Machine Learning with Financial Application

The Pre-MFE Program at Baruch College

February 4 – April 1, 2026

All the Pre-MFE seminars are offered online, via Zoom. Registration is limited to 40 students.

The seminars are offered on an eight session schedule, with each session lasting four hours:

- Lecture from 7-10pm (taught by the instructor; New York time)
- Review Session 10-11pm (taught by the teaching assistants; New York time)

Mathematical and financial concepts that are fundamental for a successful learning experience in financial engineering graduate programs will be presented and explained in detail. Strong emphasis will be placed on fully understanding the material.

Mathematical topics (selected):

- Supervised learning and bias variance decomposition
- Model selection, Shrinkage methods
- Classification: Logistic regression and LDA
- Unsupervised learning: K-means
- Singular Value Decomposition and Principal Component Analysis
- Tree-based algorithms

Financial topics (selected):

- Asset pricing via ML
- Multi-factor models (Fama-French and CAPM) regression
- Fraud detection
- Default prediction: credit risk classification
- Regime prediction and detection in financial markets
- Portfolio optimization and large covariance matrix estimation

Dates and Times:
Lectures: February 4, 11, 18, 25, March 4, 11, 18, 25
Final Exam: April 1
Times: lecture 7-10pm; review session 10-11pm, New York time

Instructor: Giulio Trigila, Faculty, Baruch College Financial Engineering Program

Tuition: $1,650

Certification: Upon successfully completing the seminar and passing the final exam, a Certificate of Completion will be issued by the Baruch MFE Program. A Certificate of Completion with Distinction will be issued to every participant completing the seminar with an average above 90

Upon request, recommendation letters reflecting performance in the seminar will also be provided.

Registration: To register or to receive more information about the Machine Learning with Financial Application seminar, send an email to **baruch.mfe@baruch.cuny.edu**.

Textbooks:

"An Introduction to Statistical Learning", by James, G., Witten, D., Hastie, T., & Tibshirani, R.. New York: Springer, 2013.
"Pattern Recognition and Machine Learning", by Bishop, C. M., & Nasrabadi, N. M., New York: Springer, 2006.

Prerequisites:

- Calculus I and II.
- Familiarity with matrix notation and discrete probability is assumed. Course specific requirements of linear algebra and probability will be reviewed in class.

Detailed Syllabus

Session 1:

- Review of elementary linear algebra
- Review of basic probability and statistics
- ML as an optimization problem
- The least square problem and its solution

Financial Applications:

- Numpy and Pandas
- Fetching and cleaning data
- Data visualization

Session 2

- Multivariate least square
- Bias Variance decomposition
- Model selection: relevant features
- R^2 and adjusted R^2

Financial Applications:

- Preliminary analysis on stock adjusted returns
- Macro-economic and financial features
- In sample vs out of sample accuracy

Session 3

- Shrinkage: Lasso vs Ridge
- Cross Validation
- The problem of multicollinearity
- Reading the output of sci-kitlearn

Financial Applications:

- Preliminary analysis on stock adjusted returns
- Macro-economic and financial features
- In sample vs out of sample accuracy

Session 4

- Classification: logistic regression
- Linear and quadratic discriminant analysis
- Evaluating your classifier: the confusion matrix

Financial Applications:

- Fraud detection: fine tuning the decision baundary
- Credit risk data set
- Visualization of the ROC curve

Session 5

- Unsupervised learning: K-means
- Lloyd algorithm with sklearn
- Information criteria to determine K
- The Iris data set

Financial Applications:

- Fraud detection: fine tuning the decision boundary
- Credit risk data set
- Visualization of the ROC curve

Session 6

- Dimensionality reduction
- SVD and PCA
- The MNIST data set

Financial Application

- Likelihood estimate of the covariance matrix
- Principal component portfolio
- Factor models and portfolio optimization

Session 7

- Regression trees
- Binary recursive partitioning
- Boosting and bagging
- Classification trees

Financial Applications:

- xGBoost
- Regime prediction and detection in financial markets

Session 8

- Large Covariance Matrix Estimation
- Shrinking
- Random matrix theory

Financial Applications:

- Portfolio optimization
- Risk Estimate