IE 604 Integer Programming
Spring 2021

Instructor: Beste Basciftci

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Lecture Hours: Tuesday 10:40-11:30 and Thursday 10:40-12:30

Office Hours: Tuesday 11:40-12:30 (if there is any appointment)

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

Textbook: Integer and Combinatorial Optimization, G.L. Nemhauser and L.A. Wolsey, 1988

Course Outline: Main topics can be listed as follows:

- Modelling through Mixed Integer Programming
- Introduction to Computational Complexity
- Identifying Easy Integer Programs
- Polyhedral Theory
- Fundamental Theorems in Integer Programming
- The Modern Integer Programming Solvers and Solution Techniques
- Reformulation and Decomposition Techniques of Integer Programs

Grading:

- Lecture Scribing (%10)
- Assignments (%25)
- Exam (%35)
- Project (%30)

Notes:

- Zoom links of the lectures will be sent through Sucourse and students need to enter the sessions with their Sabanci University e-mail addresses.
- Scribing part requires typing the lecture notes using Latex, and it will be done in turn by the students throughout the semester in a way that each student is responsible from equal number of classes. Lecture Scribes should elaborate the issues that are discussed in the class and cover mathematical formulations rigorously, even if that part or notation is skimmed during the lecture.
- 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.
- Class Project requires students to select a subject relevant to the Integer Programming or its applications on a specific problem, and focus on relevant academic papers to extensively work on this problem from both theoretical and computational perspectives. Each project should demonstrate the use of theory covered in the class along with the implementation of an algorithm as a solution approach.
  - Project topics and relevant academic papers need to be selected in consultation with the class instructor. Afterwards, project proposals need to be submitted on a date that will be announced later.
  - Each project will have a mid-evaluation within the semester, and regular progress in the project is required for its successful completion.
  - Projects will be submitted during the final exam week at a date that will be announced later. Projects will also be presented to the class through a session, after the submission.
  - Although there is no restriction for the implementation language, Python programming language and Gurobi optimization solver are suggested.
  - Interested students are strongly encouraged to work on the class project rigorously throughout the semester, as the good projects can be studied further after this semester for journal or conference publications.

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