

Introduction to Networks and Integer Programming

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42113 Network and Integer Programming

Computer software

Modelling software

- During the course we will use the optimization software-package **CPLEX** available on the GBAR system.
- This is a “light” modelling language with power enough for our use.
- If you know **GAMS** or another modelling language and prefer to use that, it is ok, but we do not necessarily “support” it.

Course Material

Teaching book

- Laurence A. Wolsey “Integer Programming”.



Lecture Notes

- Larsen & Clausen “Supplementary Notes in Networks and Integer Programming”.

Course website

New information, slides, solutions to exercises etc. will be placed on the course website at:

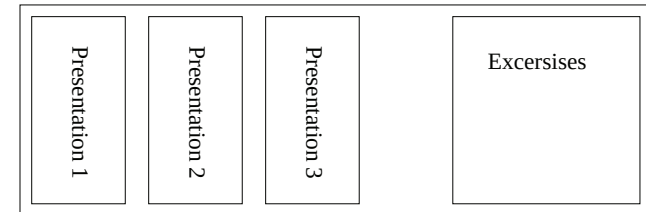
<http://www.imm.dtu.dk/courses/02713/>

Prerequisites

Linear Programming

- Introduction to Operations Research (42101, formerly known as 02701) or a corresponding introductory course to Operations Research.
- If you haven't had an introductory course in Operations Research and do not know linear programming you will have difficulties following the course.

General structure of the lectures



- 3 times 30 minutes of presentation (with 10-minute breaks in-between).
- 25 minute break.
- Exercises.

Where?

Lectures

Building 306, lecture hall 37: Tuesdays 13.00 - 15.00 and Fridays 8.30 - 10.30.

Exercises

Building 306, lecture hall 37: Tuesdays 15.15 - 17.00 and Fridays 10.45 - 12.00. For computer exercises, the location is building 303, databar R47.

Projects and final grade

Projects

During the course there are two compulsory project assignments. Groups of max. 3 persons.

Oral exam

30 min. oral exam with 30 min. preparation.

Grade

7 step scale, based on a weighted average of the 2 projects assignments and the oral exam in accordance with the "learning objectives". Both parts (project assignments and the oral exam) contributes equally to the final grade.

Networks and Integer Programming

Network

A collection of nodes (vertices), V , plus a collection of arcs (edges), A . Arcs are usually directed from one node to another, while edges are undirected between two nodes. The two sets form a network, denoted $N = (V, A)$. As such, it can be viewed as a graph.

Integer Programming

Extend our models from Introduction to Operations Research by allowing variables take on only have integer values.

42113 – Formulations

Week	Date	Lecture topic	Lecturer
37	14 sep	Formulations of Integer Programs	jla
	17 sep	Optimality, relaxation, and bounds	jla

Contents

- Formulation and comparison of formulations
- Optimality and related definitions

42113 – Introduction

Week	Date	Lecture topic	Lecturer
35	31 aug	Introduction	jla
	3 sep	Linear Programming – Simplex	dp
36	7 sep	Dual simplex and Duality	dp
	10 sep	Modelling with IP variables	jla

Contents

- Introduction
- Review of linear programming
- Review of duality
- Modelling with integer variables

42113 – Networks

Week	Date	Lecture topic	Lecturer
38	21 sep	Data structures and complexity	dp
	24 sep	Minimum Spanning Trees	dp
39	28 sep	Shortest Paths	dp
	1 oct	Maximum Flow I	dp
40	5 oct	Maximum Flow II	dp
	8 oct	Min Cost Flow I	dp
41	12 oct	Min Cost Flow II	dp

Contents

- Certain IP-problems can be solved efficiently, here we explore some of the most important ones

42113 – General IP

Week	Date	Lecture topic	Lecturer
43	29 oct	Dynamic Programming	pi
44	2 nov 5 nov	Complexity and problem reduction Branch-and-Bound I	pi jla
45	9 nov 12 nov	Branch-and-Bound II Lagrange Duality	jla jla
46	16 nov 19 nov	Cutting Planes and Branch-and-Cut Strong valid inequalities	jla jla

Contents

- General techniques for solving IPs
- Techniques for improving the efficiency of solution methods
- Complexity and problem reduction

42113 – Cases and Heuristics

Week	Date	Lecture topic	Lecturer
48	30 nov	Heuristics	jla
	3 dec	Branch-and-Cut for symmetric TSP	jla

Contents

- Examples of applications of techniques
- Example of an advanced case for the TSP
- Introduction to near-optimal methods