Course guide
200616 - OC - Continuous Optimisation

Last modified: 11/04/2024

Unit in charge: School of Mathematics and Statistics
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.

Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: FRANCISCO JAVIER HEREDIA CERVERA

Others: Primer quadrimestre:
JORDI CASTRO PÉREZ - A
FRANCISCO JAVIER HEREDIA CERVERA - A
ALBERT SOLÀ VILALTA - A

PRIOR SKILLS

A background equivalent to one/two degree-level semesters of algebra, analysis and optimization/operations research is advisable, though not mandatory, as the course intends to be self-contained.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
3. CE-2. Ability to master the proper terminology in a field that is necessary to apply statistical or operations research models and methods to solve real problems.
4. CE-3. Ability to formulate, analyze and validate models applicable to practical problems. Ability to select the method and / or statistical or operations research technique more appropriate to apply this model to the situation or problem.
5. CE-5. Ability to formulate and solve real problems of decision-making in different application areas being able to choose the statistical method and the optimization algorithm more suitable in every occasion.
Translate to english
6. CE-6. Ability to use appropriate software to perform the necessary calculations in solving a problem.

Transversal:
1. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

2. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

TEACHING METHODOLOGY

The course is composed by both theory and laboratory sessions.
During the theoretical sessions the fundamental properties of the continuous optimization problems and its solution algorithms will be introduced, with special interest to all the issues related the numerical solution of practical optimization problems arising both in statistics as well as in operations research.
During the laboratory sessions the students will have the opportunity to learn how to find the numerical solution to the different kinds of continuous optimization problems studied in the theoretical sessions with the help of languages for mathematical optimization modeling (as AMPL or SAS/OR) as well as numerical/statistic software (as MATLAB or R).

LEARNING OBJECTIVES OF THE SUBJECT

* To know the different types of continuous optimization problems and to understand its properties.
* To know the most relevant algorithms for continuous optimization and to understand its local and global convergence properties.
* To known some of the most relevant continuous optimization problems arising both in statistics and operations research and to be able to solve with the most efficient optimization algorithms.
* To be able to formulate and numerically solve real cases instances of continuous optimization problems from statistics and operations research with professional optimization software.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours small group	15,0	12.00
Hours large group	30,0	24.00

Total learning time: 125 h

CONTENTS

Computational modelization solution of mathematical optimization problems.

Description:
Continuous optimization problems in statistics and operations research. Modeling languages for mathematical optimization problems. Solvers for continuous optimization problems.

Full-or-part-time: 41h 40m
Theory classes: 10h
Laboratory classes: 5h
Self study : 26h 40m

Unconstrained optimization

Description:
Fundamentals of unconstrained optimization. Nelder-Mead procedure. Gradient method. Conjugate gradient method. Newton's and modified Newton's method. Quasi-Newton methods.

Full-or-part-time: 41h
Theory classes: 10h
Laboratory classes: 5h
Self study : 26h

Constrained optimization

Description:
Fundamentals of constrained continuous optimization: definitions, local and global minima, optimality conditions, convex problems. Optimization with linear constraints: the reduced gradient - active set method, the simplex algorithm. Optimization with non linear constraints: generalized reduced gradient, projected and augmented Lagrangians, sequential quadratic programming.

Full-or-part-time: 42h 20m
Theory classes: 10h
Laboratory classes: 5h
Self study : 27h 20m

GRADING SYSTEM

Two laboratory assignments (20% of the total grade each) and a final exam covering the two parts of the course contents (30% of the total grade each part).

BIBLIOGRAPHY

Basic:
- Nocedal, Jorge; Wright, Stephen J. Numerical optimization [on line]. 2nd ed. New York: Springer, 2006 [Consultation: 04/07/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-40065-5. ISBN 0387987932.
- Luenberger, David G. Linear and nonlinear programming [on line]. 3rd ed. Springer, 2008 [Consultation: 04/07/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-74503-9. ISBN 1402075936.
- Fourer, Robert ;Gay, David M. ;Kernighan, Brian W. AMPL: a modeling language for mathematical programming. 2nd ed. Duxbury Press / Brooks/Cole Publishing Company, 2003. ISBN 0534388094.

Complementary:
- Athanary, T.S. ; Dodge, Y. Mathematical programming in statistics. NY: John Wiley & Sons, 1993. ISBN 0471592129.
- Bertsekas, Dimitri P. Nonlinear programming. 2nd ed. Belmont: Athena Scientific, 1999. ISBN 1886529000.
- Gill, Philip E.; Murray, Walter; Wright, Margaret H. Practical optimization. London: Academic Press, 1991. ISBN 0122839501.
- Boyd, Stephen ; Vandenberghe, Lieven. Convex optimization. Cambridge: Cambridge University Press, 2004. ISBN 9780521833783.
- SAS/OR® 9.3 User's guide : mathematical programming [on line]. Cary, NC: SAS Institute Inc, 2011 [Consultation: 17/07/2013]. Available on: http://support.sas.com/documentation/cdl/en/ormpug/63975/PDF/default/ormpug.pdf.