Allievi Program
Master in Economics
PhD in Economics

Optimization for Economics

Instructors: Claudio Mattalia and Luca Regis

Contact Information

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Objective of the course

The goal of this course is to provide students with mathematical tools that are necessary for understanding modern economics, doing research or practical work. The object of study in this course is the problem of finding an optimal course of actions subject to feasibility constraints, in a static or a dynamic setup. Such a problem appears in almost every field of finance and economics (consumption/investment choices, theory of the firm, macroeconomics, industrial organization, labor economics, etc.). The emphasis will be put on the theory of static constrained optimization and on dynamic programming, keeping a balance between mathematical rigour and a focus on economic applications.

Structure of the course

During the lectures, the theory and mathematical background will be presented and typical problems will be solved. We will assign a problem set each week, and provide the solutions the week after. Problem sets are not evaluated.

Formal course requirements include attendance to the lectures, a midterm exam and a final exam. Both the midterm exam and the final exam will have a maximum grade of 15/30 each, and the final grade will be the sum of the grades of the two partial exams.

Outline of the course

A good command of single and several variable calculus and linear algebra is required. The topics presented during the course are the following:

Part I – Static optimization (16 hours – Luca Regis)

- *Unconstrained optimization*: statement of the problem, first-order necessary conditions, second-order sufficient conditions, concave and convex objective functions.
- *Constrained optimization with equality constraints*: the constrained problem in 2 variables and in *n* variables, Lagrange method.
- *Constrained optimization with inequality constraints*: Kuhn-Tucker points and the Kuhn-Tucker method.
- *Economic applications*: monotonicity and concavity for functions of several variables, the problem of the consumer, the problem of the firm, optimal investment, value function and Lagrange multipliers.

Part II – Dynamic optimization (16 hours – Claudio Mattalia)

- *Intertemporal optimization in discrete time*: examples of problems in discrete time. The method of dynamic programming. Bellman equations and Euler equations.
- *Intertemporal optimization in continuous time*: first-order linear ordinary differential equations (ODE's) and linear systems of ODE's, phase diagrams and graphic solutions, analytic solutions. Non-linear systems of ODE's and linearization.
- *Intertemporal optimization in continuous time*: example of problems in continuous time. Pontryagin maximum principle and the Hamiltonian function. Hamilton-Jacobi-Bellman equations.

Textbooks

The main reference is represented by lecture notes of the teachers that will be available each week.

Useful references are also:

- Simon C. P. - Blume L., *"Mathematics for Economists"*, W. W. Norton & Company, 1994.

- Chiang A. C., *"Elements of Dynamic Optimization"*, Mac Graw Hill, 1992.