

i-MATH Intensive School on Mathematical Programming and its Applications

CIEM, Castro Urdiales
28 January– 8 February 2008

1.- INTRODUCTION

Since the Second World War, Operations Research (OR) has successfully used the scientific method, and its main tool, namely, Mathematics, to address complex decision-making problems in different contexts such as Industry, Administration, Health, Ecology, etc.

Within this process, a fundamental role is played by **Mathematical Programming**. Following the Mathematical Programming Society, the term Mathematical Programming (MP) refers to the study of the problems of optimization of a function with or without constraints, their mathematical properties, the development and implementation of algorithms to solve these problems, and the application of these algorithms to real world problems. Hence, OR seeks optimal solutions in decision-making problems, and, to attain this goal, MP is used.

Many universities in Spain have research groups in MP. Some of them do theoretical research whereas some others are more oriented towards applications, or methodological and algorithmic issues. Independent of their focus, they share a rather high scientific level, as evidenced by their active presence in international institutions, the organization of scientific events, the high number of publications in journals of the highest level, as well as their involvement in R+D+i projects in cooperation with industry.

According to the Report submitted by i-MATH (<http://www.i-math.org/>), the main topics addressed by the researchers in MP in Spain are, among others:

1. Large scale optimization problems, with a large number of variables and constraints, with some different degrees of stochasticity and uncertainty, as those appearing in the aggregation of preferences, database management, statistical disclosure, data mining, image and data compression, optimal design of transportation networks and routes, facility location, production planning, etc.

2. Methodologies needed to address these complex decision problems: a) polynomial-time algorithms (e.g. interior point methods) and heuristics; b) polyhedral combinatorics, discrete and computational geometry; c) global optimization; d) stochastic and dynamic programming; e) non-smooth optimization; f) stability and sensitivity analysis in MP; g) optimization with an infinite number of constraints, as well as the links of such problems with optimal control problems and functional approximation; h) operator theory, etc.

3. Complex decision-making problems involving different objectives and/or agents, with probability theory, stochastic processes, game theory, multiobjective optimization and multicriteria decision aid as main tools, with applications in: a) equilibria in economic models, b) conflict and cooperation in problems related with resource management, flow and social networks, and c) other problems in economics and engineering such as tariffication and auctions.

According to the above mentioned report, the advances in any of these research areas would enhance transfer of knowledge, increasing the visibility of Mathematics in Society.

For these reasons, the i-MATH Steering Committee considered of strategic interest to promote an Intensive School on Mathematical Programming and its Applications, with the aim of attracting young researchers, offering them an adequate training to ease their successful integration in the already existing research groups. Such groups would then increase their human resources, and their capabilities to face new research projects, mainly of applied nature.

2.- AIMS

The school aims to offer training in the basic concepts and tools in MP, together with advanced tools linked with different key problems in information societies, finances, data mining, distribution and others of similar relevance. The specific aims are to promote and encourage:

- An enhancement in the state of the art in MP.
- Young mathematicians in their training age to enter into the field of MP, via a series of courses presenting, in an attractive and rigorous way, the main issues in MP and their most promising areas of applications.
- Interaction of participants in a friendly atmosphere, exploring possible cooperation within the European Commission Frame Program VII.
- Research of the highest quality, supporting the cooperation of students, trainers and their research groups.
- The study of models of higher complexity and applicability, calling for different methodologies and tools, which, due to their complexity, are usually not considered in the standard academic framework.
- Visibility of the selected topics, and thus also of the research groups addressing them. It is important to design actions which create bridges between scientific and economic agents. In this sense, it is convenient to include in the School the expertise already obtained within the i-MATH (Consulting) project "Acciones en Investigación Operativa", headed by Mikel Lezaun.
- The awareness of the different agents involved in R+D+i activities and resources management.

2.- ORGANIZATION

The School is supported by i-MATH and cofinanced by CIEM. It will take place at CIEM (Castro Urdiales), in the two weeks from the 28th January to the 8th of February 2008. These dates fit with the non-teaching period in most universities in Spain, enabling the participation of Spanish trainers and trainees.

The Organizing Committee has the following members:

Marco A. López (Univ. de Alicante), Chair,
Emilio Carrizosa (Univ. de Sevilla),
Laureano Escudero (Univ. Rey Juan Carlos de Madrid),
Justo Puerto (Univ. de Sevilla).

3.- STUDENTS

The upper limit for the number of students is 20, either from Spain or from abroad. They will be chosen by the applicants CV. They should be students in their pre-doctoral or post-doctoral training stages, with age below 35. English will be the official language of the School.

Since it is sought to enhance the human resources of the Spanish groups in OR and MP, the presence of Spanish students should be notable. However, it is very convenient to allocate 5-8 seats for foreigner students. This would allow a higher internationalization of the activities and would support networking of our students with other students from abroad.

Living expenses of the 20 students will be covered. Moreover, 10 students will receive a grant of 250 Euros each to support their travel expenses. This will apply only for those students showing they do not have access to any other source of financial support, according to the criteria of the Organizing Committee.

4.- REGISTRATION

The period for registration is from 1st of October to the 15th of November, 2007. Those students who are interested in participating in the school should address a message to ciem@unican.es, whose subject should be "i-MATHProgSchoolApplication", providing their names and affiliations, and attaching a copy of their C.V.'s.

5.- PROGRAM

The School will have:

- 4 Courses of 6 hours each, taught by professors from abroad with highest scientific records
- 8 Workshops, of different length (see provisional timetable attached), supervised by Spanish experts of high scientific level.
- 1 Discussion Panel about "Social and Industrial Applications and Technological Transfer of MP", with the participation of potential users of MP, coming from industries, companies, etc.

The organizers will encourage professors and students to stay the longest possible period at CIEM. Following the timetable attached, the students will take in total 51 hours of courses, in blocks of 2 hours or 90 minutes, never with more than 7 hours per day, and every day with both Courses and Workshops.

COURSES:

1. Linear Programming (L.P). Theory and Applications

T. Terlaky (McMaster University, Canada),

<http://www.cas.mcmaster.ca/~terlaky/>

3 blocks of 2 hours.

- Pivot algorithms, sensitivity and parametric analysis of LO
- Interior point methods
- Pivot v/s Interior Point Methods, worst case examples and conjectures

2. Conic and robust optimization

A. Ben-Tal (Technion Israel Institute of Technology, Israel)

<http://iew3.technion.ac.il/Home/Users/SECOND.php?morbt+Aharon+Ben-Tal+1+2>

3 blocks of 2 hours

- Review of conic optimization
- Robust linear optimization
- Robust conic optimization

3. Global Optimization

P. Hansen (GERAD Montreal, Canada)

<http://www.hec.ca/profs/pierre.hansen.html>

3 blocks of 2 hours

- General concave minimization
- Difference of convex functions. D.C. programming
- Lipschitz optimization
- Metaheuristics.

4. Integer and Combinatorial Optimization

E. Johnson (Georgia Tech- College of Engineering)

<http://www2.isye.gatech.edu/~ejohnson/>

3 blocks of 2 hours

- Strong LP formulations
- Preprocessing
- Gomory's asymptotic theorem of integer programming
- Knapsack and cyclic group problems
- Subadditive functions and cutting planes
- Generalization to the mixed integer case

WORKSHOPS

1. Optimization Models

M.A. Goberna (Univ. de Alicante),

<http://www.eio.ua.es/busqueda/infoper.asp?cod=6>

2 blocks of 90 minutes.

- Model building in decision problems.
- Two case studies.
- Linear programming models.
- Other optimization models.

2. Numerical Nonlinear Programming (NLP)

F. J. Prieto (Univ. Carlos III),

<http://www.uc3m.es/uc3m/dpto/DEE/profesorado/personal/fjp.html>

J. Castro (Univ. Polit cnica de Catalu na)

<http://www-eio.upc.es/~jcastro/>

3 blocks of 90 minutes.

- Interior point methods for LP,QP and convex problems: theory, implementation, and applications
- Active-set methods for NLPs: theory, SQP algorithms, implementation, the non-convex case
- Filter methods: theory and implementation.

3. Optimization and Uncertainty

L. Escudero (Univ. Rey Juan Carlos),

<http://www.umh.es/profesores/fichaprofesor.asp?NP=95220>

A. Alonso (Univ. Rey Juan Carlos),

<http://bayes.escet.urjc.es/~aalonso/>

2 blocks of 90 minutes.

- Uncertainty analysis.
- Algorithms for continuous Stochastic Programming.
- Algorithms for integer Stochastic Programming.
- Large-scale optimization.
- Important applications.

4. Discrete Optimization in Logistics

E. Fernández (Univ. Politécnica de Cataluña),
<http://www-eio.upc.es/personal/index.php?personal=014>

A. Corberán (Univ. de Valencia),

<http://www.uv.es/corberan/>

A. Marín (Univ. De Murcia),

<http://www.um.es/or/>

3 blocks of 90 minutes.

- Location problems
- Routing problems
- Combined problems

5. Optimization for Decision-Making

C. Romero (Univ. Politécnica de Madrid)

http://www.montes.upm.es/Dptos/DptoEconomia/PrincipiosEconomia/CarlosRomero/c_romero.htm

J. Puerto (Univ. de Sevilla),

http://investigacion.us.es/sisius/sis_showpub.php?idpers=1063

3 blocks of 90 minutes.

- Goal programming: Methodology and applications
- Operations Research Games.

6. Convex Analysis and its Applications

M. A. López (Univ. de Alicante),

<http://www.eio.ua.es/busqueda/infoper.asp?cod=10>

E. Carrizosa (Univ. de Sevilla),

http://investigacion.us.es/sisius/sis_showpub.php?idpers=1043

3 blocks of 90 minutes..

- Fundamentals of Convex Analysis
- Optimality Conditions in Convex Optimization
- Subgradient methods
- Applications: Continuous location, Support vector machines.

7. Optimization and Finance

J. Nogales (Univ. Carlos III),

<http://halweb.uc3m.es/esp/Personal/personas/fjnm/>

1 block of 90 minutes

- Portfolio Optimization (Error Estimation, Risk Management, Robust Optimization)
- Calibration of Derivatives Pricing Models

8. Optimization of dynamic and stochastic systems

J. Niño Mora (Univ. Carlos III)

<http://www.uc3m.es/uc3m/dpto/DEE/profesorado/personal/jnino.html>

1 block of 90 minutes

- Dynamic Programming Equations and their Linear Programming Formulation
- Applications: Traffic Flow Optimization in Internet Networks; Finance
- Dynamic Priority Index Policies and Performance Bounds