Machine Learning in Finance

Rutgers Math 16:643:628 Fall 2024

Elliot Noma, Ph.D. : 7:00-10:00 PM Tuesday, Hill 705

Office Hours: upon request

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Course Description This course provides an introduction to the application of machine learning models to financial markets. No previous experience in machine learning is needed, but students should be comfortable programming in Jupyter notebooks using Python. Students will need access to Google.colab (available to all who have a Google drive account). Emphasis will be on creating a solid understanding of standard machine learning models with priority given to models and model validation techniques most frequently used in the areas of market strategy, risk management, and credit analysis. Each class will be a mix of theory and hands-on programming.

Topics covered include

* implementation and backtesting of quant trading models
* Decision tree and linear supervised learning models
* Neural networks and time series neural network models
* Clustering and other unsupervised learning models
* Reinforcement learning

Course Schedule Week 1: Sept 3, 2024 Week 14: Dec 10, 2024

1. 09/03 How is Machine Learning used in finance
2. 09/10 Traditional quant trading and backtesting
3. 09/17 Supervised learning: introduction, regression models, tree models
4. 09/24 Supervised learning
5. 10/01 Supervised learning
6. 10/08 Neural Networks: ANN, DNN, CNN, RNN, LSTM, GRU
7. 10/15 Neural Networks
8. 10/22 Midterm exam
9. 10/29 Cleaning financial data and modeling trading strategies
10. 11/05 Unsupervised learning: cluster analysis, factor modeling (PCA)
11. 11/12 Unsupervised learning
12. 11/19 Reinforcement Learning
13. 12/03 Reinforcement Learning (**no class on 11/26**)
14. 12/10 Project presentations (completed projects in pdf format due 12/15)

Students should electronically submit the homework assignment prior to the class covering that topic.

Students will be given credit for handing in homework and showing effort to answer each question as judged by the instructor. Students will have homework assignments requiring them to program in Python.

For the last class, students will give a 5 minute PowerPoint presentation highlighting the theory behind their model and the results of their analysis. Emphasis will be on your ability to effectively communicate what your solution achieves and it’s short-comings to your fellow students. You will be required to use data from one or more approved databases. This project can be used to fulfill the Master Essay requirement.

Earlier in the term, students will give a short in-class presentation on a published application of machine learning. This presentation will describe the problem solved, the machine learning model applied to solve the problem, and statistics used to evaluate the model performance. The presentations will assess the degree to which the model solved the problem and ways to improve the application.

Core Readings:

1. [Hao Ni](https://www.amazon.com/s/ref=dp_byline_sr_book_1?ie=UTF8&field-author=Hao+Ni&text=Hao+Ni&sort=relevancerank&search-alias=books), [Xin Dong](https://www.amazon.com/s/ref=dp_byline_sr_book_2?ie=UTF8&field-author=Xin+Dong&text=Xin+Dong&sort=relevancerank&search-alias=books), [Jinsong Zheng](https://www.amazon.com/s/ref=dp_byline_sr_book_3?ie=UTF8&field-author=Jinsong+Zheng&text=Jinsong+Zheng&sort=relevancerank&search-alias=books), [Guangxi Yu](https://www.amazon.com/s/ref=dp_byline_sr_book_4?ie=UTF8&field-author=Guangxi+Yu&text=Guangxi+Yu&sort=relevancerank&search-alias=books), Introduction To Machine Learning In Quantitative Finance, An (Advanced Textbooks In Mathematics), World Scientific, 2021

Academic Integrity: All students are expected to know, understand, and live up to the standards of academic integrity explained in Rutgers’ Policy on Academic Integrity, http://academicintegrity.rutgers.edu/academicintegrity-at-rutgers. The minimum penalty for any cheating in an exam is immediate failure of the course.

Quizzes and the midterm are open-book, open-notes. You are to do all work on quizzes, midterm, and homework without assistance from others and within the allotted time. There will be no makeups for missed quizzes, midterm, homework, or final project. If you have any issues completing any of these by the allotted time, you must contact the instructor prior to the due date and time. You will receive a zero if you do not contact the instructor prior to the due date and time.

Grading:

1. Final project: 45% = 5% for class presentation + 40% for submitted paper
2. Midterm: 30%
3. Quiz: 10%
4. In class model application presentation 10%
5. Homework 5%