MATH 4800, Spring 2019
Financial Machine Learning

Time and Place: MW 4:35-5:55 pm, JWB 308

Instructor: Jingyi Zhu, 801-581-3236, zhu@math.utah.edu

Office Hours: MW 3:00-4:00 pm, or by appointment, LCB 335

Text: Various papers from the literature will be used for discussions.

Prerequisites: Instructor's consent.

Course Objectives:
In modern day finance, with intrinsic nonlinearities in the models and vast amount of data sets available, machine learning (ML) is destined to transform the financial world as we know it, ranging from customer services and security measures. In this course we will discuss two particular data analysis subjects closely related to traditional quantitative financial analysis: portfolio selection and algorithmic trading. We will begin with a quick survey of a wide variety of data structures available and the challenges presented, and the basic notions of machine learning tools. The nature of finance makes it particularly difficult for standard machine learning tools to apply and yield successful results consistently. The rate of failure in financial ML is rather high and we would like to explain the reasons and provide clues to recognize the shortcomings. One area we would like to address is the assessment of values of strategies, and another is the detection of structural breaks. Regarding models, we will discuss the basic ideas in cross-validation and backtesting. For asset allocation, we will discuss approaches beyond the traditional quadratic optimizers that can compute a portfolio on ill-degenerated covariance matrix that is quite practical in reality.

Specifically, we will target the following objectives:

- Understand the basic concepts and practices in financial markets.
- Understand the main issues and challenges in financial data analysis.
- Learn about the data structures used in financial world.
- Be familiar with the basic ideas and learn about the main techniques in machine learning.
- Understand the ideas of backtesting and cross-validation.
- Learn about various trading strategies and their potential pitfalls.
- Understand and assess strategy risk for some basic strategies.
- Understand the basic portfolio optimization theory.
- Learn about machine learning for asset allocation.

- Get introduced to some high-performance computing issues in financial engineering.

Programming: Computer implementation is an essential component in this field, and you will be required to do some of your coursework with computer programs. Any of Matlab, R, Python, Java or Excel will be acceptable, but we strongly encourage you to learn some basic Matlab programming if you have no prior experience with any computer programming.

Grading:

- Paper presentation (50%);
- Four projects (50%).

ADA Statement: The American with Disabilities Act requires that reasonable accommodations be provided for students with physical, sensory, cognitive, systemic, learning, and psychiatric disabilities. Please contact the instructor at the beginning of the semester to discuss any such accommodations you may require for this course.

Tentative Schedule

Week	Date	Topic
1	Jan 7 - 9	Basic Introduction to Financial Markets
2	Jan 14 - 16	Tasks and Challenges for Data Analysis in Financial Engineering
3	Jan 23	Elements of Machine Learning
4	Jan 28 - 30	Elements of Machine Learning
5	Feb 4 - 6	Financial Data Structures
6	Feb 11 - 13	Ensemble Methods
7	Feb 20	Cross-Validation
8	Feb 25 - 27	Backtesting
9	Mar 4 - 6	Backtesting and Cross-Validation
10	Mar 10 - 17	Spring Break
11	Mar 18 - 20	High Frequency Trading Strategies
12	Mar 25 - 27	Understanding and Managing Strategy Risk
13	Apr 1 - 3	Theory of Portfolio Optimization
14	Apr 8 - 10	Machine Learning Asset Allocation
15	Apr 15 - 17	High-Performance Computing
16	Apr 22	Review