Instructor: Tamon Stephen
Meeting Time: MWF 9:30–10:20 in SUR 2980
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Web page: http://www.math.sfu.ca/~tamon/Teaching/1167_Math408/
Office Hours: Wednesday 10:30–11:20 (tentative) and by appointment.
Text: Optimization over Integers by Bertsimas and Weismantel
Grading: 25% Homework, 25% Midterm, 50% Final.
748: 20% Homework, 20% Presentation, 20% Midterm, 40% Final.

1. **Syllabus.** This course is an introduction to discrete optimization. The focus is on modelling problems as integer programs and polyhedral methods for solving these programs. Topics that we plan to cover include:

   Model building using integer, binary and mixed integer variables. Computer solution of integer programming models, linear programming relaxations, Lagrangian relations, duality, simple upper bounds using greedy algorithms. Branch and bound algorithms, implicit enumeration, LP based branch and bound.

   Valid inequalities, Gomory's fractional cut, mixed integer cuts, strong valid inequalities, simple facets for 0-1 knapsack polytope and the travelling salesman polytope, branch and cut algorithms.

   Lagrangian relaxation, strength of the Lagrangian dual, Lagrangian heuristics.

   Column generation algorithm, solving symmetric travelling salesman problem using column generation.

   Greedy and local search algorithms, construction heuristics, worst case analysis of heuristics.

2. **Graduate student projects.** Near the end of the term, each graduate student will present a brief (25 to 30 minute) introductory lecture on a current topic in integer programming. The topic will be selected in conjunction with the instructor. Possible sources of topics are the book *Algebraic and Geometric Ideas in the Theory of Discrete Optimization* by De Loera, Hemmecke and Köppe or the surveys from *50 Years of Integer Programming 1958-2008* by Jünger. Both are on reserve in the SFU Surrey library. There may be an option to give these presentations in the SFU Operations Research Seminar series rather than in class.

3. **Homework.** There will be five homework assignments during the term. Late homework will not be accepted.

   You are encouraged to talk with each other and the instructor about the homework, but you must write up the solutions yourself, using your own words. Solutions copied from other students, textbooks or the Internet are **not** acceptable.

   Note that model solutions to homework problems will **not** be provided, even after the fact.

4. **Computing.** Integer programming is by its nature a computational subject, and students are encouraged to experiment with software for integer programming. Some integer programming capability is now available even in general purpose software such as the `Microsoft Excel` spreadsheet. There are also many specialized free and commercial packages for mathematical optimization. For instance, you can obtain student versions of the `AMPL` modelling language with several (limited) solvers from `http://www.ampl.com`. Depending on interest and availability of computing resources, we may also try out a full-featured version of the `CPLEX` solver.

The assignments may involve the use of such software, however no prior computing background is required.

5. **Exams.** Books, notes and calculators cannot be used on the exams. Students **must** plan to take the tests at their scheduled times.

   The tentative dates and times for the tests are:

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   Midterm: Friday, October 21st, 9:30-10:20 AM  (in class)
   Final: Wednesday, December 14th, 12:00-3:00 PM
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6. **Textbook.** The main textbook for this course is *Optimization Over Integers* by Dimitris Bertsimas and Robert Weismantel. However, we will occasionally supplement from other sources, including Vanderbei's *Linear Programming: Foundations and Extensions*, which is available on-line through the SFU library.

   If you find the textbook challenging to read, you may also consult Wolsey's *Integer Programming*, Lee's *A First Course in Combinatorial Optimization* or Parker and Rardin's *Discrete Optimization*. All of these are on reserve at the SFU Surrey library.

7. **Additional Reserve Books.** Besides the textbooks and related mentioned above, there are some relevant books on reserve at the SFU Surrey library.

   Schrijver's *Combinatorial Optimization* is an excellent reference book in this area. For a refresher on linear programming, Chvatál's book is available. The books of Papadimitriou and Papadimitriou and Steiglitz provide background on computational complexity theory. Some more advanced current topics are developed in the book of De Loera, Hemmecke and Köppe.

   A nice overview of the development of integer programming is contained in the book *50 Years of Integer Programming 1958-2008*, edited by Jünger et al., and *The Traveling Salesman Problem* by Applegate, Bixby, Chvátal and Cook gives a view of modern computation on this challenging problem, developing from scratch, through techniques presented in this course, right to the cutting edge (of ten years ago).

Have a great term!