Module Description, available in: EN

Optimization

General Information

Number of ECTS Credits

3

Module code

FTP_Optimiz

Valid for academic year

2020-21

Last modification

2020-01-23

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Linear algebra:

- Systems of linear equations, Gauss algorithm
- Basics of vector and matrix algebra, linear spaces

Analysis:

- Calculus with functions of one variable
- Zeros of functions (Newton algorithm)

Programming:

- Basics of procedural programming and ability to implement small programs in an arbitrary language, e.g. Python, Matlab, R, Java, C#, C++, C, etc.

Brief course description of module objectives and content

This course offers an introduction to optimization, emphasizing basic methodologies and underlying mathematical structures. Optimization refers to the application of mathematical models and algorithms to decision making. A large number of quantitative real-world problems can be formulated and solved in this general framework. Applications of optimization comprise, for instance, decision problems in production planning, supply chain management, transportation networks, machine and workforce scheduling, blending of components, telecommunication network design, airline fleet assignment, and revenue management.

Aims, content, methods

Learning objectives and acquired competencies

- The student has an overview of the various fields and approaches to optimization.
- The student has a basic mathematical and algorithmic understanding of the major optimization methods used in practice (Linear Programming (LP), Integer Programming (ILP), Nonlinear Programming, Optimization in Graphs, Metaheuristics).
- The student is able to analyze basic real-world decision problems and formulate appropriate optimization models.
- The student is able to implement and solve basic LP/ILP models in a spreadsheet.
- The student has developed a certain intuition on how to approach and analyze real-world optimization problems, to correctly estimate their complexity, and to choose appropriate modeling approaches and implementation tools.

Contents of module with emphasis on teaching content

Week	Topics
1	**PART 1:**
2	**Introduction to Optimization** • Basic concepts: models, variables, parameters, constraints, objective, optima • Examples of problems and models of different types: linear/nonlinear, discrete/continuous, deterministic/stochastic constrained/unconstrained • Solution methods: exact algorithms, constructive heuristics, improvement heuristics • Global vs. local optima, basic ideas of convex optimization
3	**Linear Programming** • Mathematical formulation and terminology, canonical and standard form, transformations • Geometry: linear inequalities, polyhedra, graphical representation, examples • Simplex algorithm
4	
5	
6	**Integer Programming** • Basic concepts • Branch-and-Bound method • Cutting Planes method • Various applications and modeling techniques
7	
8	**PART 2:** **Nonlinear Optimization** • Unconstrained multidimensional optimization: optimality conditions, Gradient- and Newton-methods
9	**Graphs and Networks** • Optimization in graphs • Paths and cycles • Network flows • Selected combinatorial optimization problems
10	
11	
12	**Heuristics and Metaheuristics** • Trajectory-based methods: hill climbing, tabu search, simulated annealing, ... • Population-based methods: evolutionary algorithms, ant colony optimization, ...
13	
14	

Teaching and learning methods

Lectures and exercises

Literature

Assessment

Certification requirements

Module does not use certification requirements

Basic principle for exams

As a rule, all the standard final exams for modules and also all resit exams are to be in written form

Standard final exam for a module and written resit exam

Kind of exam

written

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None.
In particular: Pocket calculators are not allowed.

Other permissible aids

Exam "open book": Any written documents are allowed.

Special case: Resit exam as oral exam

Kind of exam

oral

Duration of exam

30 minutes

Permissible aids

No aids permitted