3 ECTS

15D018

Machine Learning for Finance

Overview and Objectives

The course subjects of study range across themes from artificial intelligence, mathematical finance, numerical methods and computer algorithms with the objective of understanding the behaviour of financial time series, forecasting, assess the financial risk of various financial instruments, and ultimately help in the design of investment strategies.

Course Outline

The course covers the following list of topics:

1. **An Abridge Introduction to Finance:** Securities (bonds, stocks, options); price and payoff. Stylized empirical facts of asset returns. Forecasting. Volatility.
2. **Networks of financial time series**. Measures of dependence. Clustering of financial time series. Causality Networks.
3. **Financial Time Series Models:** Quick review of ARMA, ARCH and GARCH models. Then we go fully into Neural Networks, Support Vector Machines and Kernel methods in financial forecasting and price modeling. Multivariate Dynamic Kernels for financial time series.
4. **Optimization Heuristics in Finance.** Simulated Annealing, Genetic Programming, Differential Evolution and other heuristics and their application to finance: parameter estimation of GARCH, forecasting, valuing options.
5. **Portfolio Optimization**. Review of Mean-Variance portfolio theory; porfolio optimization under different constraints sets.

The course is mostly based on Chapters 1,2, 3, 4, 7 and 8 of my book : Computational Finance. Check the content in the web page of the book http://computationalfinance.lsi.upc.edu/?page_id=123
No deep numerical abilities are needed for this course, as we will make use of many functions and packages in software R that already do the job of modeling and statistics analysis, so you only have to learn how to assemble these functions, not to program from scratch. In fact, one of the goal of this course is to teach you how to use some of these packages for modeling time series data. A partial list of R packages for financial engineering that we use in this course: quantmod, PerformanceAnalytics, fArma, fGarch (RMetrics), e1071, nnet, kernlab, caret, boot, PortfolioAnalytics, GenSA, CVXR.
Classes will alternate between theory and programming experiments and simulations in R.

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Evaluation Criteria

There will be no written exam. The evaluation consists on take home work, once a week for the duration of the course, consisting on some R explorations and exercises to complement the theory. These home works will be done by groups of two students, except for the last to be done individually. The course will be graded as follows: Homework (average of first 2 assignments) 30%+ third assigment 30% and Project 40%.

Materials

Books:

A. Arratia, Computational Finance, An Introductory Course with R, Atlantis Press & Springer, 2014.

R. Tsay. Analysis of Financial Time Series. Wiley, 2013

Corver, T. A., and Thomas, J. A., Elements of Information Theory, Second ed. (Wiley, 2006).

McNelis, P. D. (2005). Neural Networks in Finance: Gaining predictive edge in the market. Elsevier

Other:

A list of other resources (data sets, papers,...) will be provided as the course progresses