FRE 9743: Financial Statistics and Data Science

Instructor: Prof. A. Papanicolaou

Office: 12 Metrotech Office, 26th floor office 268.

Office Hours: Wednesday 2-3PM, Thursday 12-1PM

Lecture periods: 2.5 hours

Laboratory periods: 0 hours

Recitation periods: 0 hours

Credits: 3

Description:

Financial statistics includes things like estimation of distribution to compute VaR and shortfall distributions, time series analysis, and copulas. The data science element will be comprised of lessons on methods such as PCA, LASSO regression, logistic regression, K-nearest neighbor classifiers, support vector machines, neural networks, the set cover problem, and the page-rank algorithm.

Prerequisites:

Students are expected to have knowledge in basic probability and some R programming

Assessment

-Homeworks 40%

-Midterm Examination 25%

-Final Examination 35%

Textbook(s):

Efron & Hastie, Computer Age Statistical Inference: Algorithms, Evidence and Data Science, (Cambridge)

Carmona, Statistical Analysis of Financial Data in R 2nd Ed. (Springer)

https://www.princeton.edu/~rcarmona/SAFD_books.html

Chan, Time Series: Applications to Finance with R and S-Plus (Wiley)

Hastie, Tibshirani, Friedman, The Elements of Statistical Learning: Dating Mining, Inference, and Prediction (Springer)

Goodfellow, Bengio and Courville, Deep Learning (MIT Press)

Syllabus

Week	Topics
1&2	**Statistical methods:** hypothesis testing, CLT, maximum likelihood estimation, Fisher information, Bayesian inference, the James-Stein estimator
3&4	**Regression analysis:** OLS, ANOVA, ridge regression, Fama-MacBeth regression, LASSO, quantile regression, nonlinear regression
5&6	**Time Series:** AR and MA models, causality and stationarity, the Box-Jenkins approach, Dickey-Fuller test, ACF and PACF, Vector AR, Kalman filtering, ARCH and GARCH
7	**Midterm (in class October 17)**
8	**Non-Parametric methods:** kernel regression, Kolmogorov-Smirnoff test, projection pursuit, Extreme-Value theory, bootstrap methods
9	**Covariance Matrix Estimation:** principle component analysis, Wishart matrices, Marchenko-Pastur distributions, matrix completion (soft impute) methods, robust PCA, applications to Markowitz portfolio theory
10&11	**Copulas:** basics of copulas, fitting copulas, Marshall-Olkin Copulas, Vine Copulas, nested copulas
12,13&14	**Topics in Machine Learning:** logistic regression, KNN, SVM, ROC curves, neural nets, page-rank algorithm, set-cover problem, Boltzman machines
15	**Final Examination, (in class December 19)**

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If they haven't already done so, students should read and understand the university's academic misconduct policy http://engineering.nyu.edu/academics/code-of-conduct/academic-misconduct