OPTIMIZATION TECHNIQUES AND PORTFOLIO THEORY (m63104p)

Instructors: I.VRONTOS - E.KYRIAKIDIS - G.PAPAGIANNIS

Core Course, 2nd semester, 5 ECTS units
Course level: Graduate (MSc)
Language: Greek

Course Description

A plethora of empirical financial problems such as portfolio construction, risk management, pricing of financial derivatives etc. require solving different optimization problems. This course will introduce and develop the relevant mathematical tools and numerical methods/techniques for analyzing and solving optimization problems in finance. The course covers linear, quadratic and dynamic programming problems. It presents nonlinear programming, introduces the basic ideas, dual methods, Lagrange multipliers, and optimality conditions for unconstrained and constrained optimization problems. Gradient descent method, steepest descent method, Newton and quasi-newton numerical schemes are presented and developed. The basic framework of evolutionary algorithms and stochastic optimization approaches is introduced and non-smooth and non-convex optimization problems are described. Different method and techniques are presented such as the genetic algorithm, particle swarm optimization, simulated annealing, and stochastic gradient methods. Application of different optimization techniques in estimating the parameters of nonlinear statistical and econometric models is presented. Illustration of the proposed methods and techniques is given using empirical financial applications including construction of mean-variance optimal portfolios, estimation of the efficient frontier, optimization of Value-at-Risk and conditional Value-at-Risk, asset-liability management and risk management.

Prerequisites

No prerequisites.

Target Learning Outcomes

The aim of this module is to provide students with advanced analytical and numerical skills required to solve optimization problems in finance. After successfully completing the course, students will be able to:

- describe and solve linear programming problems
- describe and solve quadratic programming problems
- describe and explain dynamic programming problems
- describe and solve nonlinear programming problems
- explain convex sets and functions, constrained and unconstrained maximization problems
- demonstrate an understanding of numerical algorithms for solving several programming problems
- demonstrate an understanding of basic evolutionary algorithms and stochastic optimization problems
- apply optimization methods for estimating the parameters of univariate and multivariate nonlinear models

- solve simple asset-liability management problems
- solve mean-variance optimization problems
- optimize Value-at-Risk and conditional Value-at-Risk
- apply optimization methods in risk management

Recommended Bibliography

- Cornuejols, G., Pena, J., and Tutuncu, R. (2018). Optimization Methods in Finance, Cambridge University Press
- Bertsekas, D.P. (2014). Constrained optimization and Lagrange multiplier methods, Academic Press
- Boyd, S. and Vandenberghe, L. (2004). Convex optimization, Cambridge University Press
- Kroese, D.P., Taimre, T., and Botev, Z.I. (2013). Handbook of monte carlo methods, John Wiley & Sons
- Nocedal, J., and Wright, S. (2006). Numerical optimization, Springer Science & Business Media
- Simon, D. (2013). Evolutionary optimization algorithms, John Wiley & Sons
- Selected papers

Teaching and Learning Activities

One three-hour lecture per week, study exercises, and programming exercises as homework (some to be submitted).

Assessment and Grading Methods

The final grade is the average of the final examination grade (weight 50%) and the grade of the study and programming exercises to be submitted (weight 50%).