UNIVERSIDAD DE MURCIA

FACULTY OF MATHEMATICS

Nonlinear Optimization

Syllabus

Course code:	1604
Number of ECTS credits:	6
Semester:	1st (September-January)
Prerequisites:	None
Recommended components:	You should be familiar with Linear Algebra (1569), Linear Optimization (1582) and differentiability of functions of several real variables (1578), as well as with computer programming using Java (1577).
Language of instruction:	Spanish (students are allowed to ask questions and write homeworks and exams in English)

Course description

This is an introductory course on nonlinear optimization, mathematical models and the corresponding solution methods. The course will focus on different classes of problems depending on the type of functions involved in each case. Formally, a nonlinear programming model is either a minimization or maximization of any function of several variables constrained with linear and/or nonlinear (in)equalities. We study the properties related to the minimization problem for convex functions and its generalizations, as well as a variety of algorithms to find the optimal solutions.

Learning outcomes and competences

After completion of this course you will:

1. be able to recognize situations where NLO can be used and formulate problems as NLO's.
2. know the fundamentals about minimization and maximization of functions on convex sets.
3. know the fundamentals about minimization and maximization of functions on polyhedral sets.
4. know the optimality conditions for unconstrained problems.
5. know the Kuhn-Tucker optimality conditions.
6. be able to implement a variety of algorithms for unconstrained problems.
7. be able to solve NLO problems using standard algorithms.
8. be able to solve quadratic and fractional optimization problems.

Course contents

I. Fundamentals of Nonlinear Programming

1. Nonlinear optimization models.
2. Convex sets.
   Definition and properties. Extreme points and extreme directions. Convex combinations. Convex hull. Separating hyperplanes. Alternative theorems.
3. Convex functions and their generalizations.
4. Differentiable convex functions.
5. Maxima and minima on polyhedral sets.

II. Algorithms for unconstrained problems

1. One dimensional search algorithms.
2. Multidimensional search algorithms.
3. Multidimensional method using derivatives.

III. Optimality conditions

1. Optimality conditions for non-differentiable functions.
2. Optimality conditions for differentiable functions.

IV. Solution methods

1. Methods of feasible directions.
2. Methods based on the simplex algorithm.

References

Main texts

1. Bazaraa M.S., Shetti H.D. , Sherali H.D. *Non Linear programming: Theory and Algorithms*; Wiley, 1993.

Supplementary references

1. Barbolla R. , Cerdá E., *Optimización : cuestiones, ejercicios y aplicaciones a la economía* ; Pretince-Hall, 2001.
2. Luenberger D.G. *Programación Lineal y No Lineal*; Addison-Wesley, 1989.
3. Minoux M. *Mathematical programming : theory and algorithms.*; Wiley, 1986.
4. Balbás A. , Gil J.A. *Programación matemática*; Madrid, AC 1990.
5. Hillier F.S. y Lieberman G.J. *Introducción a la Investigación de Operaciones*; McGraw-Hill, 1997.