Study programme(s): Applied Mathematics – Data Science

Level: master studies

Course title: Operations research

Lecturer: Nataša Krejić

Status: elective

ECTS: 5

Requirements: Basics of linear algebra and probability

Learning objectives

- Understanding of a wide range of important optimization methods in finance as well as some of the key issues related to modelling and stability of financial networks

Learning outcomes

- Ability to understand, implement in *Mathematica* and measure performance of various optimal portfolio selection models using real financial data
- Ability to comprehend key ways in which one selects, implements and validates statistical methods for measure market risk
- Ability to analyse issues related to stability of financial networks and notion of system crisis

Syllabus

Participants shall be provided with a set of comprehensive interactive Mathematica-based lecture notes. Thus we initially provide an introduction to programming in Mathematica. After that, the following topics shall be covered:

Portfolio optimization: Markowitz approach, alternative formulation, risk-based measurement of investment performance, transaction costs, other realistic investment constraints, portfolio optimization using different risk measures, robust parameter estimation, shrinkage estimators, concepts of convex optimization, robust portfolio optimization methods, multi-period binomial tree portfolio optimization, essentials of stochastic calculus, portfolio optimization in continuous time (Bellman equation, direct optimization and martingale approach)

Market risk models: financial time series, historical and analytical VaR models, GARCH, fat tails, backtesting VaR models

An overview of concepts and papers related to stability of financial networks

Literature

Selected parts of the following books:

22. Fabozzi, F., Kolm, P., Pachamanova, A., and Focardi, S., Robust Portfolio Optimization and Management, John Wiley, 2007.
23. Cvitanić, J. and Zapatero, F., Economics and Mathematics of Financial Markets, MIT Press, 2004.
24. Christoffersen, P., Elements of Financial Risk Management (2^{nd} Edition), Academic Press, San Diego, CA, 2012.
25. Welin, P., Programming with Mathematica, Cambridge University Press, 2013.
26. Papers on financial stability and financial networks

Weekly teaching load				Other: 0
Lectures: 2	Exercises: 2	Other forms of teaching: 0	Student research: 0	

Teaching methodology

Lectures; revisions of the material; active students' participation in problem solving;

Mathematica-based homeworks.			
Grading (maximum number of points 100)			
Pre-exam obligations	**points**	**Final exam**	**points**
Mathematica-based homeworks	50	Mathematica-based project with oral presentation	50