UNIVERSIDAD DE MURCIA

FACULTY OF MATHEMATICS

Advanced techniques for optimization

Syllabus

Course code:	6375
Number of ECTS credits:	3
Semester:	1st (September-January)
Recommended components:	Linear programming (1582), Graphs and Discrete Optimization (1592), Nonlinear optimization (1604). It is recommended that the student knows and uses the programming language C/C++.
Language of instruction:	Spanish (students are allowed to write homeworks and exams in English)

Course description

In enterprise and industry, many optimization problems must be modeled and solved efficiently within the time constraints and resources available.

In this course, we present and analyze various advanced optimization models that can be used to represent different problems. Characterizing these models very broadly, we can find uni-objective and multi-objective models, with different variants depending on the types of data used, types of constraints, objective functions, etc. We also present various classical techniques for solving these models. Additionally, because in many real situations these models (and therefore the problems) are difficult to solve exactly with classical methods, advanced heuristic techniques are required.

Such techniques are based on the use of heuristic concept, and therefore, the solutions will be obtained efficiently with respect to time and resources although in some cases are approximate solutions. Some of the most successful heuristic techniques are presented, and the tools necessary for their implementation will be used.

Learning outcomes and competences

After completion of this course you will:

1. understand and model various problems adequately according to their elements.
2. select, integrate and evaluate models to the analysis, description and solve optimization problems.
3. apply different techniques to model, design and develop applications and intelligent systems to solve problems.
4. understand and assess the scope that heuristic techniques may have in the field of optimization.
5. use and develop methodologies, heuristic methods and techniques in the field of optimization, having the ability to innovate.

Course contents

I. THEORY

1. Analysis of optimization models.
   Optimization Models: Classification and Solutions. Uni-objective Optimization models: Concept and Optimality. Multi-objective Optimization models: Concept and Optimality
2. Techniques for uni-objective optimization.
   Introduction. Basic concepts and theorems. Linear and Nonlinear Optimization. Conditions for the existence of solutions. Solution methods to uni-objective optimization: Simplex, penalty, Lagrangian, etc.
3. Metaheuristics for optimization.
   Heuristics and metaheuristics for optimization. Trajectories-based metaheuristics. Population-based metaheuristics.
4. Multi-objective optimization.
   Introduction. Concept of dominance and Pareto optimal frontier. Solution methods for Multi-objective Optimization: Generators and preferences-based techniques.

II. COMPUTER PRACTISES

1. Models and techniques for optimization.
   Uni-objective and Multi-objective optimization models. Free and commercial libraries and Internet resources. Metaheuristic techniques based on trajectories and populations.
2. Metaheuristics and uni-objective/multi-objective models.
   Design and implementation of metaheuristics for solving uni-objective and multi-objective models.

References

Main texts

1. Burke, E.K., Kendall, G. *Search Methodologies. Introductory Tutorials in Optimization and Decision Support Techniques*, Springer, 2005.
2. Ehrgott, M. *Multicriteria optimization (2nd ed.)*, Springer, 2005.
3. Glover, F., Kochenberge, G.A. *Handbook of metaheuristics*, Kluwer, 2003.
4. Hillier, F.S., Lieberman, G.J. *Introducción a la Investigación de Operaciones (8a edición)*, McGraw Hill, 2006.
5. Wall, M. *GAlib – A C++ Library of Genetic Algorithm Components*, Massachusetts Institute of Technology (MIT).
6. Williams, H.P. *Model Building in Mathematical Programming (4th edition)*, John Wiley and Sons, 2008.

Supplementary references

1. Duarte, A., Pantrigo, J.J., Gallego, M. *Metaheurísticas*, Servicio Publicaciones U. Rey Juan Carlos, 2007.

2. Reeves, C.R. *Modern heuristic techniques for combinatorial problems*, McGraw-Hill, 1995.

3. Romero, C. *Teoría de la Decisión Multicriterio: Conceptos, Técnicas y Aplicaciones*, Alianza Universidad, 1993.

4. Taha, H.A. *Investigación de operaciones (7a edición)*, Pearson, 2004.

5. Zapfel, G., Braune, R., Bogl, M. *Metaheuristic Search Concepts. A Tutorial with Applications to Production and Logistics*, Springer, 2010.