1 Lectures

Class sessions:

- Lecturer: Fabricio Oliveira (fabricio.oliveira@aalto.fi);
- Session info: Tue, 10:15h - 12:00h, check rooms in schedule (Otakaari 1);
- Office hours: Wed 14:00h - 15:00h (book beforehand), room Y219 (Otakaari 1).

Exercise sessions:

- Lecturer: Juho Andelmin (juho.andelmin@aalto.fi);
- Session info: Thu, 14:15h - 16:00h, check rooms in schedule (Otakaari 1).

2 Course description

Mathematical optimisation (Nonlinear optimisation, in its most general form) is a powerful framework in which one seeks to find variable values within a domain that maximise (or minimise) the value of a given function. Using the analogy that variables represent decisions or parameters to be defined and the function is a measure of performance, one can use that framework to support decision making in a wide range of applications, from planning industrial chemical plants to training models that learn from data.

In this course, the student will learn the basic optimisation theory behind the main numerical algorithms available and how they can be applied to solve optimisation problems. At the end of the course, it is expected that the student will be capable of analysing the main characteristics of an optimisation problem and decide what is the most suitable method to be employed for its solution.

3 Learning outcomes

Upon completing this course, the student should be able to

- understand how several important problems arising from diverse fields can be cast and solved as nonlinear optimisation problems;
- know the main techniques for solving nonlinear optimisation problems and how to apply them in practice;
- know how to use optimisation software for implementing and solving nonlinear optimisation problems.

4 Teaching methods

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

- lectures;
- guided self-study;
- theoretical and computational exercises;
- project assignment and feedback.

5 Assessment

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

H: 10 homework assignments;
$P1$: Project assignment 1;

$P2$: Project assignment 2;

Each component will be graded individually in an scale of 0-100. The final grade FG will be calculated as

$$FG = 0.4 \times H + 0.3 \times P1 + 0.3 \times P2.$$

The conversion scale for 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

5.1 Homework assignments

A total of 10 weekly homework assignments will be handed out. Each homework is worth 10 points, adding to a total of 100 points. The homework for each week will be available on Wednesdays from Mycourses website and will have as deadline the Thursday evening of the following week. The submission of the solutions must be made through the course Mycourses website. Homework submissions will not be accepted after the deadlines.

Students that have an attendance to classes and exercise sessions greater or equal than 80% (20/24 sessions) will automatically earn 20 points in this component.

The homework will be composed by theoretical and computational exercises. The computational skills required to solve the exercises will be introduced during the exercise sessions, but it is expected that the student learn and practise the language on its own. Supporting material for that will be provided. The programming language that will be used in this course is Julia (julialang.org).

5.2 Project assignments

The students will be requested to develop guided projects on two distinct topics to be provided. The objective of the projects is to use the acquired knowledge in nonlinear optimisation in practice and discuss related technical aspects.

The projects can be conducted individually or in pairs. Each project will comprise a implementation using Julia that address the requirements of the projects and a 5-page report. Each report will be graded by three referees: course lectures and one/ two students of the course. Grading other's report will be part of the assessment of the project.

6 Course material

Main study material: lecture notes, exercises, homework assignments, course book.

Main course book: *M. Bazaraa et al., Nonlinear Programming, Wiley-Interscience, 2006.*

7 Electronics policy

As a general rule, don't be rude! You are free to use electronic devices during class for note taking purposes. It is strongly recommended that note taking is by hand rather than using laptops.

8 Course schedule

A tentative schedule for the course is given. Content of each class may be adapted according to the pace of the classes.

Week	Lecture	Content	Room (Class/ Exercise)
37	1	Admin. and introduction	U9(U271) / U5(U147)
38	2	Topology - Convex sets	U9(U271) / D-Sali (Y122)
39	3	Analysis - Convex functions	U9(U271) / M1
40	4	Optimality conditions I	U9(U271) / C-Sali (Y205)
41	5	Optimality conditions II	U9(U271) / U5 (U147)
42	6	Lagrangian duality	U9(U271) / M1
44	7	Unconstrained optimisation methods I	U356 / A1
45	8	Unconstrained optimisation methods II	A1 / U6 (U149)
46	9	Constrained optimisation methods I	U356 / U6 (U149)
47	10	Constrained optimisation methods II	U356 / U6 (U149)
48	11	Constrained optimisation methods III	U356 / U6 (U149)
49	12	Closing session	U356 / U6(U149)