NYU TANDON SCHOOL OF ENGINEERING

Finance & Risk Engineering

FALL 2024

FRE-GY 6811 A ▶ Financial Software Laboratory – Python

Tuesday, 11AM – 1:41PM

Rogers 216, Brooklyn

Instructor Information

- **Lecturer:** Bruno G. Kamdem, Ph.D.
- **Contact:** bgk8384@nyu.edu; (410) 772-3948.

- **Office Hours:** Before and after class or by appointment (in-person or virtually)

Course Information

- **Prerequisite:** Graduate standing — Proficiency in a programming language (e.g., Python) is required.
- **Credits:** 1.5.
- **Term:** October 23 – December 12 (2^{nd} half).

- **Description:**
  This course is designed to equip students with the skills to develop their own Python software package for financial modeling and simulation. With starting salaries for financial engineers who possess deep programming knowledge, especially in Python, being highly competitive, mastering these skills will put you on a fast track to success. Throughout the course, you'll learn essential topics like portfolio optimization, option pricing models, and simulation techniques. Additionally, you'll gain hands-on experience with effective use of GitHub for collaborative development and code management, ensuring your software is built and managed in a professional environment. You'll also be introduced to cloud computing with AWS or Google Cloud, covering deploying and managing Python applications in the cloud, and integrating real-time financial data using APIs to enhance your models with live data streams. By the end of the course, you'll have a fully functional Python package, tested and ready for real-world application in financial data analysis and modeling. You'll not only leave with a powerful tool but also a valuable skill set that can lead to competitive job offers or provide the foundation for your own entrepreneurial ventures, should you choose that path.

- **Course Learning Outcomes:**
  1. Empower students to design, develop, and deploy Python-based financial software packages, with an emphasis on utilizing cloud platforms like AWS or Google Cloud for real-world financial applications.
  2. Cultivate the ability to critically assess, analyze, and interpret financial data using advanced Python techniques, including integrating real-time financial data through APIs.
  3. Guide students in implementing and applying key financial models, such as portfolio optimization and option pricing, while ensuring proficiency in deploying and managing Python applications in the cloud.
  4. Facilitate comprehension of Monte Carlo simulations, enabling students to explain and utilize these techniques in finance, with practical cloud-based implementations.

5. Enhance students' expertise in evaluating and leveraging Python libraries, machine learning techniques, and version control systems like GitHub for collaborative development and code management.
6. Provide opportunities for students to integrate and synthesize knowledge through hands-on coding assignments, cloud-based deployments, and a collaborative group project.
7. Enable students to collaborate effectively, utilizing GitHub for version control and cloud platforms for computational tasks, ensuring smooth teamwork and project execution in a professional environment.

- **General Course Requirements:**
  This course will be structured around a variety of interactive and instructional components, which will serve as the core of the learning experience:
  - **Weekly in-Person Lectures:** These will provide foundational knowledge and facilitate in-depth discussions on key concepts.
  - **Weekly Activities:** These will include weekly assignments to practice, apply, and evaluate the acquired knowledge.
  - **Term Group Project:** The goal of this Term Group Financial Software Project is to provide students with hands-on experience in designing, developing, and deploying a fully functional Python-based financial software package.
  - **Weekly Group Presentations:** To help ensure that students remain engaged with the material, develop teamwork skills, and continuously refine their projects, ultimately preparing them for both technical and collaborative aspects of professional financial software development.
  - **Guest Speakers:** Occasional presentations by industry experts to align theoretical knowledge with practical industry applications, giving students a comprehensive understanding of the skills required to succeed in the financial engineering industry.

  Please refer to the Course Schedule (see page 6) for detailed information on assignments and deadlines.

- **Readings:**
  Weekly slides and materials will be distributed to students in advance on *NYU Brightspace*. Additional readings and links to relevant resources will be regularly posted on *NYU Brightspace*.
  - **Suggested Additional Readings:** Suggested readings are footnoted throughout the weekly course slides and will also be posted on *NYU Brightspace*.

- **Resources:**
  - Access to course materials: NYU Brightspace.
  - Databases, journal articles, miscellaneous: Bern Dibner Library.
  - Collection of business research resources: NYU Business Library.
  - 24/7 technology assistance:
    * Tandon IT Help Desk: soehelpdesk@nyu.edu, (646) 997-3123.
    * NYU IT Service Desk: AskIT@nyu.edu, (212) 998-3333.

- **Course Expectations:**
  Students are expected to review weekly slides and readings prior to class. Attendance is crucial, and students should come prepared to engage, participate, and ask questions about any concepts they do not fully understand from the lecture notes and in-class lab sessions. All assignments are due by 11:59 PM on the last day of the class week (see the full Course Schedule on page 6). Assignments must be submitted on time through NYU Brightspace for review and reception by the Teaching Assistant. It is important to dedicate the necessary time and effort to this course to achieve the expected outcomes by the end of the term. If you encounter any challenges during the semester, please inform me promptly. Additionally, contact me if you anticipate missing a class. I am available and ready to support your success.

Performance Evaluation

(1) **Class Presentations:**
Weekly presentations are designed to equip students with the tools they need to excel in interviews and perform effectively in their professional roles. Additionally, these presentations will enhance students' understanding, critical thinking, and application of concepts covered in the corresponding lecture. The presentations offer an opportunity to explore practical applications, current trends, and real-world examples within the realm of this course. **Each presentation must directly connect to the main theme or topic described in the course schedule, ensuring a cohesive and thorough exploration of the course material** (see the full Course Schedule on page 6). This weekly drill will promote active learning and encourage independent research among students. Where applicable, insights into current market trends, developments, or news that align with the week's topic should be included. This encourages staying informed about the dynamic nature of financial markets. Sources for market updates should be reliable and credible references. For further insights and detailed information, you are encouraged to consult with a librarian. Students will be pre-assigned to groups of three or four, depending on the class size. It is recommended to prepare for every class in study groups, whether or not there is a group assignment. Each group will lead a brief 10 to 15-minute verbal discussion at the beginning of each class on the first class of the week. Presentations will be graded in real-time. To earn full credit, you will need to follow the class presentation grading rubric that will be provided later on NYU Brightspace. Sources for weekly presentations should be serious and credible references such as The *Wall Street Journal*, the *Financial Times*, *Bloomberg*, the *Economist*, $\cdots$. The University is already subscribed to most credible journals. You can find them directly linked on the *NYU Libraries* website under "Articles & Databases" $\rightarrow$ "Business" $\rightarrow$ "Articles, News, & Working Papers" or "Company & Financial Information" (*Bloomberg*).

(2) **Group Term Project:**
The group project for this course is the Financial Software Project, aimed at giving students practical experience in designing, developing, and deploying a fully functional financial software package using Python. This project encourages collaborative problem-solving and application of the course's key concepts, such as financial modeling, simulation techniques, and real-time data integration. By working in teams, students are expected to (1)apply financial models like portfolio optimization, option pricing, and Monte Carlo simulations, (2)utilize cloud platforms (AWS or Google Cloud) for deploying and managing financial applications, (3)collaborate effectively using GitHub for version control and APIs for integrating real-time financial data, and (4)synthesize their knowledge through coding, testing, and deploying the software to solve real-world financial problems. The project culminates in a practical software solution that is applicable to the financial industry, helping students gain experience with technical tools and teamwork in a professional setting.
The group project also aims to provide students with hands-on experience, enhancing their attractiveness to potential employers. By working with real-world data sets, students will simulate the types of data they are likely to encounter in industry settings. The project includes a written report and a live graded in-class presentation. To ensure the quality and relevance of the project report and presentation, evaluations by experts will be utilized to provide effective feedback. Adherence to the provided group project grading rubrics is necessary to achieve a perfect score. Specific instructions on the group project, including detailed guidelines and grading rubrics, will be provided later in the term and posted on NYU Brightspace.
Students are expected to form their own groups beginning in the first week of classes, preferably consisting of three members from diverse backgrounds, and have their subject and group pre-approved by the professor before the initial proposal date. The group project accounts for 50% of the final grade, highlighting its significance in the overall course assessment. See Table 1 below for grading distribution and defined deadline. Ultimately, the group project is designed to enhance students' analytical skills and prepare them for successful careers in business.

Table 1

Form groups		Week 1
Planning the Software	20%	Week 3
Software Design and Architecture	30%	Week 5
Implementation and Testing	40%	Final Exam date
Presentation	10%	Week 7

(3) **Weekly Assignments:**
There will be 6 weekly assignments (see the full Course Schedule on page 6) aimed at reinforcing key concepts and ensuring progressive mastery of financial modeling and Python software development skills. Each assignment is designed to build upon the week's lessons, guiding students through the stages of developing a fully functional Python software package. Assignments will focus on applying theoretical knowledge to practical tasks, such as implementing portfolio optimization techniques, pricing options using various models, and performing simulations. Additionally, they will introduce students to collaborative development using GitHub, deploying Python applications to the cloud, and integrating real-time financial data through APIs. By the end of the course, the assignments will culminate in the creation of a well-tested, real-world-ready Python package. These assignments are essential for developing the hands-on experience necessary to succeed in financial engineering roles, as well as to prepare students for competitive job opportunities or entrepreneurial ventures in the field. All assignments should be submitted either physically or electronically (preferred) on *NYU Brightspace* by 11:59pm on the due date unless stated otherwise (see the full Course Schedule on page 6) for full credit to the Teaching Assistant. Attendance is expected at each class meeting. If you have to miss a class for family or health obligation, notify me in advance. A class roster will be taken before the start of each class. Consistent and constructive class participation may result in a student's grade being rounded up if very close to a higher letter grade once the curve is complete. Please, regularly check for new announcements on *NYU Brightspace*.

(4) **Grading:**

Assignments	30%	weekly
Class Presentations	20%	weekly
Term Group Project	50%	week 1 – week 7
TOTAL	**100%**	

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\begin{aligned}
&\texttt{if grade} \geq 95\% \Leftrightarrow \texttt{4.00:A} \\
&\texttt{else if } 90\% \leq \texttt{grade} \leq 94.99\% \Leftrightarrow \texttt{3.67:A-} \\
&\texttt{else if } 87.5\% \leq \texttt{grade} \leq 89,99\% \Leftrightarrow \texttt{3.33:B+} \\
&\texttt{else if } 82.5\% \leq \texttt{grade} \leq 87.49\% \Leftrightarrow \texttt{3.00:B} \\
&\texttt{else if } 80\% \leq \texttt{grade} \leq 82.49\% \Leftrightarrow \texttt{2.67:B-} \\
&\texttt{else if } 77.5\% \leq \texttt{grade} \leq 79.99\% \Leftrightarrow \texttt{2.33:C+} \\
&\texttt{else if } 72.5\% \leq \texttt{grade} \leq 77.49\% \Leftrightarrow \texttt{2.00:C} \\
&\texttt{else if } 70\% \leq \texttt{grade} \leq 72.49\% \Leftrightarrow \texttt{1.67:C-} \\
&\texttt{else if } 67.5\% \leq \texttt{grade} \leq 69.99\% \Leftrightarrow \texttt{1.33:D+} \\
&\texttt{else if } 62.5\% \leq \texttt{grade} \leq 67.49\% \Leftrightarrow \texttt{1.00:D} \\
&\texttt{else if } 60\% \leq \texttt{grade} \leq 62.49\% \Leftrightarrow \texttt{0.67:D-} \\
&\texttt{else F}
\end{aligned}
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Academic Misconduct

(A) **Introduction (School of Engineering Student Code of Conduct):** The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School's rules on academic

integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct available here.

(B) **Definition:** Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to the following:

1. **Cheating:** intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
2. **Fabrication:** including but not limited to, falsifying experimental data and/or citations.
3. **Plagiarism:** intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
4. **Unauthorized collaboration:** working together on work that was meant to be your own.
5. **Duplicating work:** : presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.
6. **Forgery:** altering any academic document, including, but not limited to academic records, admissions materials, or medical excuses.

Inclusion Statement

The NYU Tandon School values an inclusive and equitable environment for all our students. I hope to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. It is my intent that all students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. If this standard is not being upheld, please feel free to speak with me.

Unexpected Events

You may encounter unforeseen family, health, or other issues during the semester which create circumstances that prevent you from meeting course requirements. In this case, please raise the issue(s) directly with **Deanna Rayment** in the Office of Student Affairs at (646) 997-3046 or deanna.rayment@nyu.edu before requesting any accommodation from me.

Disability Disclosure Statement

Academic accommodations are available for students with disabilities. Please contact the **Moses Center for Students with Disabilities (CSD)** at (212) 998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at `www.nyu.edu/csd`. The Moses Center is located at 726 Broadway on the 2nd floor.

Course Schedule

TOPICS	LECTURE	ASSIGNMENTS
Week 1 (Wed, Oct 23 – Tue, Oct 29)		o Review Class Syllabus
• Guest Speaker		o Welcome email (confirm reception)
• Introduction to Portfolio Models		o Plan and organize Weekly Group Presentations
• Python Fundamentals for Financial Software Development		o Discuss Group Term Financial Software Project
• Setting Up a Development Environment		o Assignment 1:
• Introduction to Version Control with GitHub	Tue, Oct 29	(Design a portfolio optimization tool
• Best Practices in Software Dev. and Project Structure	(11:00 AM – 1:41 PM)	that minimizes risk while achieving a target return)
Week 2 (Wed, Oct 30 – Tue, Nov 5)		Assignment 1 DUE
• Calculating Efficient Portfolios		o Weekly Group Presentation 1:
• Advanced Data Manipulation with Pandas and NumPy		(Moderm Applications of the Markowith Model)
• Effective Use of GitHub Collaborative Dev & Code Man.		o Assignment 2:
• Basics of Fin. Data Structures and Time-Series Analysis	Tue, Nov 5	(Develop code for calculating efficient portfolios)
	(11:00 AM – 1:41 PM)	
Week 3 (Wed, Nov 6 – Tue, Nov 12)		Assignment 2 DUE
• Estimating Betas and the Security Market Line		Group Term Project (Planning the Software) DUE
• Creating Fin. Charts and Dashboards (Matplotlib, Seaborn)		o Weekly Group Presentation 2:
• Software Design Prin.: Modularity, Reusability, Scalability		(Recent Progress in Portfolio Models)
• Intro to Object-Oriented Programming in Python for Fin.	Tue, Nov 12	o Assignment 3:
	(11:00 AM – 1:41 PM)	(Craft code for beta estimation and SML plotting)
Week 4 (Wed, Nov 13 – Tue, Nov 19)		Assignment 3 DUE
• The Binomial Option Pricing Model		o Weekly Group Presentation 3:
• Building Basic Financial Models using Python		(Demonstration of option pricing models)
• Introduction to Machine Learning with Scikit-learn	Tue, Nov 19	o Assignment 4:
• Implementing Unit and Integration Testings for Fin. Models	(11:00 AM – 1:41 PM)	(Build a binomial option pricing calculator)
Week 5 (Wed, Nov 20 – Tue, Nov 26)		Assignment 4 DUE
• The Black-Scholes Model and Stock Price Simulations		Group Term Project (Software Design and Architecture) DUE
• Advanced Machine Learning Techniques in Finance		o Weekly Group Presentation 4:
• Integrating Real-Time Financial Data Using APIs		(Various Implementations of the Black-Scholes Model)
• Developing and Testing Trading Algorithms	Tue, Nov 26	o Assignment 5:
	(11:00 AM – 1:41 PM)	(Craft code for stock price simulations and option pricing)
Week 6 (Wed, Nov 27 – Tue, Dec 3)		Assignment 5 DUE
• Monte Carlo Simulations and Option Strategies		o Weekly Group Presentation 5:
• Introduction to Cloud Computing wt AWS or Google Cloud		Demonstration of Monte Carlo simulations for options
• Deploying and Managing Python Applications in the Cloud	Tue, Dec 3	o Assignment 6:
• Security and Compliance in Cloud-Based Financial Apps	(11:00 AM – 1:41 PM)	Build a Monte Carlo simulation tool for options
Week 7 (Wed, Dec 4 – Thu, Dec 12)		Assignment 6 DUE
• Guest Speaker	Tue, Dec 10	o Finalize and optimize the Python financial software(s)
• Group Term Project (Presentation)	(11:00 AM – 1:41 PM)	o Catch-up on late assignments
Final Exam Period (Mon, Dec 16 – Fri, Dec 20)		Group Term Project (Implementation and Testing) DUE
	Tue, Dec 17	Complete Written Report DUE