EPFL

MATH-329 **Nonlinear optimization**

Boumal Nicolas

Cursus	Sem.	Type
Mathematics	BA6	Opt.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Written
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course introduces students to continuous, nonlinear optimization. We discuss properties of optimization problems with continuous variables, and we analyze and implement important algorithms to solve constrained and unconstrained problems.

Content

* Unconstrained optimization of differentiable functions
-- Necessary optimality conditions
-- The role of Lipschitz assumptions
-- Gradient descent and Newton's method
-- The trust-regions method (focus)
-- Nonlinear least-squares
* Constrained optimization of differentiable functions
-- Necessary optimality conditions, cones
-- The quadratic penalty method
-- Notions of duality
-- The augmented Lagrangian method (focus)
* Special topics (to be determined; e.g.: convexity, relaxations, conic programming, nonsmooth problems and smoothing, derivative free methods, ...)
Note: as this is a new course, the precise contents may change during the semester.

Learning Prerequisites

Required courses

Students are expected to be comfortable with linear algebra, analysis and mathematical proofs. The main programming language for the course is Matlab: students are expected to be comfortable writing simple code in Matlab, though they may be allowed to write some of their work in Python or Julia.

MATH-351 is not a prerequisite, but the courses are synchronized so that students who take both will benefit from both.

Learning Outcomes

By the end of the course, the student must be able to:

- Recognize and formulate a mathematical optimization problem.
- Analyze and implement the gradient descent method, Newton's method, the trust-region method and the augmented Lagrangian method, among others.
- Establish and discuss local and global convergence guarantees for iterative algorithms.

- Exploit elementary notions of convexity and duality in optimization.
- Apply the general theory to particular cases.
- Prove some of the most important theorems studied in class.

Teaching methods

Lectures + exercise sessions

Expected student activities

Students are expected to attend lectures and participate actively in class and exercises. Exercises will include both theoretical work and programming assignments. Students also complete projects that likewise include theoretical and numerical work.

Assessment methods

Final exam (may be a take-home exam) (40%) + homework/projects (60%)

Resources

Bibliography

Book "Numerical Optimization", J. Nocedal and S. Wright, Springer 2006: https://link.springer.com/book/10.1007/978-0-387-40065-5

Ressources en bibliothèque

- Numerical Optimization / J. Nocedal & S. Wright