ELEC/IEDA3180 – Data-Driven Portfolio Optimization
Spring 2022-23, HKUST

Basic Information

Instructor: Prof. Daniel P. Palomar (https://www.danielppalomar.com/)
E-mail: palomar@ust.hk
Office: Rm2398 (lifts 17-18)
Office Hours: by email appointment
TAs: YU Yifan <mailto:yyuco@connect.ust.hk> and Amir Javaheri <sajavaheri@connect.ust.hk>
Website: https://canvas.ust.hk/courses/36331
Lecture Time: Mon & Wed, 9am – 10:20am
Lecture Venue: CYTG002

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

- 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 some programming knowledge in Python or R.

Grading:

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

Course Schedule

Date	Lect	Topic
6-Feb	1	Theory: Introduction to convex optimization
8-Feb	2	Practice: Python for finance primer
13-Feb	3	Theory: Convex optimization problems
15-Feb	4	Practice: Solvers in Python
20-Feb	5	Financial data modeling: i.i.d. case
22-Feb	6	(cont'd)
27-Feb	7	(cont'd)
1-Mar	8	Portfolio optimization
6-Mar	9	(cont'd)
8-Mar	10	Data cleaning: data munging, missing values, and outliers
13-Mar	11	(cont'd)
15-Mar	12	Financial data modeling: time series
20-Mar	13	(cont'd)
22-Mar		- Midterm -
27-Mar	14	Backtesting
29-Mar	15	Algorithms: Primer
3-Apr	16	Algorithms: Majorization-Minimization (MM) and Successive Convex Approximation (SCA)
12-Apr	17	Risk parity portfolio via Newton, BCD, and SCA
17-Apr	18	(cont'd)
19-Apr	19	Index tracking of financial markets via MM
24-Apr	20	Portfolio optimization with alternative risk measures
26-Apr	21	(cont'd)
3-May	22	Special topic by TAs: TBD
8-May		Project presentations by students