Combinatorial Optimization with Environmental Applications

Programme course

8 credits

Kombinatorisk optimering med miljötillämpningar

TAOP86

Valid from: 2017 Spring semester

Determined by
Board of Studies for Computer Science and Media Technology

Date determined
2017-01-25

Replaced by
TAOP89

Main field of study
Mathematics, Applied Mathematics

Course level
First cycle

Advancement level
G2X

Course offered for
- Information Technology, M Sc in Engineering

Specific information
Is not allowed in the diploma together with TAOP33.

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Linear algebra, Discrete structures, Data structures and algorithms

Intended learning outcomes

The course deals with mathematical tools for formulating, solving and analyzing combinatorial optimization problems, often based on different network and graph structures. Sustainable development and environmental aspects are prominent aspects in the applications that are discussed. An important point is the ability to choose and use the most efficient algorithm for each specific problem structure. The algorithms are intended to be suitable for large scale problems and implementation on computer.
After finishing the course, the student shall be able to:
describe important types of combinatorial optimization problems.
formulate combinatorial optimization problems as mathematical models,possibly with graph terminology, and determine the difficulty of the problems with the help of complexity theory.
explain the design of and the principles behind efficient solution methods and choose and use the methods for solving different types of combinatorial optimization problems.
use available software for solving optimization problems.
take part of development of software for optimization problems.
develop heuristics for certain structured combinatorial optimization problems.
explain and use basic concepts, such as local and global optimality, convexity, extreme point, complexity, duality, heuristic, branch-and-bound, cutting planes, and basic graph theory, especially trees and cycles of different kinds.
give examples of how combinatorial optimization can be used to promote sustainable development and improve the environment.

Course content

Introduction to optimization, problem formulation, graphical solution, computational complexity, problem complexity. The simplex method, linear duality and sensitivity analysis. Basic graph theory and overview of different optimization problems in graphs. Models and methods for finding minimal spanning tree, minimum cost traveling salesman tour, minimum cost postman tour, shortest path, minimum cost assignment, minimum cost flow and maximal flow. Methods for integer programming, especially branch-and-bound, cutting planes and dynamic programming. Heuristics for hard combinatorial optimization problems. Examples on applications that concern different aspects within sustainable development, for instance concerning a scenario that is common for several courses.

Teaching and working methods

The course is given as seminars, computer exercises and work in PBL groups. The seminars can be seen as a mixture of lectures and exercises, and treats theory, methods and models. Time is also spend on exercises in model formulation and problem solving. The computer exercises contain both implementation of optimization algorithms and solution of combinatorial optimization problems with the help of available software.

Examination

BAS1	Work in PBL group	2 credits	U, G
LAB1	Laborations	2 credits	U, G
TEN1	Written examination	4 credits	U, 3, 4, 5

Grades

Four-grade scale, LiU, U, 3, 4, 5

Department

Matematiska institutionen

Director of Studies or equivalent

Ingegerd Skoglund

Examiner

Kaj Holmberg

Course website and other links

http://courses.mai.liu.se/GU/TAOP86

Education components

Preliminary scheduled hours: 68 h
Recommended self-study hours: 145 h

Course literature

Kaj Holmberg: Optimering (Liber, 2010).

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.