Winter 2020

Course description

COMP 567 - Discrete Optimisation 2

1. Objectives

This course is an introduction to

- deterministic discrete optimisation: linear programming, integer linear programming, network flows
- stochastic integer programming
- decomposition
- metaheuristics

It includes some of the basic mathematical principles required to understand different solution techniques introduced in the lectures. No prerequisites are required to follow the course, but we assume that the students have some mathematical maturity, and that they know basically linear algebra and analysis.

2. Course content

Week 1 (Introduction)

- Introduction
- Introduction to discrete optimization (Components of a mathematical model, linear programming models, integer programming models, MIPs..)
- Classical problems in discrete optimization (knapsack, assignment problem, …)

Week 2 (A review of linear programming)

- The simplex method (the algorithm, outcomes, cycling and degeneracy)

Week 3 (Duality)

- Duality (Dual formulation, Duality theorems, some uses of duality)
- Dual simplex method

Week 4 (Integer programming)

- Relaxations (motivation, definition, linear relaxation)
- Gomory’s cutting plane methods

Week 5 (Integer programming)

- Branch and Bound (the algorithm, branching strategies, node selection

Week 6 (Network flows)

- Simplex method for problems with bounded variables
- Minimum cost flow problem solved by the simplex method

Week 7 (Network flows, midterm exam)

- Minimum cost flow problem solved by the simplex method
- **Midterm exam**

Week 8 (Stochastic programming)

- Stochastic integer programming

Week 9 (Stochastic programming, Decomposition)

- Stochastic integer programming
- Restriction approach
- Dantzid-Wolfe decomposition method and column generation

Week 10 (Decomposition)

- Relaxation approach
- Benders decomposition

Week 11 (Metaheuristics : local search)

- Metaheuristics: Local search methods (Descent, Tabu search, Simulated annealing, Variable Neighborhood Search)
- Adaptive large neighborhood search

Week 12 (Metaheuristics : population based)

- Metaheuristics: Population based methods (Genetic algorithm, Scatter Search, particle swarm)

Week 13 (Final exam)

- **Final Exam**

3. Course grade

Homework: 25%
Midterm exam (1.5 hours): 30%
Final Exam (3 hours): 45%

4. Schedule

Tuesday 10:00 – 11:30 a.m.
Thursday 10:00 – 11:30 a.m.

Room: MC #321
McConnell Engineering Bldg., Room 321
3480 University St., Montréal, Qc H3A 0E9

5. Course slides available in the following website:

http://www.iro.umontreal.ca/~ferland/COMP/index.html

Textbooks:

- Linear and nonlinear programming, D.G. Luenberger, Y. Ye, 2008
- Linear programming, V. Chvatal, 1983
- Integer programming, L.A. Wolsey, 1998
- Integer and Combinatorial Optimization, G. Nemhauser and L.A. Wolsey, 1988
- Introduction to Stochastic Programming, Birge and Louveaux, 2011
- Handbook of metaheuristics - Second Edition, International Series in Operations Research & Management Science, M. Gendreau and J.Y. Potvin (Eds.), 2010
- Introduction to Operations Research, Hillier and Lieberman, " Mc Graw-Hill (2005)
- Linear Programming and Network Flows, Bazaraa, Jarvis, Sherali, John Wiley & Sons (2005)
- Linear Programming and Extensions, Dantzig, Princeton University Press (1963)
- Perspectives on Optimization, Geoffrion, Addison-Wesley (1972)

IMPORTANT:

- McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures
(see www.mcgill.ca/students/srr/honest/ for more information).
- In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.