ORI 391Q.4 - Integer Programming

Syllabus

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Office Hours
T Th, 1:00 – 1:45 p.m., (or, stop by anytime, I'll meet with you if I am not busy)

Class Meetings
Times: T Th, 2:00 p.m. – 3:30 p.m., Room: ETC 2.114

Course Web Page
Canvas: canvas.utexas.edu

(Official) Course Description
Subject Matter Description: Mathematical optimization techniques with applications to engineering and industrial problems. *Topic Description*: Models, theory, and computational methods for problems with discrete decision alternatives. Greedy algorithms, branch and bound, cutting plane methods, Lagrangian relaxation, and heuristics. *Meeting Information*: Three lecture hours a week for one semester. *Degree Plan Information*: May be repeated for credit when the topics vary. *Prerequisite*: Graduate standing and a course in operations research methods.

Other Prerequisites
ME 366L (OR Models) or equivalent; a working knowledge of at least one computer programming language (e.g., C++, Java, Python).

Objectives
Many problems that arise in industrial and socio-economic systems, such as machine scheduling, vehicle routing, resource allocation and management, and telecommunications network design, can be modeled as integer or mixed-integer programs. Generic models that make up the field of combinatorial optimization also fit the integer programming (IP) format. The aim of this course is to present the theory and exact and approximate techniques that have been developed to solve these models. These techniques include branch and bound, cutting planes, Lagrangian relaxation, and column generation. However, it is rare that any one technique can be applied successfully in solving IPs of realistic size. In most cases, it is necessary to identify and exploit a familiar underlying structure in the model. Polyhedral theory will play an important role in this regard and will be discussed at some length. In addition, students will be required to program a number of algorithms.

Text
Laurence A. Wolsey, *Integer Programming*, John Wiley and Sons, 1998.

Other references

- D. Bertsimas and R. Weismantel, *Optimization over Integers*, Dynamic Ideas, 2005.
- G.L. Nemhauser and L.A. Wolsey, *Integer and Combinatorial Optimization*, Wiley, 1988.
- A. Schrijver, *Theory of Linear and Integer Programming*, Wiley, 1986.
- C.H. Papadimitriou and K. Stiglitz, *Combinatorial Optimization: Algorithms and Complexity*, Prentice-Hall, 1982.

Software

- Modeling languages:
  - AMPL (www.ampl.com)
  - GAMS (www.gams.com)
  - Xpress-MOSEL (www.fico.com/en/products/fico-xpress-optimization-suite)
- Solvers and callable libraries:
  - CPLEX (www-01.ibm.com/software/commerce/optimization/cplex-optimizer/)
  - XPRESS-MP (www.fico.com/en/products/fico-xpress-optimization-suite)
  - GUROBI (www.gurobi.com)
- Open source optimization software: COIN OR Project: www.coin-or.org
- Microsoft Excel Solver: Frontline (www.solver.com) and Open-source alternatives (www.opensolver.org)

Web Sites

- The Institute for Operations Research and Management Sciences (INFORMS) (www.informs.org), including
  - Mathematical Programming Glossary (glossary.informs.org/ver2/mpgwiki/index.php?title=Main_Page)
- NEOS Server for Optimization (neos-server.org/neos/)

(Tentative) Outline

- Introduction, Modeling, and Illustrative Examples (Chapter 1).
- Optimality, Relaxation, and Bounds (Chapter 2)
- Well-Solved Problems (Chapter 3)
- Computational Complexity (Chapter 6)
- Branch and Bound (Chapter 7)
- Cutting Plane Algorithms (Chapter 8)
- Strong Valid Inequalities (Chapter 9)
- Lagrangian Duality (Chapter 10)
- Column Generation Algorithms (Chapter 11)
- Heuristic Algorithms (Chapter 12)
- From Theory to Solutions (Chapter 13)

Grading
The grading will be based on the following weights:

- Homework (each due before class): 15%
- Computer Assignments (done in groups, each due before class): 20%
- Midterm Exam ( ): 30%
- Final Exam ( ): 35%

I expect that each assignment (homework, computer assignments, project reports, and exams) be neat and professional. You will not be allowed to make up exams unless there is a documented emergency. Homework and computer assignments are graded on a 0-5 scale and an assignment that is one class late is penalized with a grade level reduction; it will not be accepted after that date.

Academic Dishonesty
Each student in the course is expected to abide by the University of Texas Honor Code: "As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity." Plagiarism is taken very seriously at UT. Therefore, if you use words or ideas that are not your own (or that you have used in previous class), you must cite your sources. Otherwise you will be guilty of plagiarism and subject to academic disciplinary action, including failure of the course or dismissal from the University. Cheating will not be tolerated, and incidents of dishonesty will be reported. You are responsible for understanding UT's Academic Honesty and the University Honor Code which can be found at the following web address: deanofstudents.utexas.edu/conduct/.

Classroom Interaction and Expectations
I expect that each of you will pay attention to class, ask questions, and participate in lecture, discussion, and other activities in class. Any action that disturbs this environment, including cell phone use or use of computers besides authorized class activity, is not allowed during class.

Students with Disabilities
The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 512-471-6259, diversity.utexas.edu/disability/.

Course Evaluation
Near the end of the semester, you will have an opportunity to anonymously evaluate the course and instructor using the standard Cockrell School of Engineering evaluation form.

E-mail Notifications
In this course e-mail will be used as a means of communication with students. You will be responsible for checking your e-mail regularly for class work and announcements. The complete text of this policy and instructions for updating your e-mail address are available here:
cio.utexas.edu/policies/university-electronic-mail-student-notification-policy

Dropping the Course
An engineering student must have the Dean's approval to add or drop a course after the 12th class day of the semester. A student seeking to drop a class after the 12th class day should visit the Cockrell School of Engineering Student Services (Engineering Student Services Building, 471-4321).