2CC3005 – Optimisation - DUAL

Instructors: Charles Soussen
Department: DÉPARTEMENT MATHÉMATIQUES
Language of instruction: FRANCAIS, ANGLAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 36,00

Description

Optimization arises in many domains including science, mathematics, engineering, economy and finance. For instance, the problems of stock management, resource allocation, control of mechanical structures, and data analysis may all be addressed as optimization problems. Although these problems are of various nature, they can all be formulated as the minimization of a cost function over a given domain and under a set of constraints. Nevertheless, there are many existing optimization methods depending on the structure of the problem at hand.

This course aims at teaching a comprehensive overview of the classical optimization approaches and algorithms. The objective is to provide the background that will allow the participants to practically address the various optimization problems they might encounter, and help them choosing the adequate algorithm. The lecture will cover local and simple global optimization methods. The topics will include gradient-based algorithms, constrained optimization, least-squares methods, and discrete optimization.

Prerequisites (in terms of CS courses)

There are no official prerequisites for this course. However, the students are expected to have basic knowledge of linear algebra and matrix computation.

Syllabus

1. Unconstrained optimization : gradient-based algorithms, Newton and quasi-Newton algorithms.

2. Least squares problems.
3. Constrained optimization.
4. Global and discrete optimization.

Class components (lecture, labs, etc.)

Teaching is composed of courses and labs (TD). The labs cover computional aspects (solve KKT systems, in particular) and the practical use of the Matlab optimization solvers.

Grading

Written final exam (2 hours, 100 %)

The evaluation of the course will be based on a written exam (2 hours). The exam may cover all topics seen during the lectures and practical sessions, with a focus on local optimization algorithms: knowledge of algorithms, simple calculations, practical knowledge of how to call optimization solvers (in this case, the help of the matlab solver will be given) using matlab pseudo-code, interpretation of the results of numerical simulations. Only basic knowledge is requested regarding global and discrete optimization. The evaluation will be possibly related to the content of the lab sessions.

No documents allowed. Computers and calculators will be forbidden. Mobile phones must be switched off.

Course support, bibliography

- J. Nocedal and J. S. Wright, Numerical optimization, 2nd edition, Springer Verlag, New York, Jul. 2006.
- R. Fletcher, Practical Methods of Optimization, 2nd edition, Wiley, 2000
- A. Björck, Numerical Methods for Least Squares Problems, Society for Industrial and Applied Mathematics, Philadephia, Apr. 1996.
- R. Horst, P. M. Pardalos, and V. T. Nguyen, Introduction to Global Optimization, 2nd edition, Springer, Dec. 2000.

Resources

- Complete slides
- Software tools: see matlab documentation (optimtool)
- Related Courses: see the books in bibliography

Learning outcomes covered on the course

The course aims to introduce students to the main concepts and numerical methods of numerical optimization. The course is mainly focused on local optimization, although some general principles of global optimization algorithms are sketched as well.

Description of the skills acquired at the end of the course

It is expected that by the end of the course, the students will have a good knowledge of the main algorithms and will be able to carry out simple calculations : calculation of gradients, Hessians, resolution of simple optimization problems, e.g. by expressing the KKT conditions and solving the related system. Additionally, the students should have a practical knowledge of how to call Matlab optimization solvers and should be able to give an interpretation of the numerical results.

SEMESTER LONG COURSES