ELEC/IEDA3180 – Data-Driven Portfolio Optimization
Spring 2024-25, HKUST

Basic Information

Instructor: Prof. Daniel P. Palomar (https://www.danielppalomar.com/)
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Office: Rm2398 (lifts 17-18)
Office Hours: by email appointment
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Website: https://canvas.ust.hk/courses/56360
Lecture Time: Wed & Fri, 4:30pm – 5:50pm
Lecture Venue: Rm 2406 (lifts 17-18)

Description

Modern portfolio theory started with Harry Markowitz's 1952 seminal paper "Portfolio Selection," for which he would later receive the Nobel prize in 1990. He put forth the idea that risk-adverse investors should optimize their portfolio based on a combination of two objectives: expected return and risk. Until today, that idea has remained central in portfolio optimization. However, the vanilla Markowitz portfolio formulation does not seem to behave as expected in practice and most practitioners tend to avoid it.

During the past half century, researchers and practitioners have reconsidered the Markowitz portfolio formulation and have proposed countless of improvements and alternatives such as robust optimization methods, alternative measures of risk, regularization via sparsity, improved estimators of the covariance matrix, robust estimators for heavy tails, factor models, volatility clustering models, risk-parity formulations, index tracking, etc.

This course will explore the Markowitz portfolio optimization in its many variations and extensions, with special emphasis on Python programming. All the course material will be complemented with Python code that will be studied in class. The homework and project will be in Python.

Textbooks

- Daniel P. Palomar (2025). *Portfolio Optimization: Theory and Application*. Cambridge University Press. [portfoliooptimizationbook.com]
- Yiyong Feng and Daniel P. Palomar. *A Signal Processing Perspective on Financial Engineering*. Foundations and Trends® in Signal Processing, Now Publishers, 2016. [https://palomar.home.ece.ust.hk/papers/2016/Feng&Palomar-FnT2016.pdf]
- Konstantinos Benidis, Yiyong Feng, and Daniel P. Palomar, *Optimization Methods for Financial Index Tracking: From Theory to Practice.* Foundations and Trends® in Optimization, Now Publishers, 2018. [https://palomar.home.ece.ust.hk/papers/2018/BenidisFengPalomar-FnT2018.pdf]
- S. Boyd and L. Vandenberghe. *Convex Optimization*. Cambridge University Press, 2004. [https://web.stanford.edu/~boyd/cvxbook/]
- G. Cornuejols and R. Tutuncu, *Optimization* Methods *in Finance*. Cambridge Univ. Press, 2007.
- F. J. Fabozzi, P. N. Kolm, D. A. Pachamanova, and S. M. Focardi, *Robust Portfolio Optimization and Management*. Wiley, 2007.

Prerequisites:

Good knowledge of linear algebra (MATH2111 or MATH2121 or MATH2131 or MATH2350), probability (IEDA2510 or IEDA2520 or IEDA2540 or ELEC2600), and programming in Python or R.

Grading:

Homework:	25%
Midterm:	25%
Final project:	35%
Final lightening presentation:	15%

Course Schedule

Date	Lect	Topic
5-Feb	1	Theory: Introduction to convex optimization
7-Feb	2	Practice: Python for finance primer
12-Feb	3	Theory: Convex optimization problems
14-Feb	4	Practice: Solvers in Python
19-Feb	5	Financial data modeling: i.i.d. case
21-Feb	6	(cont'd)
26-Feb	7	(cont'd)
28-Feb	8	(cont'd)
5-Mar	9	(cont'd)
7-Mar	10	Portfolio optimization
12-Mar	11	(cont'd)
14-Mar	12	(cont'd)
19-Mar	13	Data cleaning: data munging, missing values, and outliers
21-Mar	14	Financial data modeling: time series
26-Mar	15	(cont'd)
28-Mar	16	Backtesting
9-Apr		
11-Apr		- Midterm -
16-Apr	17	Algorithms: Primer
23-Apr	18	Index tracking of financial markets via MM
25-Apr	19	Risk parity portfolio via Newton, BCD, and SCA
30-Apr	20	Portfolio optimization with alternative risk measures
2-May	21	(cont'd)
7-May		Project presentations by students
9-May		Project presentations by students