	UE-F1: Introduction to Optimization	Semester 1
Contributes to	MICAS	

Coordinators:	Hadi Ghauch, Telecom Paris Michele Wigger, Telecom Paris	
Volume:	30h	**3 ects**
Hours:	Lectures: 22.5h, Exercises: 6h	
Assessment:	2 Assignments and 1 Final Exam	
Language:	English	

Objectives:
The course provides an in-depth study of the mathematical theory of convex and non-convex optimization, with an emphasis on learning applications.

Outcomes:
On completion of the course students should be able to:
- Understand the theory and algorithms for convex and non-convex optimization
- Apply a wide array of optimization tools

Prerequisite:
- Basic notions of linear algebra and calculus

Syllabus
- Convex functions, convex sets, strong convexity
  - Convex problems, equivalence between problems
- Lagrange duality, optimality conditions for convex problems, KKT conditions, Slater's condition, strong duality
- Algorithms to solve convex optimization problems
  - gradient methods, Newton's method, Frank-Wolfe algorithm
  - accelerated algorithms: Nesterov Acceleration, Heavy-ball method
  - proximal methods: proximal gradient
  - Convergence analysis of algorithms
  - stochastic optimization
- Decomposition methods: primal and dual decomposition methods, ADMM
- Distributed optimization:
- Non-convex optimization
  - non-convex functions/problems,
  - non-convex optimization methods: successive approximation methods, coordinate descent methods, and block coordinate descent methods
  - relaxations for non-convex problems
  - discrete/combinatorial optimization problems
    relaxation for combinatorial optimization: Lagrange relaxation, Dantzig Wolfe relaxation, semi-definite relaxation
- Applications: convex/non-convex problems in machine learning and wireless communications

Bibliography:

- S. Boyd and L. Vandenberghe, "Convex optimization", 2004.
- D. Bertsekas, "Nonlinear programming", 3rd Ed, 1999.