

From OR to Trustworthy Al: the experience of the Tuples project Matteo Pozzi, OPTIT srl, Italy

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Who is Optit?

We support decision-making providing tailored Systems & Services based on Operations Research, Data Science, Advanced Analytics & Artificial Intelligence



A Team made of 50+ Engineers, Mathematicians, Physicists, Data Scientists

and SW Developers



Bologna: HQ Cesena: Software Factory New York: US Office







Who is Optit?



CHCP Systems' Generation Management

DHC Operations and Development Optimization

DHC Network Maintenance Planning INDUSTRY & SERVICES

Digital Innovation support (industry 4.0)

Process Workflow Digitalization

Optimized Scheduling

Customized Decision Support Services ANALYTICS & OPTIMIZATION

Advanced & Customized Models And Algorithms

Business Intelligence

Machine Learning And Data Science

Data Mining

LOGISTICS & SUPPLY CHAIN

Distributive Logistics

Network Design

3-2d Bin Packing

Workforce Strategic Placement

Fleet Track & Tracing



Collection Services

On Demand Logistics

Waste Supply Chain

Waste Asset Allocation

Strategic Support Services





Different approaches: Symbolic vs. Data-driven vs. hybrid DSSs







Trustworthiness in Human-Centric A.I.



International Outreach IIInTouch EU

- 1. Human Agency and Oversight.
- 2. Technical Robustness and Safety.
- 3. Privacy and Data Governance.
- 4. Transparency.
- 5. Diversity, Non-discrimination and Fairness.
- 6. Societal and Environmental Well-being.
- 7. Accountability.





INDEPENDENT

HIGH-LEVEL EXPERT GROUP ON.

ARTIFICIAL INTELLIGENCE

SET UP BY THE EUROPEAN COMMISSION

ETHICS GUIDELINES

FOR TRUSTWORTHY AI

The TUPLES project

Trustworthy Planning and Scheduling with Learning and Explanations

- 3-year project (Oct 2022-Sep 2025)
- Budget: € 3.798.285,00
- Objective: Building trustworthy Al for planning and scheduling
- Focus: Robustness: Stability vs. small changes in the input
 Safety: Avoid risk of injuries or death
 Transparency: Explain why particular decisions are favoured
 Scalability: Tackle significant problems from the real world





The TUPLES consortium

• 8 partners: 5 Universities + 3 companies with 5(+1) use cases







UC1: Scheduling and logistics in aircraft manufacturing (AIRBUS)

Production demands

Availability of Beluga flights, jigs & trailers

 \checkmark

Scheduling of manufacturing logistics







UC1: Scheduling and logistics in aircraft manufacturing

Logistics planning	Challenges	Approaches			
Production demands and Beluga flights are uncertain.	Scalability : the system has to generate or update the logistics	Supervised Learning to learn PDDL heuristics (GOOSE algorithm)			
<i>Currently planned manually by 2-3 teams, using large rack space buffers to absorb uncertainty</i>	15 mn. Robustness: under disruptions,	Reinforcement learning for policy learning			
	system has to propose a feasible plan with high success probability in less than 15 minutes.	Psychology study on planning workers' perspectives and needs from an Al support tool			
	Explainability : the system has to provide different options and explain consequences of what-if scenarios	Minimum Unsatisfiable Property Subset Explanations			





UC1bis: Manufacturing Resource Allocation (AIRBUS)

Production demands

Teams & resources availability







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optimal solutions



UC2: Virtual AI assistant for pilot aircraft operation (AIRBUS)

An emergency occurs during a flight

Location, fuel, weather conditions



Planning to which airport divert the aircraft







UC3: Squad management for professional football clubs (SciSports)







UC4: Smart energy systems optimisation (OPTIT)

Energy demand to be met Complex energy generation plant



Scheduling of plant operation







UC4: Smart energy systems optimisation

Unit committment problem	Challenges	Approaches			
<i>Now managed as deterministic, but inputs are NOT deterministic</i>	Robustness : heating or cooling demand, electric market prices, and sometimes production unit availability, are stochastic	UNIFY method, a generalised Decision Focused Learning hybrid approach that combines RL and Constrained Optimization			
	Explainability : being able to explain why a given plan has been generated instead of another.	Contrastive explanations.			





UC5: Waste collection optimisation (OPTIT)

Several thousands bins to be collected

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Max shift time, Max truck capacity

Routing of waste collection trucks







UC5: Waste collection optimisation

Multi objective CVRP

Challenges

Approaches

Total number of trucks and shifts; Total distance of trips; Total duration of trips; Compactness of trips; Overlapping of areas covered by trips; Fairness of duration between trips. **Robustness**: quantity of collected waste, service-time duration, and travel-time duration are stochastic

Explainability: being able to explain why a given bin has been assigned to one trip instead of another.

Psychology study on the relative impact that human-Al agreement and outcome quality have on trust in the Al system.

Alternative clustering and visualization techniques (Pareto front exploration, Constrained clustering)

Contrastive explanations, Explainable constraint solving.





A multi-disciplinary approach, to include several perspectives with a focus on the quality of Human-machine/Human-AI interactions

PARTIES INVOLVED

- Al researchers
- OR researchers
- Use case owners (domain experts, end customers, business consultants)
- Psychologists
- Ethics and Al regulations consultants (legal experts)

COLLABORATION MEANS

- Multi-disciplinary teams tailored to each use case challenge
- Joint discussion on the Trustworthiness implications in each case
- Focus on approaches that improve robustness and explainability of the models
- Distill findings in a Self Assessment Tool intended for non-experts





The Self Assessment Tool

An easy-to-use diagnostic survey

that any solution provider may adopt to evaluate the coherence of their specific method with respect to the key EU guidelines on trustworthy, reliable, robust and safe Al

It has the objective of fostering awareness on Trustworthiness of Al and supporting developers of **planning and scheduling solutions** in the **evaluation of the compliance of their systems** in work environments.

Welcome to the TUPLES Self-Assessment Tool for AI Planning and Scheduling systems.

This tool is designed to help European organizations critically assess and optimize their AI systems used in planning and scheduling operations.

Purpose

The primary objectives of this self-assessment tool are to ensure your Al system is:

- Highly effective in achieving its intended purpose
- Fully aligned with ethical standards and regulatory requirements
- Compliant with EU best practices in

Were employees and their representatives informed and consulted before the introduction of the AI planning and scheduling system?

Yes	0	
No	0]
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Score level: Low

Your Al system's fairness, and impact on work and the environment requires improvement.

Recommendations: The current state of your AI system appears to inadequately address fairness, worker well-being, and environmental considerations. This could lead to workplace dissatisfaction, workers skill degradation, and undesirable environmental impact. To address these issues, please consider taking the following actions:





The Beluga[™] Al Challenge: a chance to be engaged







A novel competition platform to compares models (not results)

- When faced with launch of competition, it was realised no platform was adequate
- Leveraging on microservice model orchestrator developed by Optit and expertize of a partner operating in Open Innovation, a novel tool was developed
- The Models' Competition Platform represents an additional exploitable result



optimal solutions







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