GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2017-2018

Selected Topics in Mathematical Optimization (C003701)

Course size (nominal values; actual values may depend on programme)

Credits	3.0	Study time	75 h	Contact hrs	30.0 h

Course offerings and teaching methods in academic year 2017-2018

A (semester 2)	English	seminar: practical PC room classes	22.5 h
		lecture	7.5 h

Lecturers in academic year 2017-2018

Stock, Michiel	LA26	lecturer-in-charge

Offered in the following programmes in 2017-2018	crdts	offering
Master of Science in Bioinformatics (main subject Bioscience Engineering)	3	A
Master of Science in Bioinformatics (main subject Systems Biology)	3	A

Teaching languages

English

Keywords

applied mathematical optimization

Position of the course

As an advanced course within the field of applied mathematics, this course focuses on traditional methodologies and recent developments in the area of mathematical optimization. This course presents mathematical optimization as a flexible methodology that extends the students' problem-solving abilities. Students are taught how to translate (real-life) problems of substantial complexity into formal mathematical optimization problems. Moreover, students will learn how 'to select, apply and/or create efficient optimization procedures to solve these optimization problems efficiently. The general philosophy behind this course is application-oriented. Driven by a variety of applications in bioengineering (including but not limited to bioinformatics), several theoretical concepts on mathematical optimization will be introduced and studied up to a level that allows these concepts to be applicable in practice. Consequently, the main focus will be on the application and implementation (in a programming language) of these concepts.

Contents

The main objective of this course is to teach students how to use mathematical optimization techniques to solve a variety of real-life problems. Therefore, this course is organized around the following major pillars:

- The translation of a real-life problem setting into a formal mathematical optimization problem.
- The analysis of mathematical optimization problems with respect to global solvability, the presence of local and global optima, geometric properties, time-complexity and convexity (this list neither is binding nor complete).
- The selection of a proper optimization strategy to solve a given optimization problem.
- The use of numerical procedures for solving optimization problems: implementation, use of existing software (e.g. Matlab), with special attention to meta heuristics as used in biologically inspired optimization procedures (e.g. genetic algorithms, particle swarm optimization).
- Selected applications for bioinformatics (e.g. protein folding, sequence alignment and core subset selection) and beyond (e.g. parameter estimation, portfolio optimization and applications of combinatorial optimization).

Initial competences

- Basic knowledge of scientific programming (knowledge of Python/Matlab is an advantage, but is not a strict prerequisite if the student is willing to acquire the required skills independently)
- Basic knowledge of mathematics (in particular mathematical analysis and linear algebra, cfr. Mathematics 1 & 2, bachelor of bioscience engineering)

Final competences

1. The student understands and has insight into the main principles of mathematical optimization.
2. The student is able to recognize traditional optimization problems that are often encountered in the field of bioscience engineering.
3. The student is able to translate real-life problems into formal mathematical optimization problems.
4. The student is able to understand and judge the quality of the numerical optimization techniques underlying a variety of (bioinformatics) tools.
5. The student is able to select, apply and/or develop proper numerical optimization schemes to solve mathematical optimization problems.
6. The student is willing to routinely assess the impact of both the translation of a real-life problem into a formal optimization problem, and the optimization technique that is used to solve the resulting problem, on the solution that is found for a given problem in the field of bioengineering in general and bioinformatics in particular.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, seminar: practical PC room classes

Learning materials and price

Presentation hand-outs of theory lectures and Jupyter notebooks of practical sessions are made available

References

- H. Bockenhauer and D. Bongartz (2007). Algorithmic Aspects of Bioinformatics. Springer, 397p.
- S. Boyd and L. Vandenberghe (2004).Convex Optmization. Cambridge University Press, 716p
- J. Nocedal and S.J. Wright (1999). Numerical Optimization. Springer, 634p.
- D.E. Goldberg (1989). Genetic algorithms in Search Optimization and Machine Learning. Addison-Wesley, 412p.

Course content-related study coaching

- Contact hours: 30h (of which 12u theory and 18h seminar)
- Additional information can be provided using Minerva.
- Computer exercises are guided by assistants

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Oral examination

Examination methods in case of periodic evaluation during the second examination period

Oral examination

Examination methods in case of permanent evaluation

Report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is not possible

Extra information on the examination methods

- Periodic examination: oral exam
- Permanent evaluation: evaluation of assignments

Calculation of the examination mark

- 50% periodic evaluation

- 50% permanent evaluation