IE524 SYLLABUS

Optimization in Finance

Time/Location:	3:00 pm - 4:40 pm (MW), 101 Transportation Building.
Instructor:	Qiong Wang (qwang04@illinois.edu)
office hour:	Friday, 10am-Noon (TB 201B); also by appointments.
Teaching Assistant:	Hossein Nick Zinat Matin (nickzin2@illinois.edu)
office hour:	Tuesday 9-11 am (TB 08).

Course Objective

Develop understandings of canonical models, basic theories, and possible applications of mathematical optimization. Build up abilities of using optimization techniques to support decision-making in finance.

Teaching Materials

- Lecture notes will be posted on Compass before the class.
- Reference: Gerard Cornuejols and Reha Tütüncü, *Optimization Methods in Finance*, Cambridge University Press, 3rd printing (2011) (on reserve at Grainger Library).
- I will also give pointers to YouTube educational videos that supplement classroom teaching.

Important!

We will strictly enforce university's academic integrity policies to protect the quality of our education and the reputation of our program. Please familiarize yourself with these rules and procedures (ignorance is not a defense).

http://studentcode.illinois.edu/

Prerequisite

Students taking this course should have received basic training in calculus, linear algebra, and probability. They should also be able to write codes in C, Matlab, *or* other languages to carry out computations for homework assignments.

Grades

- in-class midterm exam (October 5, Wednesday): 35%.
- in-class final exam (cumulative) (December 5, Monday): 50%.
- homework: 15%.

1. Assignments with due dates will be posted on COMPASS.
2. Late homework will get 20% point reduction and will not be accepted after its solution has been posted on Compass.
3. While discussions are allowed, copied homework gets zero point.

Course Schedule

Lecture 1 (Aug 22, Monday)

Introduction: what is optimization? why do we do it? what are involved?

Reading: C&T, chapter 1.

Lecture 2 (Aug 24, Wednesday)

Linear Programming: formulation of LP models, graphic interpretation, and the Simplex method.

Reading: C&T, chapter 2.1, 2.4 (excluding 2.4.5 and 2.4.6).

Lecture 3 (Aug 29, Monday)

Linear Programming: duality theory and sensitivity analysis.

Reading: C&T, chapter 2.2-2.3.

Lecture 4 (Aug 31, Wednesday)

Linear Programming Application: portfolio selection, short-term financing, cash-flow matching problems.

Reading: C&T, chapter 3.

Lecture 5 (Sept 7, Wendesday)

Linear Programming Application: asset pricing and arbitrage.

Reading: C &T, chapter 4.

Lecture 6 (Sept 12, Monday)

Linear Programming Application: systematic risk assessment.

Reading: H. Elsinger, A. Lehar and M. Summer. Risk assessment for banking systems. *Management Science*, 52(9):1301-1314, 2006.
(http://pubsonline.informs.org/doi/pdf/10.1287/mnsc.1060.0531).

Lecture 7 (Sept 14, Wednesday)

Nonlinear Optimization: unconstrained optimization, models, theory, and algorithm.

Reading: C&T, chapter 5.1-5.4.

Lecture 8 (Sept 19, Monday)

Nonlinear Optimization: constrained nonlinear optimization, problems and optimality conditions.

Reading: C&T, chapter 5.5, 7.1-7.2.

Lecture 9 (Sept 21, Wednesday)

Nonlinear Optimization Application: portfolio optimization

Reading: C&T, chapter 8.1, 8.2.

Lecture 10 (Sept 26, Monday)

Nonlinear Optimization Application: information discovery by optimization.

Reading: C&T, chapter 6.1, 8.4.

Lecture 11 (Sept 28, Wednesday)

Linear and Nonlinear Programming: optional materials.

Midterm Summary (October 3, Monday)

Midterm Exam (October 5, Wednesday)

Lecture 12 (October 10, Monday)

Integer Programming: model formulation, branch-bound algorithm, and applications to index fund construction.

Reading: C&T, chapters 11 and 12.

Lecture 13 (October 12, Wednesday)

Dynamic Programming: model formulation and the optimality principle.

Reading: C &T, chapter 13.

Lecture 14 (October 17, Monday)

Dynamic Programing: value function and recursive algorithms.

Reading: C &T, chapter 13.

Lecture 15 (October 19, Wednesday)

Dynamic Programing Application: the optimal stopping problem and its application to finance.

Lecture 16 (October 24, Monday)

Dynamic Programing Application: assets backed securities

Reading: C &T, chapter 15.

Lecture 17 (October 26, Wednesday)

Stochastic Programming: two-stage models and solution procedure.

Reading: C&T, chapter 16.

Lecture 18 (October 31, Monday)
Stochastic Programming Application: (Conditional) Value at Risk.
Reading: C&T, chapter 17.

Lecture 19 (November 2, Wednesday)
Stochastic Programming Application: Russell-Yasuda Model.
Reading: C&T, chapter 18.

Lecture 20 (November 7, Monday)
Robust Optimization: Concepts and Model Formulation.
Reading: C&T, chapter 19.

Lecture 21 (November 9, Wednesday)
Robust Optimization Application: Portfolio Selection.
Reading: C&T, chapter 20.

No Lecture (November 14, Monday). Use this time to read the case on order execution that we will discuss in the next lecture:
R. Almgren and N. Chriss, Optimal Execution of Portfolio Transactions, http://www.courant.nyu.edu/~almgren/papers/optliq.pdf.

Lecture 22 (November 16, Wednesday)
Discussion of Case Study: Order execution.

Review, Discussion, and optional material (November 28, Monday and 30, Wednesday).

December 5, Final Exam.