Optimization models and applications
ISE 426 — Fall 2015

Instructor:	Katya Scheinberg
	Mohler Lab #479
	Phone: 610-758-4039
email:	katyas@lehigh.edu
office hours:	by appointment.
TAs	Sahar Tahernejad tahernejad.sahar@gmail.com and Secil Sozuer, ses515@lehigh.edu
TA office hours:	Mon 4:30-6:30 and Wed 3:30 pm-5:30pm, Rm 121, Mohler
	(you need to get access the the Mohler Lab to be able to use it)

Evaluation

Homework:	25%
Quiz #1:	10%
Quiz #2:	10%
Case study:	20%
Final exam:	25%
Class participation	10%

Scope of the course

Optimization problems arise very often in Industry, and the ability to solve them is a competitive advantage. However, modeling an Optimization problem requires special tools and skills. A problem that is not understood or modeled correctly can lead to the wrong solution or can be very difficult to solve.

The purpose of this course is to provide you with the tools and knowledge necessary to model practical Optimization problems and solve them efficiently. We will see how to properly formulate a problem, how to choose an adequate solver, and how to solve practical applications with state-of-the-art solvers.

Course material

There are several books on Modeling and Optimization, and I don't think there is an overall best. No book in particular is required, and any of the following will be sufficient for the course:

- Select chapters of "Introduction to Operations Research" by F.S. Hiller and G.J. Lieberman, McGraw-Hill: New York, NY, 1990;
- Select chapters of "Introduction to Mathematical Programming: Applications and Algorithms", Volume 1, by W.L. Winston and M. Venkataramanan;
- Select chapters of "Operations Research: Applications and Algorithms" by Wayne L. Winston, PWS-Kent Pub. Co., 1991.

The modeling language is described in "AMPL: A Modeling Language for Mathematical Programming" by Robert Fourer, David M. Gay, and Brian W. Kernighan — this book is not required for the course.

Modeling tools/language

We will be using modeling language AMPL. For your information the two alternatives are GAMS and Mosel. The latter has a good manual that also serves as an introduction to modeling.

Both AMPL and Mosel have student versions that can be downloaded for free. They are are limited to a maximum of 300 constraints and variables, but this is more than enough for most of this course.

Problems formulated in AMPL or GAMS can be solved by submitting the model at `http://www-neos.mcs.anl.gov/neos`. Many solvers can be used for free, and with no limits on the number of constraints and variables.

Homework

There will be several homeworks, and **all must be completed, no freebies**. These require modeling and solving simple problems. The problems are stated in informal language, and your task is to translate them into a model in any of the above language, solve them, and do some extra work involving other tools of the language. Homeworks will be penalized for each day they are late. After solutions are released, they will not be accepted. No exceptions.

Case Studies

An essential part of this course is a hands-on experience on real Optimization problems. As for the homeworks, **it must be completed to receive a grade**. Groups of three-four people study an Optimization problem, propose a model and solve it using a tool of their choice. The result is a short report on the whole experience, whose evaluation accounts for 20% of the final grade. There will be an informal discussion after the beginning of the study and another after the report is due. Possible topics are:

- Network design;
- Obnoxious location;
- Portfolio Optimization;
- Signal processing;
- Chemical engineering;
- Mechanical engineering;
- Electric and Computer Engineering;
- Logistics and Scheduling.

Tentative calendar

1. Introduction: 2 lectures. Optimization models: variables, constraints, objective functions. Convexity and relaxations.
2. Linear Programming: 6-8 lectures Linear Programming models, graphical solution, sensitivity analysis. Network models.
3. Integer Programming: 6 lectures. Modeling with integer and binary variables. Logical constraints and binary variables.
4. Nonlinear Programming: 2-3 lectures. Nonlinear models, KKT conditions.
5. Robust Optimization. Duality, uncertainty models.
6. Stochastic Programming: 2 lectures. Two-stage optimization, multi-stage optimization.

7. Multi-criteria Programming. Optimizing with many objective functions; Pareto-optimal solutions.

There will be two quizzes, in the middle of October and of November. They will focus on parts 1+2 and 1+3, respectively. The final exam will encompass all of the course.

Attendance

I strongly encourage you to attend all lectures and to actively participate. The material is much harder to learn on your own.

Accommodations for Students with Disabilities

If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center C212 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

Note: this syllabus is subject to change.