjezana	MD-21, TC-33
		Pelot, Ronald	MB-11		
		Peng, Shili	WD-15		
		Penna, Puca	WB-03		

Pizarro Romero, Celeste	MC-33	Puente, M. Albina	MC-34	Rasoolinezhad, Zeinab	TB-06
Pizarro, Jose	MC-20	Puerto, Justo	TD-12, TB-18, WB-18, WC-18	Rathgeber, Andreas	TA-21
Pla, LluísM	MC-26, MD-43	Puetz, Markus	TD-45	Ratli, Mustapha	MB-02
Placido, Antonio	WB-12	Pukalskyi, Bohdan	WA-41	Rauch, Jonas	WB-45
Plastria, Frank	TC-18, WB-34	Purba, Ronsen	WA-17	Rauscher, Sandra	TB-42
Plateau, Gérard	WA-03, WD-04	Pureza, Vitoria	MB-28	Raz, David	MD-08
Plaza Leiva, Victoria	TB-18	Purutcuoglu Gazi, Vilda	WB-24	Razmi, Jafar	WB-13
Plazola Zamora, Laura	MC-33	Pylypovskyi, Oleksandr	TA-22	Reade, Andy	TB-25
Pliskin, Joseph	TD-37	Pytlak, Radoslaw	MD-04	Rebaine, Djamel	TB-14
Plociennik, Kai	MC-38			Recht, Peter	TD-05
Poberiy, Maria	WB-44			Redchuk, Andrés	WD-38
Poddig, Thorsten	WA-21			Reddy, Brian	TD-39
Podkopaev, Dmitry	MD-38			Reed, Joshua	WD-20
Podobedov, Vitaly	WD-24			Rego, Cesar	TD-06
Poesz, Attila	TC-41			Reimann, Marc	WA-24
Poklepović, Tea	WB-20			Reimers, Stian	TC-24
Polat, Olcay	TC-03, MA-05, WC-12			Reinecke, Philipp	TD-36
Polat, Refet	WB-16			Reinelt, Gerhard	MD-03
Poldi, Kelly	TD-10			Reinhardt, Wolfgang	WD-22
Polovinkin, Alexey	WA-23			Reizes, Erwin	TB-28, TD-41
Polushina, Tatiana	WD-42			Reklaite, Agne	WB-34
Polyak, Boris	WA-01			Relvas, Susana	TA-10, TA-29
Pomarico, Silvia	TC-27			Requejo, Cristina	MB-37
Pons, Montserrat	MC-34			Resat, Giray	TB-33
Poole, Travis	TA-16			Resende, Mauricio	MB-16
Pop, Emilia-Loredana	MB-38			Rest, Klaus-Dieter	WC-37
Pope, Brandon	MB-30			Reunanen, Pasi	MD-38
Porcheron, Marc	MC-44			Reuther, Markus	WA-12
Porschen, Stefan	WA-08			Revie, Matthew	TA-16
Portal, Gabriel	WC-03			Rey, David	TA-29
Portela, Maria	MB-36, MC-36			Reyer, Ivan	TB-44
Portillo, Fabiola	WA-32			Rezapoor, Shabnam	MC-10
Possani Espinosa, Andre	WB-39			Rezapour, Shabnam	TA-08
Possani, Edgar	WD-07, WB-39			Rezgui, Mohamed	MC-08
Post, Gerhard F.	MA-09			Ribeiro, Cassilda	TA-09
Postmus, Douwe	WC-26, WD-31, TA-37, TD-37			Ribeiro, Celso	MB-06
Potapovs, Andrejs	WB-38			Ribeiro, Cristina	MB-09
Potthoff, Daniel	TD-12			Ribeiro, Patrícia	TA-29
Potts, Chris	WA-35			Ribeiro, Rita	WC-27
Pourouchottamin, Prabodh	WA-25			Ricca, Federica	MA-19
Pozo, Miguel Angel	TD-12, MD-17			Riccardi, Rossana	MC-31
Prachalias, Chrysovaladis	WD-32			Ricci, Olivia	WA-25
Pranevicius, Henrikas	MA-37			Richards, Deborah	WD-12
Pranevicius, Mindaugas	MA-37			Richards, Russell	MB-25
Pranevicius, Osvaldas	MA-37			Richter, Knut	MD-13
Prasanna, G. N. Srinivasa	MA-10, WD-23, WB-25, WC-34			Riera, Daniel	MB-16
Pratsini, Eleni	WA-42, WD-45			Rijo, Pedro	TA-08
Prekopa, Andras	MB-21, MD-43			Rinaldi, Francesco	MB-29
Prestwich, Steven	TA-24, WD-42, TC-45, WD-45			Rios-Insua, David	MD-33, WD-38
Prieto, Angel M.	MA-38			Rios-Mercado, Roger Z.	MC-26
Prieur, Fabien	TB-16			Rios-solis, Yasmin	WD-03
Prigent, Jean-luc	WA-20			Ritt, Marcus	WC-03
Prins, Christian	WC-07			Ritzinger, Ulrike	TA-45
Prior, Diego	WA-32			Rivreau, David	WA-02
Prochorskaite, Agne	WB-33			Robledo, Jose	MC-33
Prodan, Radu	WA-37			Rocha, Humberto	TD-19
Prot, Damien	WB-02			Rocha, Paula	WB-42
Protti, Fabio	WA-05			Rocha, Pedro	MD-09
Prskawetz, Alexia	MC-04			Rocha, Roger	WB-42
Psarftis, Harilaos	MB-05			Rodríguez Álvarez, Margarita	TB-15
Pticina, Irina	TD-02			Rodríguez, Victoria	TD-07
Puchinger, Jakob	TA-45			Rodríguez-Puerta, Inmaculada	TC-10
Puechmorel, Stephane	TA-04			Rodrigues, Antonio	TB-24, WB-24
				Rodrigues, Rui	MD-09
				Rodriguez Aguilar, Roman	MA-30
				Rodriguez, J. Tinguaro	MC-33

Rodriguez-Chia, Antonio Manuel	WB-18	Safia, Kedad-Sidhoum	TD-09, WD-09	Schmidt, Christiane	WB-17
Rodriguez-Sanchez, Sara Veronica	MC-26	Sagarra, Martí	MA-18	Schmidt, Günter	WD-20
Rodriguez-Ulloa, Ricardo	MA-32	Sagbansua, Lutfu	TD-06	Schmidt, Kerstin	WD-13
Roitch, Vladimir	TB-43	Sager, Sebastian	WB-45	Schmidt, Marie	TB-12
Rojas-Medar, Marko A.	TC-15	Saha, Rajib	TA-37	Schnell, Alexander	WA-02
Rokou, Elena	MC-14	Sahin, Oz	MB-25	Schoen, Cornelia	TA-35
Roland, Julien	TB-39	Sahman, Mehmet Akif	WD-10, WA-30	Schoenauer, Marc	WB-40
Romanin-Jacur, Giorgio	MA-06	Sakalauskas, Leonidas	MA-30, WB-42	Scholten, Lisa	TB-27
Romanova, Tatiana	MB-09	Salani, Matteo	MB-11	Scholz-Reiter, Bernd	WD-10
Romero, Ruben	TB-09	Salasc, Baptiste	WA-26	Schoppmeyer, Christian	WA-30
Ronconi, Debora	MC-13	Salazar González, Juan José	WA-07	Schröder, Andreas	TC-32
Roos, Kees	MD-42	Saldanha, Rodney	WB-21, MA-40	Schrödl, Holger	MB-14
Ropke, Stefan	TC-06	Saldanha-da-Gama, Francisco	MA-17, MC-17, TB-17	Schramme, Torben	WA-02
Roset, Alain	WC-07	Sales, Alessandro	WB-14	Schreiber, Ulrich	MD-25
Rosseti, Isabel	MB-06	Saliba, Sleman	MB-02	Schreider, Sergei	WD-06
Rossi, André	TA-06, WB-09	Salkın, Sultan Ceren	MA-42	Schroeder, Werner	WA-10
Rossi, Fabrizio	MA-29	Salles Neto, Luiz	TA-09, TB-33	Schultmann, Frank	TD-20, WD-27, TD-32
Rossi, Riccardo	MB-11	Salman, Sibel	MC-03	Schultz, Rüdiger	MD-29, TB-29, WB-43
Rossi, Roberto	TA-24, TC-45	Salo, Ahti	TD-27, WC-30	Schwab, Melanie	TC-07
Rossi, Sebastiano	MB-20	Salvador, Manuel	MD-18	Schwaninger, Markus	WC-40
Rossomakhine, Serguei	TD-04, TC-16	Samii, Behzad	WA-26, MB-45	Schwarze, Silvia	MC-05
Rotaru, Kristian	WA-27	Samouylov, Konstantin	TD-36	Schweiger, Jonas	TB-29, TA-43
Roupin, Frederic	WA-03, MA-29	San-José, Luis A.	MD-10	Schwindt, Christoph	WB-02
Rouwette, Etienne	MA-27	Sanchez-rodriguez, Luis	TB-35	Sciomachen, Anna	TA-11
Rovatti, Riccardo	MC-29	Sander, Onderstal	MB-18	Scozzari, Andrea	MA-19, MB-20, WB-20
Rozenknop, Antoine	WA-03	Sandikci, Burhaneddin	WD-37	Sebag, Michèle	WB-40
Rozga, Ante	WC-21	Sano, Marcello	MB-25	Sedlak, Otilija	WB-10
Rozin, Boris	MA-10	Santos Martin, M. Teresa	TD-42	Seferlis, Panos	WC-45
Rozycki, Rafal	MB-14	Santos, Dorabella	MB-08, MC-08	Segovia-Gonzalez, M. Manuela	WB-21
Ruan, Yu-Xun	TD-40	Santos, Felipe	WB-21, MA-40	Segura Maroto, Marina	MD-26, TD-26
Rubio, Sergio	WC-41	Santos, Jorge	TA-31	Segura, Baldomero	MD-26, TD-26
Rudec, Tomislav	WB-05	Santos, Maristela	MA-13, MD-13	Seidmann, Abraham	WC-34, TA-37
Rufián-Lizana, Antonio	TC-15	Santos, Paulo Sergio	WC-23	Seifert, Matthias	MC-27
Ruhland, Johannes	TA-37	Santos, Sérgio	WC-32, MD-35	Seifert, Ralf W.	MB-35
Ruiz, Ana Belen	TB-38	Santos-Peñate, Dolores R.	TC-18	Sel, Çağrı	TC-08
Ruiz, José L.	MA-36	Sarabando, Paula	MC-27	Selih, Jana	WB-33
Ruiz, Marc	MB-08	Saraiva, Erlandson	WB-30	Selim, Shokri	MA-10
Ruiz, Natalia	WC-23	Sarto, José Luis	MD-18	Sellami, Khaled	TA-31
Ruiz, Ruben	WA-11	Sartik, Yunus	MB-26	Selosse, Sandrine	WA-25, WB-25
Ruiz-Garzón, Gabriel	TC-15	Satiroglu, Sait	TB-20	Sels, Peter	TB-12
Ruiz-Hernandez, Diego	MD-17	Sato, Kimitoshi	MA-44	Sena, Galeno	TA-09
Rusdiana, Siti	TB-34	Sato, Yuji	WD-13	Sender, Julia	TB-03
Rustem, Berc	MD-19	Sawada, Kiyoshi	WB-05	Sener, Emrah	TB-20
Rustogi, Kabir	TB-02	Sawaki, Katsushige	MA-44	Sener, Nazmi	MC-12
Ruuska, Sauli	TA-38	Sbihi, Abdelkader	WB-05	Sengul, Serkan	TC-22
Ruza, Vecislavs	MD-12	Scandolo, Giacomo	MB-19	Senna, Fernanda	MC-37
Ruzika, Stefan	WB-05	Scarpel, Rodrigo	WA-29	Senturk, Sevil	WC-22
Ruziyeva, Alina	WB-15	Schüle, Ingmar	MC-38	Serafini, Paolo	TB-39
Ryan, David	WC-14	Schöbel, Anita	TA-01, TB-12, MB-29, WA-38	Serpell, Martin	TD-30
S		Schäfer, Andreas	TA-28	Sethi, Suresh	MA-45
Saatkamp, Helmut	MC-26	Schäfer, Ulrich	TD-45	Sevaux, Marc	MC-03, TA-06, WD-09
Sabeghi, Narjes	TB-18	Schönberger, Jörn	MA-11, WA-45	Seyhun, Omer Kayhan	MA-20
Saborido Infantes, Rubén	TB-38	Schöpferl, Andreas	MA-13	Sezer, Demet	WC-19, WD-19
Saboya, Martha	MB-31	Schatka, Anne	TB-25	Sezer, Devin	WC-42
Sadeh, Arik	WA-27	Schaudt, Oliver	WB-08	Shabtay, Dvir	MD-14
Sadoghi, Amirhossein	TA-08	Scheimberg, Susana	WC-23	Shafransky, Yakov	TA-02, TA-14
Sadyadharma, Hendaru	TA-34, TC-34	Scheithauer, Guntram	TA-09	Shahraki, Narges	TB-11
Sadiç, Şenay	TD-07	Schewe, Lars	TB-29	Sharifi, Mohammad Bagher	MC-40
Sørensen, Michael	MA-29	Schlechte, Thomas	WA-12	Sharma, Megha	MB-45
Sürmeli, Gökhan	TC-44	Schlegel, Patrice	WA-40	Shaw, Duncan	TA-32
Süss, Philipp	MC-38	Schmehl, Meike	TC-25	Shen, Hwa-Rong	MA-39
Sörensen, Kenneth	MD-01, WD-07, WA-14, TD-22, WD-24	Schmid, Verena	WA-07		

Sherali, Hanif	WD-15	Sobeyko, Oleh	MC-02	Steponavice, Ingrida	TA-38
Sherker, Shauna	MB-25	Sobotka, Fabian	TB-29	Sterna, Malgorzata	MA-02
Shevchenko, Yaroslav	WA-41	Sobotka, Olena	TD-20	Sternbeck, Michael	MB-35
Shi, Xiaoning	MC-05	Socha, Leslaw	TB-22	Stetsyuk, Petro	TA-22, TC-22
Shibata, Takashi	WC-20	Sofronov, Georgy	WD-42	Steuer, Ralph E.	WB-20
Shih, Su-Chuan	TA-41	Sohn, So Young	MB-21, MC-35	Stewart, Theodor	MB-27, TD-34
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