



Faculty of Applied Sciences

INMA2450 Combinatorial optimization

[30h+15h exercises] 4 credits

This course is taught in the 1st semester

Teacher(s): Laurence Wolsey
Language: French
Level: Second cycle

Aims

This course is about finding effective ways to solve discrete optimization problems that arise in graphs, production planning, logistics, circuit layout, etc. Given that most practical problems are "hard", the emphasis is on understanding how to model such problems and then choose an appropriate algorithm - branch-and-bound, branch-and-cut, decomposition, heuristics - so as to produce provably optimal solutions, or practical solutions of guaranteed quality.

Main themes

The course is about different ways to solve optimization problems with discrete or integer variables, which are used to handle indivisibilities, or on/off decisions, such as choosing an edge in a graph, buying a machine, using a warehouse, etc. Such problems arise in scheduling trains or aircraft, constructing a tour in a graph, drawing up a production plan for electricity generation, etc. The theory involves the study of polyhedra, matrices, graphs and aspects of complexity and the development of tight formulations. The algorithmic approaches covered include implicit enumeration and cutting planes (branch-and-cut), Lagrangian relaxation, dynamic programming and approximation algorithms.

Content and teaching methods

INTRODUCTION

Lecture 1: Formulation of combinatorial optimization and integer programming problems

Lecture 2: Finding bounds on the optimal value and using them to prove optimality

EASY PROBLEMS

Lecture 3: Recognizing certain easy problems - network flows, trees

Lecture 4: Matching and assignment Problems

Lecture 5: Introduction to the distinction between easy and hard problems

HARD PROBLEMS

Lecture 6: Intelligent enumeration - the branch-and-bound algorithm

Lecture 7: Lagrangian relaxation - a decomposition approach

Lecture 8: Using the geometry - general cutting plane algorithms

Lecture 9: Using problem structure - specialized cutting planes, branch-and-cut

Lecture 10: Heuristic methods to find good solutions quickly

FURTHER TOPICS

Lecture 11: Problems solvable by dynamic programming

Lecture 12: Decomposition using column generation

Lecture 13: More on formulations and problem solving

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

An exercise session is held every two weeks. The students will be expected to use a commercial modelling language and optimization system to solve several small practical problems. They will also be asked to program and test one of the algorithms seen in the course.

REFERENCE: Integer Programming, L.A. Wolsey, Wiley, New York 1998.

Other credits in programs

ECGE3DS/SC	Diplôme d'études spécialisées en économie et gestion (Master in business administration) (Supply Chain Management)	(4 credits)	Mandatory
MAP22	Deuxième année du programme conduisant au grade d'ingénieur civil en mathématiques appliquées	(4 credits)	
MAP23	Troisième année du programme conduisant au grade d'ingénieur civil en mathématiques appliquées	(4 credits)	
MATH22/G	Deuxième licence en sciences mathématiques	(4 credits)	