ISE 537 Financial Analytics
Units: 3
Fall 2021- Tue & Thurs 12:30–1:50 PM
Location: KAP 158

Instructor: Renyuan Xu
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Teaching Assistant: Jiajun Xu
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Course Format

Lectures will be provided in a hybrid format. Students can attend the lectures either in KAP 158 or online via Zoom. Office hours will only be held via Zoom. All Zoom links are available on Blackboard.

Catalog Description

Modern Portfolio Theory.

Optimal Decision-making Problems in Finance.

Market Microstructure and High-frequency Trading.

Statistical Learning and Machine Learning for Finance.

Course Description

This course aims to prepare students with the basic knowledge of modern portfolio management, time-series analysis, market microstructure, and optimal execution. Various statistical methods and machine learning techniques will be introduced given their flexibility and computational power in analyzing financial data. This course also features advanced topics in machine learning for finance such as trading with reinforcement learning, market prediction with neural networks and market simulator construction via generative adversarial networks.

Learning Objectives

By the end of this course, students will be able to:

- Identify the basic structure of capital asset markets
- Identify the main investment vehicles and investment strategy categories
- Have some basic knowledge about market microstructure and high-frequency trading
- Work with real financial data at different frequency (low frequency; middle frequency and high frequency)
- Understand the most fundamental (multi-period) decision-making problems in financial markets
- Knowledge about the most popular statistical methods and machine learning techniques with their applications in finance

Prerequisite(s): None

Recommended Preparation Expected to have knowledge of Engineering Statistics on the level of ISE 225 and data analysis experience with some programming languages.

Course Notes
The course materials are available on Blackboard.

Technological Proficiency and Hardware/Software
You can work with any programming language you prefer but Python is recommended.

Required Textbook None

Supplementary Materials (for reference)

- Statistics and Data Analysis for Financial Engineering with R examples. Authors: David Ruppert and David S. Matteson; ISBN: 978-1-4939-2613-8

- Papers (or reading assignments) will be available on Blackboard.

Description and Assessment of Assignments

- **Midterm Exam: take-home**. Midterm exam sheet will be released at 12:20PM on Sept 19th (Tuesday) and due at 12:20PM on October 20th (Wednesday).
- **Final Examination** will be based on a take-home data analysis project
- **Homework assignments** include six homework assignments.
  - The assignments are exercises related to the topics discussed in class.
  - Students should submit all of them to the Blackboard before the class on Tuesday (unless otherwise indicated). They will be graded and returned in the following week.
  - No late homework will be accepted.
  - For homework questions related to coding and data analysis, please type up your solutions. For homework questions related to calculations and proofs, hand-written solutions are also acceptable.

Grading Policy

- Homework   40%
- Midterm Exam   30%
- Final Project   30%

Grading Scale (Course final grades will be determined using the following scale)

A   95-100
A- 90-94
B+ 87-89
B   83-86
B- 80-82
C+ 77-79
C   73-76
C- 70-72
D+ 67-69
D   63-66
D- 60-62
F   59 and below

Total points will be curved for the final letter grade. Letter grade with minus and plus are also considered.

Assignment Submission Policy
- Assignments should be submitted on Blackboard before due.
- No late assignment is considered unless under emergencies.
- No makeup exams are considered.

Course Schedule: A Weekly Breakdown

Week	Topics/Daily Activities	Homework
1 8/22-8/28	Course Introduction Risk and Modern Portfolio Theory	
2 8/29-9/4	Capital Asset Pricing Model (CAPM) Arbitrage Pricing Theory (APT)	HW1 available
3 9/5-9/11	Linear Regression Factor Models	HW1 due
4 9/12-9/18	Principal Component Analysis (PCA) Statistical Arbitrage	HW2 available
5 9/19-9/25	Time Series Analysis I	HW2 due
6 9/26-10/2	Time Series Analysis II	HW3 available
7 10/3-10/9	(Multi-period) Optimal Execution of Portfolio with Transaction Cost	HW3 due (Thursday) HW4 available (Thursday)
8 10/10-10/16	Review Session (Tuesday) Fall Recess (Thursday)	
9 10/17-10/23	Midterm Exam (take-home, Tuesday-Wednesday) Introduction to Deep Learning I (Thursday)	HW4 due
10 10/24-10/30	Introduction to Deep Learning II Deep Learning for Time Series Prediction (Tuesday)	HW5 available
11 10/31-11/6	Limit Order Book and Market Microstructure High Frequency Trading	
12 11/7-11/13	Reinforcement Learning and Optimal Execution (revisited)	HW5 due
13 11/14-11/20	Guest Lecturer on Tuesday (Nov 16): Giuseppe Nuti (UBS) -- Machine Learning for Algorithmic Trading Generative Adversarial Networks (GANs) and Market Simulator Construction	HW6 available
14 11/21-11/27	Generative Adversarial Networks (GANs) and Market Simulator Construction (II) Thanksgiving Holiday (Thursday)	
15 11/28-12/04	Guest Lecture on Tuesday (Nov 30): Sumitra Ganesh (JP Morgan) -- Agent-based Simulator for Financial Market Project Q&A	HW6 due
Final	No in-class final exam Final project will be released in Nov and due on Dec 14th.	

* Disclaimer: Materials covered in each week may vary from the schedule.

Date and time of the final for this class shown in the USC *Schedule of Classes* at classes.usc.edu/.

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious
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academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in
SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other
forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university
policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling,
stress fitness workshops, and crisis intervention.
National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a
week.
*Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press "0" after hours –
24/7 on call*
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected
classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university
prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin,
ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability,
medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other
characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits
sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious
dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX
for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing
readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural
barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710
uscsa.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.