1 Course description

In this course, we will learn about mathematical programming methods for modelling and solving optimisation problems under uncertainty. This is critical for the use of mathematical programming approaches in real settings, where the uncertainty related to the input data must be taken into account.

We will learn about the two main paradigms for uncertainty consideration: stochastic programming and robust optimisation. Our focus will be primarily practical, meaning that we will learn about good modelling practice and uncertainty representation.

2 Learning outcomes

Upon completing this course, the student should

- understand how optimisation models can be enhanced to consider uncertainty in the input data;
- understand the main techniques for modelling and solving optimisation problems under uncertainty in practice;
- know how to use optimisation software for implementing and solving stochastic programming and robust optimisation problems.

3 Teaching methods

This course uses a combination of lectures, tutorials and seminars. The lectures are targeted to introduce the basic concepts related to stochastic programming and robust optimisation. To complement the lectures, tutorial sessions will also take place. These will consist of exercises that are aimed at clarifying the content discussed in the lectures and discussing computational aspects and practical applications.

The second part of the course will consist of seminars given by the students. The seminars will target recent publications showcasing new developments and trends within the topics covered in the course. The seminar sessions will additionally be focused on presenting the course's project work.

The course will be taught by a composition of the following methods:

- lectures;
- tutorial sessions;
- guided self-study;
- seminar presentations;
- project work and feedback.

The course is implemented in person. Participation and discussions are part of the learning and thus required. Under special circumstances, participation via video conference may be arranged if no other alternative is possible. The seminar presentations are to be delivered in person unless unforeseen circumstances prevent it from being the case.

4 Assessment

The final grade of the course is composed of three components:

P: Participation in the sessions: 20%;
R: Research paper presentation: 30 %;
W: Project work: 50 %.

The conversion scale to the 1-5 scale is as follows.

1-5	0-100
Fail	0-50
1	51-60
2	61-70
3	71-80
4	81-90
5	91-100

Table 1: Conversion from 0-100 to 1-5 scale

4.1 Participation

Attendance to the sessions will be recorded. Full points are given if the student attends at least 80% of the sessions. Otherwise, attendance points are given proportionally.

4.2 Research paper presentation

Each student will be required to prepare a 30-minute presentation about a research paper of their choosing. The choice of paper must be agreed upon with the lecturer by no later than the end of Week 41.

The paper must be related to topics covered in the course. The paper can be, for example, presenting an application of some of the topics covered to solve a particular problem, or present novel developments associated with stochastic programming or robust optimisation that have not been covered in the course.

4.3 Project work

Each student will also be required to develop a small computational project in which some of the techniques and methods seen in the course are applied to a stylised problem. A list of project examples includes:

1. Choose a problem from this reference (link) and develop a version of it under uncertainty, using the techniques discussed in the course
2. Apply one or more of the techniques to a problem of your own choice (e.g., related to your MSc or DSc topic)
3. Replicate (to some extent) and/or extend some of the computational experiments from a chosen research article (can be, e.g., the same presented)

The project scope must be agreed upon with the lecturer by no later than the end of Week 44. The deliverables of the project are the set of slides used to present the project and the code developed.

5 Course material

Main study material: lecture slides, selected research papers, and tutorial notebooks.

6 Course schedule

A tentative schedule for the course is given. The content of each class may be adapted according to the pace of the classes and the number of students.

Week	Session	Content
36	1	Introduction (course organisation, basic setup)
37	2	Two- and multi-stage stochastic optimisation
38	3	Scenario generation and sample average approximation
39	4	Chance constraints and risk measures
40	5	Decomposition methods
41	6	Static and adaptive robust optimisation
42	–	*Break between Periods I and II*
43	7	Research paper seminars I/III
44	8	Research paper seminars II/III
45	9	Research paper seminars III/III
46	10	Project seminars I/III
47	11	Project seminars I/III
48	12	Project seminars III/III

Table 2: Course schedule