UCLouvain

linma2450

2020

Combinatorial optimization

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

5 credits	30.0 h + 22.5 h	Q1

Teacher(s)	Delvenne Jean-Charles ;Hendrickx Julien ;
Language :	English
Place of the course	Louvain-la-Neuve
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.
Aims	Learning outcomes: • AA1: 1,2 More specifically, at the end of the course, the student should be able to : 1 • formulate different combinatorial problems as integer programmes • explore different formulations for a same problem • find lower and upper bounds to the solution of an integer programme • recognize and solve some integer programmes that are solvable in polynomial time • recognize some integer programmes that are hard to solve (NP-hard) • apply various techniques (branch-and-bound, Lagrangian relaxation, heuristics) to solve hard problems approximately Tranversal learning outcomes: • Use of Matlab or other softwares to solve medium-size problems - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Written or oral exam (depending on the circumstances and on the number of students), and grades of the homework. The exam can take place remotely if required by the sanitary situation or practical constraints. The teaching team may organize a (compulsory) oral exam to obtain complementary information in case of need, or of doubt on the grade to assign.
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Lectures, possibly complemented by individual discovery of certain topics, and supervised exercises sessions. These activities take place in the classroom or in "co-modal" form depending on practical constraints and on the number of students present. Students also complete one or several more advanced homework, using an optimization software.
Content	1. Formulation of combinatorial optimization and integer programming problems. 2. Finding bounds on the optimal value and using them to prove optimality 3. Recognizing and solving certain easy problems - network flows, trees, matching and assignment problems 4. Introduction to the distinction between easy and hard problems: NP-hardness 5. Intelligent enumeration - the branch-and-bound algorithm 6. Lagrangian relaxation 7. Introduction to cutting plane algorithms 8. Heuristic methods to find good solutions quickly
Inline resources	Moodle page of the course.

Bibliography	Integer Programming, L.A. Wolsey, Wiley, New York 1998.
Faculty or entity in charge	MAP

Force majeure

Teaching methods	Lecture and supervised exercices sessions take place online.
Evaluation methods	The exam is written, on site. An exam of adapted form will be proposed to the students with a valid quarantine certificate or a 'formulaire retour' from the Foreign Office, if the teachers (Julien Hendrickx and Jean-Charles Delvenne) are warned asap and in any case before the main exam. This alternative exam will cover the same topics as the main exam, and will be organised in a form compatible with the situation of the student.

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Mathematics	MATH2M	5		
Master [120] in Computer Science and Engineering	INFO2M	5		
Master [120] in Computer Science	SINF2M	5		
Master [120] in Mathematical Engineering	MAP2M	5		
Master [120] in Data Science Engineering	DATE2M	5		
Master [120] in Data Science: Information Technology	DATI2M	5		