IE 604 – Integer Programming

Spring 2023

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Lecture Hours: Tuesday, 11:40 – 13:30 (FENS L058)
Thursday, 13:40 – 14:30 (FENS L035)

Catalog Description:
In this course, the students will learn the mathematics of discrete optimization including the representation of problems by mathematical models and the solution of these models. In computational complexity part, the concepts of polynomial computation and NP-completeness will be introduced, and equivalence of separation and optimization will be discussed. Then, basic approaches and algorithms for solving discrete optimization problems will be introduced. The branch-and-bound algorithm, the theory of valid inequalities, and the results known for simplest discrete sets that are necessary to understand the cutting planes generated by today's commercial solvers will be covered. In polyhedral theory, the concepts of facets of polyhedra and the idea of representing the convex hull of a discrete set of points will be covered. Extended formulations and the reformulations that enable decomposition algorithms will be addressed.

Prerequisites: IE 501 Linear Programming & Extensions

Textbooks and References:

Nemhauser, G.L. and L.A. Wolsey (1998) *Integer and Combinatorial Optimization*. John Wiley and Sons, New York

Wolsey, L.A. (1998) Integer Programming. Wiley, New York.

Tentative Course Outline:

- Formulating (Mixed) Integer Programs
- Well-Solved Problems
- Complexity and Problem Reductions
- Polyhedral Theory
- Computational Methods

Objectives of the Course:

At the end of the semester, the students should be able to

1. Model integer programming problems (IP) and understand what makes a model “better” than another one.
2. Comment on the computational complexity of a problem.
3. Comment on the performance of an algorithm.
4. Understand the common methodology for the solution of IPs.
5. Understand the basic concepts of polyhedral theory and how they apply to IP.
6. Understand the theory of valid inequalities and their usage in the solution of IPs.
7. Propose exact (and heuristic) solution methods to solve IPs.

Grading:

- Assignments (30%)
- Midterm exam (30%)
- Final exam (40%)

Notes:

- Syllabus is tentative and there might be changes over the semester. Please carefully review the announcements made during the classes and through SuCourse+ throughout the semester.
- We may have to revise the course plan according to the countrywide reassessment to be made regarding higher education. This is expected to happen at the beginning of April. The method of course delivery, the number and dates of exams, and some other details are subject to change.
- Some homework problems might require implementing mathematical models and/or solution algorithms. Although there is no restriction for the implementation language, Python programming language and Gurobi optimization solver are suggested. It is your responsibility to how learn these software.

Academic Integrity:

By taking this course, each student agrees to abide by the academic integrity policy at Sabanci University.