Special Lecture on Financial Engineering
Quantitative Investment and Trading

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Course Description

The industry landscape of investment, trading, and risk management has been revolutionized by computing technologies, data science, and financial engineering. To progress in tandem with the changes in the industry, the topics covered in this course include Alternative ETF Construction, Market Microstructure, and Algorithmic Trading

In addition to mathematical modeling, an important part of this course is the practical aspect: computational implementations with statistical tests. Given that implementation and test procedures are involved, this quantitative finance course is algorithmic and hands-on in nature.

Learning Objectives

The objective is to help you understand deeply by applying various algorithms to solve problems of practical relevance to the financial institutions. By the end of this course, you will be able to, for example,

1. Compute the Nikkei 225 Index from its component stocks, and the fair value of Nikkei 225 futures contract;
2. Distinguish which stock price is a random walk and which is not;
3. Construct "smart" beta using variance ratio and other exotic factors;
4. Evaluate the effect of a quarterly earnings announcement on stock price;
5. Estimate the liquidity parameters;
6. Design optimal trading strategy for agency execution of large order.

To facilitate effective learning, a mini project will be introduced to help you apply the algorithms for designing and evaluating exotic beta portfolio against TOPIX or other indexes.

Assessment Methods

Class Activity/Test:	10%
Homework:	50%
Mini Project:	40%

Programming Language

Python [2.7.xx — Anaconda2-x.x.x-os-y (64-bit)]

Topics (subject to change)

Session **1** **Introduction** (June 7, 11:15-12:45)

- Recent evolution of Quantitative Finance
- Nikkei 225 Index: A Case Study
- Fundamental Indexation
- Python programming
- Project description, requirements, and data

Session **2** **Random Walks** (June 8, 9:30-11:00)

- Random Walk Models
- Linear Scaling Law
- Variance Ratio Test

Session **3** **Event Study** (June 11, 11:15-12:45)

- How does stock price react to new information?
- Abnormal return, cumulative abnormal return
- Long-short trading strategy in event study

Session **4** **Multi-Factor Analysis of Expected Returns** (June 11, 14:00-15:30)

- Factor neutral portfolio construction
- Arbitrage pricing theory
- French's data library
- ETFs

Session **5** **Principal Component Analysis** (June 12, 11:15-12:45)

- Matrix Calculus
- PCA Eigenvector
- Singular Vector Decomposition
- PCA of Yield Curve

Session **6** **Summary** (June 12, 14:00-15:30)

- Test
- Students' Presentation of Project Ideas

Session **7** **Introduction to Market Microstructure** (June 13, 11:15-12:45)

- Liquidity
- Limit Order Markets
- Quoted Spread, Effective Spread, Realized Spread
- Off-line Collection of Bloomberg Tick Data with Python API

Session **8** **The Roll Model of Trade Prices** (June 13, 14:00-15:30)

- Statistical Analysis of Price Series
- The Roll Model of Bid, Ask and Transaction Prices
- Extensions of the Roll Model

Session **9** **Univariate Time Series Analysis** (June 14, 11:15-12:45)

- Stationarity and Ergodicity
- Moving Average Models
- Autoregressive Models
- Estimation and Forecasting
- Strengths and Weaknesses of Linear Time Series Models

Session **10** **A Generalized Roll Model of Trade Prices** (June 14, 14:00-15:30)

- The Structural Model
- Statistical Representations
- Forecasting and Filtering
- Identification in Random-Walk Decompositions

Session **11** **Hands-on Programming** (June 15, 11:15-12:45)

- Implementation of the Roll Model
- Implementation of Tee and Ting's Structural Model

Session **12** **Multivariate Linear Microstructure Models** (June 15, 14:00-15:30)

- Modeling Vector Time Series
- A Structural Model of Prices and Trades
- Resolution of Contemporaneous Effects
- The Random-Walk Variance

Session **13** **Market Microstructure of Algo Trading** (June 15, 15:45-17:15)

- Overview of algorithmic agency execution
- The Almgren-Chriss model
- Implementation shortfall algorithm

Session **14** **Market Price of Liquidity Risk and Liquidity Index** (June 18, 11:15-12:45)

- Price impact
- Market price of liquidity risk
- Liquidity index

Session **15** **Student Project Presentations** (June 19, 15:45-17:15)

Textbook

Empirical Market Microstructure: The Institutions, Economics, and Econometrics of Securities Trading, Joel Hasbrouck, Oxford University Press (2007)