

Course Syllabus



FE670 - Algorithmic Trading Strategies

School of Business

Fall 2023

Instructor: **Steve Yang**

Course Address: **McLean 209**

Course Schedule: Lectures on **Thursday 06:30-09:00PM** (09-01-2023 – 12-18-2023)

Contact Info: steve.yang@stevens.edu (<mailto:steve.yang@stevens.edu>)

Office Hours: **Wednesday 10:00AM-11:00AM**

Virtual session URL: <https://stevens.zoom.us/my/dr.syang>

Prerequisite(s): **FE570 or Waiver**

Corequisite(s): None

Cross-listed with: None

COURSE DESCRIPTION

This course investigates methods implemented in multiple quantitative trading strategies with emphasis on automated trading and quantitative finance based approaches to enhance the trade-decision making mechanism. The course provides a comprehensive view of the algorithmic trading paradigm and some of the key quantitative finance foundations of these trading strategies. Topics

explore markets, financial modeling and its pitfalls, factor model based strategies, portfolio trading strategies, liquidation strategies, arbitrage strategies, and machine learning enhanced strategies. The data mining, machine learning, and artificial intelligence-based trading strategies include, but not limited to, weak classifier method, decision tree, neural network, and genetic programming algorithmic, and other deep learning methods. The course will also introduce emerging technologies in trading decisions such as Explainable AI, Large Language Models (LLMs), and Environmental Social and Governance (ESG) investing through use case studies.


STUDENT LEARNING OUTCOMES

This is an advanced course in financial market and algorithmic trading. The learning objectives include mastering the fundamental techniques used in security trading that would include the fundamental factor based investing, portfolio based trading decision, arbitrage trading strategies, execution strategies, and machine learning/artificial intelligence enhanced trading strategies. The learning objectives also include that the students should understand the mathematical foundation and formulation of these trading strategies. Although the students are not required to derive these algorithms or models, they need to understand the rationale and key assumptions used in these techniques. Applications of the major advanced trading strategies are the focus of the course. To support the proficient understanding and application, the course requires students to implement all the major categories of advanced trading strategies using Python programming language, and the students are expected to master the understating of the standard libraries introduced in the course as well as the public domain financial data retrieving techniques using Python packages.

After successful completion of this course, students will be able to demonstrate proficient knowledge and application capabilities in the following areas:

- Understand the mathematical rationale and algorithms among the major trading strategies including fundamental factors, portfolio trading, execution, and arbitrage strategies.
- Able to apply advanced statistical, machine learning, and artificial intelligence techniques to the major trading strategies to enhance the trading outcomes.
- Understand the major machines learning and artificial intelligence techniques and apply them effectively in implementing the major trading strategies using Python programming language.
- Obtain fundamental knowledge in algorithmic trading and be able to read latest research papers to acquire recent development in the field and enhance the baseline trading algorithms.
- Understand the full lifecycle of developing a trading system where advanced trading strategies can be effectively incorporated and updated for better performance and operation efficiency.
- Learn emerging concepts around quantitative investment decision making using Explainable AI, LLMs, and ESG analytics, etc. Students will be equipped with Python programming skills to explore new techniques.

COURSE FORMAT AND STRUCTURE

This course is on-campus. To access the course, please visit stevens.edu/canvas  (<http://stevens.edu/canvas>). For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

Course Logistics

- All lecture notes will be posted the day before the lecture. All students registered to this class are expected to attend the lectures in person. Participation in discussions is expected. All assignments should be submitted in PDF format with code as appendix:
 - Please do not just submit code only. All assignments require your specific answers to the questions. Python code should only be used to analyze the data and support your answers.
 - When assignments are due, they are due by 11:59 pm EST on the due date listed in the course schedule.
 - Course requirements must be completed and posted or submitted on or before the specified due date and delivery time deadline. Due dates and delivery time deadlines are in Eastern Time (as used in Hoboken, NJ).
 - Assignments received 1-6 days late will have 20% of the total points deducted from the full score of the assignments.
 - Assignments received more than one week late will receive 0 points. This policy is consistent with the late policy of this course.
 - An assignment file should be appended by your username, such as "assignment1_john33.doc". This makes it easier for me to manage assignment files you download to my computer.

Office Hours

Office Hours are a synchronous session (through Zoom or Blackboard Collaborate) to discuss questions related to weekly readings and/or assignments. Office hours will be held Wednesday 10:00AM-11:00AM EST in Babbio 536. To connect to the weekly session, go to <https://stevens.zoom.us/my/dr.syang>.

Online Etiquette Guidelines

- Do not dominate any discussion. Allow other students to join in the discussion.
- Do not use offensive language. Present ideas appropriately.

- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular and/or slang language as it could lead to misinterpretation.
- Keep an "open-mind" and be willing to express even your minority opinion.
- Think and edit before you push the "Send" button.
- Do not hesitate to ask for feedback.

TENTATIVE COURSE SCHEDULE

Week	Topic(s)	Reading(s)	HW
1	An Overview of Trading and Markets	Velu, Hardy, Nehren [1], Barry Johnson [1,2]	
2	Basic Models and Empirics	Velu, Hardy, Nehren [2,3], Jansen [2,3]	
3	Factor Models and Estimation	Fabozzi, Focardi, Kolm [5], Jansen [4]	HW1
4	Alpha Barra Factor Trading Strategies	Fabozzi, Focardi, Kolm [6-7], Jansen [7]	
5	Cross-Sectional Models, Factor Zoo, and Advanced Factor Strategies	Fabozzi, Focardi, Kolm [8] Capponi and Lehalle [32]	
6	Mean Variance Portfolio Theory	Fabozzi, Focardi, Kolm [9],	HW2
7	Portfolio Theory Beyond Markowitz	Fabozzi, Focardi, Kolm [10]	EXAM-I
8	Robust Portfolio Optimization	Velu, Hardy, Nehren [4, 5]	

9	Machine Learning and Artificial Intelligence in Trading	Research Papers, Jansen [11, 12]	
10	Machine Learning Trading Strategies: Random Forests, Ada Boosting, Gradient Boosting	Research Papers, Jansen [15, 16, 18, 19]	HW3
11	Trading Strategies Based on Alternative Data: Topic Model and Sentiment Analytics	Research Papers, Jansen [20, 21, 22]	
12	Deep Learning Strategies: ANN, LSTM, and Recurrent Reinforcement Learning	Velu, Hardy, Nehren [8], Capponi and Lehalle [11]	Proposal
13	Statistical Arbitrage and Pairs Trading Strategies	Barry Johnson [7, 8, 9], Research Papers Barry Johnson [10],	HW4
14	Transaction Cost and Trading Execution	Velu, Hardy, Nehren [11, 12], Capponi and Lehalle [12]	
15	Final Project Presentation		EXAM-II

COURSE MATERIALS

Textbook(s):

Raja Velu, Maxence Hardy, Daniel Nehren, "**Algorithmic Trading and Quantitative Strategies**", Chapman and Hall/CRC Financial Mathematics Series, 1st Edition (2020)

Frank J. Fabozzi, Sergio M. Focardi, and Petter N. Kolm, "**Quantitative Equity Investing: Techniques and Strategies**" (Wiley, 2010).

Other Readings:

Agostino Capponi, Charles-Albert Lehalle, "**Machine Learning and Data Sciences for Financial Markets: A Guide to Contemporary Practices**" 1st Edition (2023)

Stefan Jansen, "*Machine Learning for Algorithmic Trading: Predictive models to extract signals*", Packt Publishing, Ltd. 2nd Edition (2021)

Barry Johnson, "*Algorithmic Trading & DMA*", 4Myeloma Press London, 2010.

Materials: Use Python 3.7 or above - you may use PyCharm or Jupyter Notebook

COURSE REQUIREMENTS

Attendance Students are expected to attend lectures.

Participation Students are expected to participate in class work.

Homework Students are required to hand-in homework on time. Failure to do so will carry a penalty to the homework grade.

Exam Students are required to complete a final group exam.

TECHNOLOGY REQUIREMENTS

Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Canvas

Technology skills necessary for this specific course

- Live web conferencing using Zoom
- Recording a slide presentation with audio narration
- Recording, editing, and uploading video via Kaltura

Required Equipment

- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

Required Software

- Python 3.7 or above and Jupyter Notebook

GRADING PROCEDURES

Grades will be based on:

Homework	40%
Midterm	30%
Final Project	30%

Late Policy

All assignments should be the work of an individual student are due on the date shown in the course schedule. Submit to Canvas any late assignments. Late homework will be penalized one grade letter per late week. Grading will be based upon your understanding and analysis of the issues presented in class and readings.

TECHNOLOGY REQUIREMENTS

Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Canvas
- Familiar with Hanlon Lab resources, i.e. computers, and dataset, etc.

Technology skills necessary for this specific course

- Recording a slide presentation with audio narration
- Recording, editing, and uploading video via Panopto

Required Equipment

- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

Required Software

- Python; Jupyter Notebook; Anaconda;

Academic Integrity

- You can discuss the problems between yourselves, but once you begin writing up your solution, you must do so independently, and cannot show one another any parts of your written solutions.
- Your solutions to the homework and exam problems have to be typed (written legibly) and uploaded to the Canvas course website in one single PDF file (no other file format will be accepted). Any changes to the course schedule or due date of assignments will be announced through the course website announcement system. If you have problem to save your files to PDF, please let me know.
- To understand the course material and get a good grade, you need to invest a substantial amount of time reading the required chapters and working on the assignments. Each homework assignment will contain 3-5 problems, and will be posted on the class website. No late homework will be accepted under any circumstances.

Generative AI Technologies

You may use AI programs e.g. ChatGPT to help generate ideas and brainstorm. However, you should note that the material generated by these programs may be inaccurate, incomplete, or otherwise problematic. Beware that use may also stifle your own independent thinking and creativity.


You may not submit any work generated by an AI program as your own. If you include material generated by an AI program, it should be cited like any other reference material (with due consideration for the quality of the reference, which may be poor).

Any plagiarism or other form of cheating will be dealt with under relevant Stevens policies.

Academic Integrity

Undergraduate Honor System


Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System

Constitution. More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at <http://web.stevens.edu/honor/>  (<http://web.stevens.edu/honor/>).

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.


“I pledge my honor that I have abided by the Stevens Honor System.”

Reporting Honor System Violations

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at www.stevens.edu/honor  (<http://www.stevens.edu/honor>).

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics  (<http://www.stevens.edu/provost/graduate-academics>).

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more

information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the Bylaws of the Honor System document, located on the Honor Board website.

EXAM CONDITIONS

The following procedures apply to quizzes and exams for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Conditions on the quiz or exam.

1. Students may use the following materials during quizzes and/or exams. Any materials that are not mentioned in the list below are not permitted.


Material	Permitted?	
	Yes	No
Handwritten Notes Conditions: i.e. size of note sheet	x	
Typed Notes Conditions: i.e. size of note sheet	x	
Textbooks Conditions: i.e. specific books	x	
Readings Conditions: i.e. specific documents	x	
Other (specify)		x

2. Students are/are not allowed to work with or talk to other students during quizzes and/or exams.

3. Specific Parameters: [if you permit students to communicate with each other during exams, be sure to explain exactly what is permitted.]

LEARNING ACCOMMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other such disabilities in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

For more information about Disability Services and the process to receive accommodations, visit <https://www.stevens.edu/office-disability-services>  (<https://www.stevens.edu/office-disability-services>). If you have any questions please contact: Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at pgehman@stevens.edu (<mailto:pgehman@stevens.edu>) or by phone 201-216-3748.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

INCLUSIVITY

Name and Pronoun Usage

As this course includes group work and class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your name and/or pronouns, please inform the instructor of the necessary changes.

Inclusion Statement

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

MENTAL HEALTH RESOURCES

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments can be made by phone (201-216-5177).

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about the safety of yourself or someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year round. For students who do not reside near the campus and require emergency support, please contact your local emergency response providers at 911 or via your local police precinct. Other 24/7 national resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text "Home" to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at care@stevens.edu (<mailto:care@stevens.edu>). A member of the CARE Team will respond to your concern as soon as possible.