Course Syllabus

QF527800: Optimization Methods in Finance

Instructor: Chung-Han Hsieh (ch.hsieh@mx.nthu.edu.tw)

Course Description & Audience: The course serves as a twin course of Robust and Stochastic Portfolio Optimization (QF527200). After a quick review of some key topics from linear algebra, the course will dive into the theory of optimization with a focus on its application in quantitative finance. Specifically, this course covers an extensive introduction to the topics of first-order optimization methods. The coverage of material will be suitable for graduate students with a focus on financial engineering, stochastic optimization, and quantitative trading. Many of the results will be presented in a definition-theorem-proof manner. Prerequisite mathematical maturity is essential for success in this course. The intended topics of the course to cover are listed as follows.

- Vector Spaces
- Extended Real-Valued Functions
- Subgradients
- Conjugate Functions
- Smoothness and Strong Convexity
- The Proximal Operator
- Spectral Functions
- Strong Duality and Optimality Conditions
- Numerical Optimization Algorithms
  - Primal and Dual Projected Subgradient Methods
  - Mirror Descent
  - Proximal Gradient Descent
  - Frank-Wolfe Method
  - ADMM

Prerequisites: A student planning to take this course should have a fair familiarity with linear algebra, multivariate calculus, mathematical analysis, optimization, probability theory, statistics. Familiarity with some numerical software such as Matlab or Python is also *required*. If in doubt about the background, the student should consult with the instructor.

Textbooks & References: Students will be provided with handout material to support the lectures. The material will be mainly drawn from some recommended textbooks/references listed below.

1. A. Beck, *First-Order Methods in Optimization*, SIAM, 2017.
2. G. Cornuejols, J. Pena, R. Tütüncü, *Optimization Methods in Finance*, Cambridge University Press, 2018.

3. J. Nocedal and S. J. Wright, *Numerical Optimization*, Springer, 2006.

4. Y. Nesterov, *Introductory Lectures on Convex Optimization: A Basic Course*, Springer, 2004.

5. A. Shapiro, D. Dentcheva, A. Ruszczyński, *Lectures on Stochastic Programming: Modeling and Theory*, SIAM, 2021.

Time: Lectures are at T5T6T7.

Teaching Method: Lecture

Homework: Approximately bi-weekly. You are encouraged to join with other students in discussing the course work, including homework. However, *work that you hand in must have been prepared by you alone.*

Grading: The grade will be based on midterm (30%), homework (30%) and a special project (40%). The instructor may exercise discretion up to 10% in each of the grading categories.

Ethics Statement on Generative Artificial Intelligence (AI): This course adopts *conditionally open* policy. In this course, students are required to disclose the use of generative AI in their assignments, specifically detailing its role in idea generation, sentence refinement, or structure. Failure to disclose will result in academic penalties, including potential reevaluation of the work. The instructor will also transparently indicate any use of AI in course materials. Students enrolled in this course agree to the above ethics statement if registering for the class.