Doctoral School in Finance and Economics

Course ID Decision Making under Uncertainty: Stochastic-dynamic Programming

1. Course details

Semester:	2
Credit rating:	2
Pre-requisite(s):	Probability Theory, Linear Programming
Lecturer(s):	Nils Löhndorf (nils.loehndorf@uni.lu)
Administrator:	Roswitha Glorieux
Tutor(s):	
Seminar times and rooms:	Block/Semester Course
Tutorial times and rooms:	tbd
Communications	**It is important that students should regularly read their University e-mails, as important information will normally be communicated this way.**
Mode of assessment:	Grading: homeworks/assignments 100% (3 homework assignments)
Examination Periods:	
Course WebPage:	Moodle.uni.lu

2. Aims and objectives

Aims
Many problems faced by agents involve decisions where resources must be managed over time but information that is relevant for the outcome of these decisions is uncertain at the time when a decision is made. Common examples of such problems are in supply chain management, portfolio management, or natural resource management. Modeling these decision problems typically leads to high-dimensional optimization problems that cannot be solved in closed form. This course introduces students to approximate dynamic programming and multistage stochastic programming as mathematical frameworks for modeling and solving complex decision problems under uncertainty. Students will learn how to approximate solutions to two-stage programs using sample average approximation, scenario reduction techniques, as well as Benders decomposition, and they will learn how to solve multistage problems using value function approximation techniques such as least squares Monte Carlo and stochastic dual dynamic programming.
Learning Objectives The student who followed this course - can formulate stochastic-dynamic decision problems in discrete time and correctly identify decision variables, constraints, objectives, and state variables. - understand basic stochastic processes to describe uncertainty in model parameters - can apply backwards dynamic programming techniques on approximate value functions - implement sample average approximation and Benders decomposition to numerically solve stochastic programming problems - understand the principles of scenario reduction and stochastic dual dynamic programming

3. Plan of semester CK BC16

tbd

4. Course details (by topics)

- Stochastic-dynamic programming
- Two-stage stochastic programming and sample average approximation
- L-shaped method / Benders' decomposition
- Dynamic programming with approximate value functions
- Multistage stochastic programming with scenario trees
- Nested Benders' and stochastic dual dynamic programming
- Scenario reduction techniques
- Coherent risk measures

5. Reference list/ Bibliography

Main reading material:

- Powell WB (2011), Approximate Dynamic Programming
- Birge, Louveaux (2011) Introduction to Stochastic Programming
- Shapiro, Dentcheva, Rusyznski (2014) Lectures on Stochastic Programming

6. Further information about assessment

Students will receive three homework assignments and the grade will be weighted average of these three assignments. In these assignments, students need to implement numerical methods and decision models and run computational experiments.