IE524A Optimization in Finance (2023)
Syllabus

Instructor:	Qiong Wang (qwang04@illinois.edu)
Lecture time:	TB112, 3-4:20pm, MW (US central time)
office hour:	TB201B, Noon-1:30pm, Tuesday

Teaching Assistant:	Mingxuan Cui (mc96@illinois.edu)
office hour:	5-6pm, Wenesday, TB205
Course Website	https://canvas.illinois.edu/courses/38472

Teaching Arrangements:

1. Slides will be posted on course website, in the directory "Files/Slides".
2. Homework will be posted on Canvas, in the directory "Files/Homework". There will be two subdirectories: you will find problem sets in "Assignments". Solutions will be posted after the submission deadline in "Solutions".
3. Assignments are usually posted after Wednesday's class. Submissions are due midnight Thursday the week after.
4. You are encouraged to share your questions and thoughts on the discussion board on Canvas. TA and I will check in and respond regularly.

Course Objectives:

- Develop understandings of optimization theory and relevant techniques.
- Build up skills to formulate financial problems as optimization models.
- Practice optimization techniques and tools.
- Analyze optimization models and solutions for making financial decisions and gaining relevant business insights.

Reference (recommended but not required): Optimization Methods in Finance, Gerard Cornuejols and Reha Tütüncü,, Cambridge University Press, 3rd printing (2011) (Available online).

Software: The course requires the use of computer programs to solve financial optimization problems. Students are free to choose software or write their own code. AMPL (http://www.ampl.com/REFS/amplmod.pdf) is a popular optimization interface language that is easy to learn and useful to master. I have obtained free copies for teaching use from the company and uploaded

them to the directory "Software" on Canvas. Please download and install "ampl_macos64.tgz" if you use Mac machine, and 'ampl_mswin64.zip" if you use PC.

Homework

1. Assignments will be posted weekly on Canvas with due date marked. Please submit your completed homework electronically to Canvas.
2. Late homework will receive 15% point deduction and will not be accepted after its solution has been posted on Canvas.
3. While discussions are allowed, plagiarism is forbidden and will be punished by receiving zero point on homework and a low or fail final grade.

Grading: homework 40%, exam (given on Oct 12, tentative): 60%

Important!

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

http://studentcode.illinois.edu/

Course Schedule (subject to change)

Week of Aug 21: Introduction

We will first give an overview of the subject area, followed by opening our discussion on the most fundamental topic in optimization: Linear Program. We will define LP models, show how to formulate them in standard forms, and describe the underlying idea of finding optimal solutions of these problems.

Suggested reading: C&T, chapter 1. C&T, chapter 2.1 and 2.4.

Week of Aug 28: Applying and Solving LP Models:

We will present several examples to show the application of LP to financial problems: how to manage cash flows and credit lines in a corporation, how to use the technique on certain type of mean-risk portfolio management problem. We will then practice the method by using LP solvers to find optimal solutions to these problems. practicing the method bypracticing the method by use the

Suggested reading: C&T, chapter 3.

Week of Sept 6: Dual LP

There will be no class on Monday, Sept 6 (Labor Day). On Wednesday's class, we will introduce an interesting and very useful technical development of LP, the dual LP models and several relevant theorems, duality and complimentary slackness conditions, which, as we will see later, have very important implications in trading and other financial transactions.

Suggested reading: C&T, chapter 2.2-2.3

Week of Sept 11: Applications of Dual LP in Financial Transactions

We will discuss financial applications of LP duality theory. Specific topics are how to use optimal solutions to price financial instruments, how to detect the existence of arbitrage opportunities, and how to solve the LP to get risk-neutral probabilities

Suggested reading: C&T, chapter 4.

Week of Sept 18: Nonlinear Optimization Model

We will discuss the next topic, Nonlinear Optimization. We will start from a classical example in finance to motivate the development of nonlinear optimization models, followed by formal formulation and classification of models. We will then discuss the KKT condition and its use as a fundamental approach for solving a large class of nonlinear optimization models.

Suggested reading: C&T, chapter 5.1 and 5.5.

Week of Sept 25: Application of Nonlinear Optimization Model

We will discuss the most important application of nonlinear optimization model, portfolio management. We will show how to use the KKT condition to show different types of mean-risk models are equivalent to each other. We will discuss the efficient frontier from the perspective of nonlinear optimization, and use the method to compute Sharpe Ratio.

Suggested Reading: C&T, chapter 8.1-8.3

Week of Oct 2: Integer Programming

We will discuss the third and the last topic of the course: integer programming. We will focus on the use of binary variables to characterize logical conditions in financial transactions, especially in the construction of the index funds. We will also give a brief overview on how to solve Integer Programming models.

Suggested reading: C&T, chapter 11-12.

Week of Oct 9: Exam Week: we will have Q & A to go over review problems on Monday (Oct 9) and the final exam on Wednesday (Oct 11), all during regular class time.