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de Estadística e  
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## EURO PhD SCHOOL on MCDM with MP

*An activity of the PhD in Mathematical Engineering, Statistics and Operational Research of Complutense University and Technical University of Madrid*

**Topic: MULTICRITERIA DECISION MAKING WITH MATHEMATICAL PROGRAMMING**

**FEBRUARY 17 - 28, 2014**

*Location:* FACULTAD DE CIENCIAS MATEMÁTICAS,  
UNIVERSIDAD COMPLUTENSE DE MADRID, MADRID (SPAIN)

[http://www.mat.ucm.es/imeio/cursos/EPS\\_MCDM](http://www.mat.ucm.es/imeio/cursos/EPS_MCDM)

# EURO PhD SCHOOL ON MULTICRITERIA DECISION MAKING WITH MATHEMATICAL PROGRAMMING

Madrid, 17-28 February 2014



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## 1. General information about the EPS on MCDM with MP

### 1.1. Dates and venue

The first EURO PhD School, devoted to Multicriteria Decision Making with Mathematical Programming (EPS on MCDM with MP), was held in the Faculty of Mathematical Sciences of the Complutense University of Madrid, on February 17<sup>th</sup> to 28<sup>th</sup> of 2014.

The students were accommodated in the hotel JC Rooms Santo Domingo, in the centre of Madrid near of the main attractions and services of the town, and reachable easily by Metro from the Complutense University.

### 1.2. Chairs of the EPS

The chairs of the first EURO PhD School are the following two professors of the Complutense University of Madrid. They are associate professors of the Department of Statistics and Operational Research, of the Faculty of Mathematical Sciences.

JUAN TEJADA (Coordinator of the IMEIO PhD programme), [jtejada@mat.ucm.es](mailto:jtejada@mat.ucm.es)

BEGOÑA VITORIANO, [bvitoriano@mat.ucm.es](mailto:bvitoriano@mat.ucm.es)

### 1.3. Scientific Committee

The scientific committee was formed by relevant researchers on the Multicriteria Decision Making topic, including one of the chairs of the EPS:

BEGOÑA VITORIANO (Complutense University of Madrid, Spain)

XAVIER GANDIBLEUX (University of Nantes, France)

DYLAN JONES (University of Portsmouth, UK)

RAFAEL CABALLERO (University of Málaga, Spain)

CARLOS ROMERO (Technical University of Madrid, Spain)



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## **1.4. Aims and scope**

EURO PhD Schools are an instrument established to encourage the organization of post-graduate education initiatives for PhD students under a school format. The EURO PhD Schools (EPS) were proposed and approved in 2012, and the first call was launched in 2013.

This instrument differs from other EURO instruments by being training-oriented and addressed to PhD students. The other EURO instruments within the Education Initiative are both research-oriented and addressed to final year PhD students (ESWI and ORP3) or have a conference format instead of a school format (EURO-k conference tutorials).

The scope of the EURO PhD School on MCDM with MP was multicriteria decision making with continuous methods, related to mathematical programming. At the same time, the aim of the EPS was to introduce applications of mathematical programming and decision making on different sectors, mainly logistics and management.

The aim of the EPS on MCDM with MP was reaching the academic objectives in a friendly work environment with enough time to create links and networking, which can remain in the future, between young researchers of different European countries. They are the future of operational research. Besides, these young researchers can know and contact with renowned researchers in the area, even for future joint works.

The EPS is an activity of the PhD programme on Mathematical Engineering, Statistics and Operational Research, joint programme of Complutense University of Madrid and Technical University of Madrid. This is an ambitious programme that aims to unite most powerful researchers in Madrid of applied mathematics, statistics and operational research, and its applications in many different areas. So, as a PhD course, it has a number of hours (75 hours) and ECTS (3 ECTS) recognized.

## **1.5. Terms and conditions**

The maximum number of students was established in 30. The initial expectative was of 25 students, but as it can be seen in the participants section, the number of applications exceeded our expectations.

A symbolic fee of 200€ were included especially to avoid cancellations. Living costs were subsidised by the EPS. This included all accommodation, meals (breakfast, coffee break,



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lunch and dinner), transport to the Faculty of Mathematics, and social activities. Travel costs should be covered by the participants, either themselves or through external funding. It didn't include insurance covering the participants.

The accommodation was in double rooms, but option of single rooms was offered with an extra payment to be paid directly in the hotel.



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## 2. Academic programme

### 2.1. Methodology

The course was designed to be very practical, following each day 2 hours of theoretical classes where new concepts and methods are introduced, 3 hours (divided in 2 periods) of supervised training in a computing classroom, and 2 hours of personal work.

Students worked in groups (pairs or triplets). Ten case studies were prepared, and a different problem was assigned to each group on first day of the EPS. Students worked on the assigned problem throughout the course, leading to a final presentation on the last day. The problems present applications to different sectors, especially focused on logistics and management (humanitarian logistics, power generation, hospital management, project planning, socially responsible investment...). The case studies proposed and the final presentations can be seen in the website [http://www.mat.ucm.es/imeio/cursos/EPS\\_MCDM/](http://www.mat.ucm.es/imeio/cursos/EPS_MCDM/). Here is the list of these case studies, some of them based on published works or available in Internet:

1. Humanitarian Logistics I (Ortuño, Tirado, Vitoriano (2010) *TOP*)
2. Humanitarian Logistics II
3. Humanitarian Logistics III
4. Energy planning (Linares (1997)  
[www.iit.upcomillas.es/~pedrol/documents/energia97.pdf](http://www.iit.upcomillas.es/~pedrol/documents/energia97.pdf))
5. Unit Commitment (Ramos, Sánchez, Sarabia, Vitoriano (2007)  
[http://www.iit.upcomillas.es/aramos/intro\\_simio.htm](http://www.iit.upcomillas.es/aramos/intro_simio.htm))
6. Hospital management (Arenas, Bilbao, Caballero, Gómez, Rodríguez, Ruiz (2002) *JORS*)
7. Project planning
8. Portfolio selection
9. Socially responsible investing I (Cabello, Ruiz, Méndez, Pérez (2013) *ICMFII*)
10. Socially responsible investing II



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GAMS, an algebraic modelling language, was used all around the course. The first day the different problems were introduced to the students, as well as a brief introduction to programming with GAMS. So, the students began to work with the software and their problems since the first moment during the training time.

## 2.2. Contents

The EPS focused on multicriteria decision making with mathematical programming, i.e., on the continuous methods of multicriteria decision making, mainly Multiobjective Programming, Compromise Programming and Goal Programming. Discrete methods as Analytic Hierarchy Process, Electre o Promethee remained out of the scope. Contents were as follows:

1. Basic Concepts on Multicriteria Decision Making
2. Multiobjective Programming: obtaining an efficient set
3. Compromise Programming: choosing an efficient point
4. Multicriteria Interactive Methods
5. Goal Programming: satisfying logic
6. Group Decision Making
7. Interactive Methods

Next table shows the sequence of contents presentation

Feb 17 <sup>th</sup>	<b>Presentation. Problems description. Learning GAMS</b>
Feb 18 <sup>th</sup>	<b>Basic MCDM concepts.</b> Modelling problems. Pay-off matrix
Feb 19 <sup>th</sup>	<b>Multiobjective programming.</b> Obtaining Pareto frontier (Exact methods)
Feb 20 <sup>th</sup>	<b>Multiobjective programming.</b> Obtaining Pareto frontier (Metaheuristics)
Feb 21 <sup>st</sup>	<b>Preferences and group decision making.</b> Obtaining and aggregating preferences
Feb 24 <sup>th</sup>	<b>Compromise programming.</b> Choosing an efficient solution
Feb 25 <sup>th</sup>	<b>Interactive methods.</b> Interacting with decision makers
Feb 26 <sup>th</sup>	<b>Goal programming.</b> Weighted, Tchebychev and lexicographical goals
Feb 27 <sup>th</sup>	<b>Goal programming.</b> Advanced goal programming
Feb 28 <sup>th</sup>	<b>Final presentations</b>



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## **2.3. Focus on case studies**

One of the most appreciated features by participants was the training-oriented methodology of the course, and especially being based on case studies. Since the first day they had assigned their case studies, and so, each new theoretical concept or method introduced they were thinking on applying to their problems.

Students showed a high degree of motivation and involvement, probably increased by knowing that the last day they should present in public their results.

All case studies were presented on the first day for all students. Each student chose their case study by affinity with the subject, within the limits imposed by the number of cases available and attempted not to participate in a group students from the same country or who were known in advance. This constraint was imposed to avoid groups speaking other language than English and to increase the interaction between the students, and by the results, it looks that it was a good idea.

Also interaction with the training instructors was very high, something that somehow was part of the planning, even including that they should play as actors representing roles of decision makers with opposing views to obtain their individual preferences and the group decision making.

Last day students showed their work, and it could be realised that they worked hard during the school with high level presentations. While some of them contain some minor mistakes, most of them in the transcript to the presentation format, a hard work and high standards can be seen in all of them. An interesting discussion on problems, methods and results arose during presentations, contributing to the success of the day. These presentations can be seen in the website.

Here you have some pictures of that final day.



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## 3. Participants

### 3.1. Students requirements

Participants had to be from a EURO member society country, or studying in a EURO member society country. They had to be enrolled in a PhD. Programme, and, preferably, in early stages of their studies. Next list shows the member societies of EURO:

- Austria
- Belarus
- Belgium
- Croatia
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Israel
- Italy
- Lithuania
- Netherlands
- Norway
- Poland
- Portugal
- Serbia
- Slovakia
- Slovenia
- South Africa
- Spain
- Sweden



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- Switzerland
- Turkey
- United Kingdom

## 3.2. Admission process

The result of the admission process for the EPS is summarised in the following.

Total applicants:	60
Applicants meeting requirements:	45
Maximum number of participants:	30

So, a selection process had to be carried out. As the organising committee understood that EURO PhD Schools must be oriented to beginners more than to advanced researchers, the main criteria was the number of years enrolled in the PhD programme, giving priority to students in first or second year. 29 students were in their first or second year, so, we admitted to these ones. The distribution is as follows:

Applicants meeting requirements			Not meeting requirements
	Admitted	Not admitted	
	<b>30</b>	15	15
Countries			
Spain	7 (4 from UCM)		3
Lithuania	2		
Turkey	6	4	
Germany	2		
Portugal	2	1	1
Finland	1		
Denmark	2		1
Sweden	1	1	
Austria	1	2	
Belgium	2		



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Greece	1	2	1
United Kingdom	1	1	
Italy	1	1	
Poland		1	
Holland		1	
Serbia		1	
Hungary		1	
Iran			1
Mexico			1
Canada			1
Chile			1
Colombia			1
Algeria			2
Ukraine			1
Russia			1
<b>Gender of admitted students</b>			
Female	9		
Male	20		

It must be noticed that applicants who didn't meet the requirements were willing to participate even at their own expense. Also, applicants meeting requirements but not admitted asked for similar options, showing the interest that this EPS has risen.

Summarising, there were 29 participants coming from 13 European countries, including students in Europe coming from other continents (India, Mexico, Venezuela).

### 3.3. Students

Name	Country	University
Albertas Gimbutas	Lithuania	Vilnius University, Institute of Mathematics and Informatics, Lithuania
Gražina Gimbutienė	Lithuania	Vilnius University, Lithuania
Süleyman Mete	Turkey	University of Gaziantep , Turkey



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Anna Hoffmann	Germany	Fraunhofer Institute for Industrial Mathematics ITWM, Kaiserslautern, Germany
Renata M S de Oliveira	Portugal	University of Porto, Portugal
Tinkle Chugh	India	University of Jyväskylä, Finland
Shahrzad Mohammadpour	Iran	Technical University of Denmark
Carla Caldeira	Portugal	University of Coimbra-MIT Portugal
Viktor Slednev	Germany	Karlsruhe Institute of Technology (KIT), Germany
Osama Ibrahim	Egypt	Stockholm University, Sweden
Ulrich Breunig	Austria	University of Vienna, Austria
Dimitri Van Assche	Belgium	Université Libre de Bruxelles, Belgium
Stef Lemmens	Belgium	KU Leuven, Belgium
Mahmut Ersin CIRPICI	Turkey	International Black Sea University, Tbilisi, Georgia
Zeynel Abidin ÇİL	Turkey	Gaziantep University, Turkey
Constantinos Chatzoglou	Greece	National Technical University of Athens, Greece
Gazi Bilal Yildiz	Turkey	Erciyes University, Turkey
Jørgen T. Haahr	Denmark	Technical University of Denmark
Oscar Rodríguez Espíndola	Mexico	Aston University, United Kingdom
Fatih Kocaturk	Turkey	Izmir University of Economics, Turkey
Sinem Tokcaer	Turkey	Izmir University of Economics, Turkey
M. Dolores Guerrero Baena	Spain	University of Cordoba, Spain
Sara Palomo Hierro	Spain	University of Cordoba, Spain
Eloi Gabaldón	Spain	University of Lleida, Spain
Metehan Feridun Sorkun	Turkey	Ca'Foscari University of Venice, Italy
Carlos Gamallo	Spain	Technical University of Madrid, Spain
Carely Guada	Venezuela	Complutense University of Madrid, Spain
Diana Guere	Venezuela	Complutense University of Madrid, Spain
José Manuel Queipo	Spain	Complutense University of Madrid, Spain



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## 3.4. Instructors

There were two different groups of instructors of the EPS on MCDM, those ones who taught the theoretical contents and those ones who led the training. Their skills were different, being the training instructors experts on mathematical programming and GAMS besides knowing multicriteria decision making. The instructors of theoretical classes were renowned researchers of the multicriteria decision making world.

Instructors of theoretical classes:

CARLOS ROMERO (Technical University of Madrid, Spain)
XAVIER GANDIBLEUX (University of Nantes, France)
FRANCISCO RUIZ (University of Malaga, Spain)
DYLAN JONES (University of Portsmouth, UK)

Instructors of supervised training:

BEGOÑA VITORIANO (Complutense University of Madrid, Spain)
GREGORIO TIRADO (Complutense University of Madrid, Spain)
F. JAVIER MARTÍN-CAMPO (Complutense University of Madrid, Spain)
FEDERICO LIBERATORE (HUMLOG research group of Complutense University, Spain)

The next timetable shows the participation of the different instructors along the EPS.



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	9:30-11:30h		12:00-13:30h, 15:00-16:30h	
Date	Theoretical classes	Instructor	Supervised training	Instructors
Feb 17 <sup>th</sup>	Presentation. Problems description	Begoña Vitoriano	Learning GAMS	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 18 <sup>th</sup>	Basic MCDM concepts. Efficiency	Carlos Romero	Modelling. Pay-off matrix	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 19 <sup>th</sup>	Multiobjective programming Exact methods	Xavier Gandibleux	Pareto Frontier	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 20 <sup>th</sup>	Multiobjective programming Metaheuristics	Xavier Gandibleux	Pareto Frontier	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 21 <sup>st</sup>	Preferences. Group decision making	Carlos Romero	Obtaining preferences	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 24 <sup>th</sup>	Compromise programming	Francisco Ruiz	Choosing an efficient sol.	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 25 <sup>th</sup>	Interactive Methods	Francisco Ruiz	Interactive methods	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 26 <sup>th</sup>	Goal programming	Dylan Jones	Choosing a satisficing sol.	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 27 <sup>th</sup>	Goal programming	Dylan Jones	Meeting goals	B.Vitoriano/G.Tirado/ F.J. Martín/F. Liberatore
Feb 28 <sup>th</sup>	Presentations	Carlos Romero/ J. Tejada/ B. Vitoriano/ G. Tirado/ F.J. Martín/F. Liberatore		



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## 4. Social Programme

Besides the academic programme, a wide social programme was included in order to meet the objectives of strengthening ties between the participants in order to establish a future network. Nevertheless, these activities should not interfere in the academic programme and give time for personal work.

The following social activities were developed during the EPS:

- Opening session including cocktail
- Guided tour “Madrid de Los Austrias”, offered by the Madrid Convention Bureau
- Dinner and Flamenco show in “Tablao Las Carboneras”
- Guided tour to Toledo
- Guided tour to El Retiro, offered by the Hotel JC Rooms Santo Domingo
- Guided tour to Museum El Prado, offered by Museum El Prado through the Dean of the Faculty of Geography and History
- Guided tour “Madrid: La Movida”, offered by the Madrid Convention Bureau
- Closing session, including cocktail
- Closing dinner

The final timetable was as follows, where social activities are outlined in bold.

### **EPS PROGRAMME AND SOCIAL ACTIVITIES**

	9:30-16:30h-	16:30h-18:30h	18:30-20:00h	20:00-22h
Feb 17 <sup>th</sup>	Academic activity	<b>Opening session</b>		
Feb 18 <sup>th</sup>	Academic activity			
Feb 19 <sup>th</sup>	Academic activity		<b>Guided tour: Madrid de Los Austrias</b>	
Feb 20 <sup>th</sup>	Academic activity			
Feb 21 <sup>st</sup>	Academic activity			<b>Dinner and flamenco show</b>



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Feb 22 <sup>nd</sup>	<b>11:00H. Guided tour: TOLEDO</b>			
Feb 23 <sup>rd</sup>	<b>Guided tour: El Retiro</b>	Free time		
Feb 24 <sup>th</sup>	Academic activity	<b>Guided tour: Museum El Prado</b>		
Feb 25 <sup>th</sup>	Academic activity			
Feb 26 <sup>th</sup>	Academic activity			<b>Guided tour: Madrid La Movida</b>
Feb 27 <sup>th</sup>	Academic activity			
Feb 28 <sup>th</sup>	Presentations	<b>Closing ceremony</b>		<b>Closing dinner</b>



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## 5. Website: documents

A website with the relevant information and documents have been developed

[http://www.mat.ucm.es/imeio/cursos/EPS\\_MCDM/](http://www.mat.ucm.es/imeio/cursos/EPS_MCDM/)

Besides the information describing the school and previous to held it, documents used in the EPS by the instructors, the case studies description and the presentations prepared by the students are linked in this site. The right side of the webpage includes the following links

Previous information (webpages):

- Home: basic information including the scientific and organising committee
- Contents: table with the EPS contents
- Methodology: description of the methodology which was be followed
- Timetable: timetable with the academic programme
- Instructors: name of instructors
- Terms & Conditions: terms and conditions to participate

**Documents:** Documents generated mainly during the EPS:

- Flyer EPS MCDM: document with the basic information of EPS
- Case Studies: document with case studies description
- Slides: slides used by the instructors of the theoretical classes
  - o Carlos Romero I, II, III
  - o Xavier Gandibleux I, II
  - o Francisco Ruiz I, II, III
  - o Dylan Jones I, II
- Students presentations: link to a webpage where all the case studies are listed linking each of them to the presentation prepared by the students



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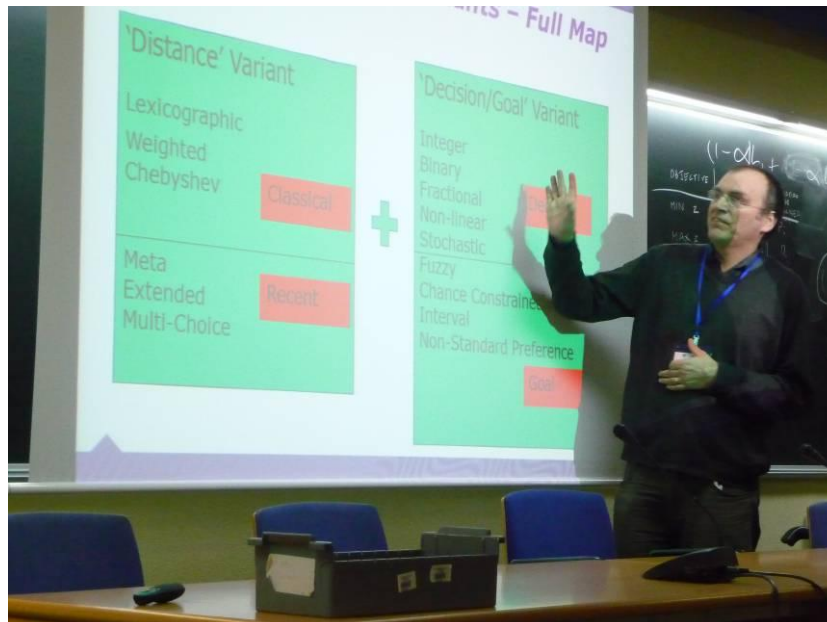
An activity of the PhD in Mathematical Engineering, Statistics and Operational Research of Complutense University and Technical University of Madrid

FEBRUARY 17 - 28, 2014

## 6. Some pictures



Professor Romero



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**FEBRUARY 17 - 28, 2014**

Professor Jones



Professor Gandibleux



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Professor Ruiz



Supervised training



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Training instructors: F. J. Martín-Campo, G. Tirado, B. Vitoriano and F. Liberatore



Dinner in “Tablao Las Carboneras”



Toledo



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Group in Toledo



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Closing ceremony (left to right): Pedro Daniel González Vice-dean for Research and Infrastructure, Javier Montero Vice-rector for Organisation, Juan Tejada and Begoña Vitoriano, coordinators of the EPS



Awarding diplomas



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Closing dinner



After dining...



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## 7. Financial report

### 7.1. Sponsoring

The EPS has been supported mainly by EURO, but also participant fees, the Institute of Interdisciplinary Mathematics (IMI) (<http://www.mat.ucm.es/imi/>), the Faculty of Mathematical Sciences (<http://matematicas.ucm.es/>) and the Department of Statistics and Operational Research (<https://www.ucm.es/dpeio>) have contributed to support the expenses of the EPS. Regarding the social activities, some of them were offered by the Madrid Convention Bureau, the hotel JC Rooms Santo Domingo and the Museum El Prado.

EURO	15000,00
Fees	5120,00
Institute of Interdisciplinary Mathematics	507,49
Faculty of Mathematical Sciences	566,86
Department of Statistics and Operational Research	450,00
<i>Total</i>	<b>21644,35</b>

### 7.2. Costs

For two weeks of course the costs were the following.

Students accommodation (breakfast and dinner included, 13 nights)	9900,00
Transport of students hotel-faculty	634,40
Lunches and coffee breaks at Faculty	1950,09
Instructors accommodation and travel	1531,57
Instructors expenses and remuneration	2028,36
Social activities (including meals, bus rental, guided tours, social dinners)	3547,40
Organisation (secretary, conference materials, bank fees etc.)	2052,53
<i>Total</i>	<b>21644,35</b>



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## 8. Acknowledgements

The EPS on MCDM has offered a unique opportunity for young students beginning their research to get into contact with renowned researchers and to practice in the field of multicriteria decision making and mathematical programming. It has been a big experience for students, being the networking created between them one of the most valuable result of this course.

We want to acknowledge especially to EURO for this initiative and its support. Also to the other sponsors as the Institute of Interdisciplinary Mathematics (IMI), the Faculty of Mathematical Sciences and the Department of Statistics and Operational Research, all of them of Complutense University of Madrid. Here is our appreciation for their support.

Besides, we want to acknowledge their cooperation to those entities who have offered their services for free, the Madrid Convention Bureau and El Prado Museum.

An important acknowledgement to the owner and staff of the JC Rooms Hotel Santo Domingo who supported the organisation along the EPS, to the staff of the “Cafeteria” of the Faculty helping anytime to participants, and to the administrative staff of the Department of Statistics and Operational Research (Alicia and Maria) by their support.

Finally, we want to acknowledge to the participants in the EPS, instructors and students, by their friendly character. The EPS can be said to have been a success thanks to the dedication of the instructors and student involvement and motivation.



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