SYLLABUS

IEOR E4729 – Model Based Trading: Computational Models of Analysis and Execution

Term: Spring 2018
Department: Industrial Engineering and Operations Research (IEOR)

Instructors:
Ken Gleason (kg2695@columbia.edu)
TA: TBD

References:
TBD

Prerequisites: IEOR 4733 Algorithmic Trading is recommended but not required.

Requirements: Basic understanding of financial markets and trading strategies, concepts and environment is recommended. Knowledge of stochastic processes, time series models and econometric analysis is will be helpful. A working knowledge of Python or similar programming or scripting language will be helpful.

Assignments and Grading: There will be 6-8 homework assignments and a group project that together determine the grade for this course. Homework assignments will be done in Python. All assignments and the project will involve groups of 3-5 students based on the class size. Grades are individually assigned, based on performance on assignments (65%), the group project write-up and presentation (25%), and class participation (10%).

Office Hours: There will be weekly office hours by each TA, with location and other details to be announced during the first session of the course.

Course Website: Courseworks (E4729)

Course Description

This course will cover a variety of topics intended to develop a deeper understanding of how trade execution strategies are constructed, as well as hands-exposure to some of the programming tools used in the construction, calibration, and statistical analysis of trading strategies. While the class primarily focuses on implementation and microstructure issues associated with single-asset strategies, we may delve into more complex multi-asset topics if time permits.
Course Outline

1. Intro to Python 3.6
   a. Installation and setup
   b. A survey of IDEs and development environments: command line and editor, PyCharm, Anaconda, etc.
   c. Python basics – the command line
   d. Basic IO Functions
   e. Overview of quant-related libraries such as numpy, scipy, pandas, statsmodels, sk-learn
   f. Database access (maybe with an intro to mySQL)

2. Data visualization tools

3. Time Series Data Manipulation
   a. Working with bar data
   b. Working with tick data
   c. Transforming data to the desired scale
   d. ARCH/GARCH models

   a. Developing a simple predictive model
   b. Develop a back-testing strategy
   c. Impacts of corporate actions on multi-day analysis
   d. Scalability in simulations and exploration of parameter spaces

5. Transaction Cost Analysis
   a. Evaluation of Trading Algorithm Execution and Performance
   b. Benchmark calculations and market microstructure implications
   c. Loading a set of transaction data
   d. Error correction (timestamps, missing data, sanity checking)
   e. Data enrichment: joining market data with transaction data to analyze market impact, reversion and adverse selection
   f. Interpretation of performance vs benchmarks
   g. Strategy "Alpha" analysis
   h. Effective visualizations and representation

6. Developing Execution Algorithm Simulations
   a. Tick level simulations for execution strategies
   b. Microstructure implications
   c. Calibration of expected transaction costs in simulation
   d. Deterministic simulation using historical data
   e. Monte Carlo testing using parameterized random walk stock processes
   f. Analyzing the features of execution algorithms

7. Machine Learning and Strategy Calibration
   a. Explore methods of optimizing performance given a strategy with certain parameters
   b. Using brute force parameter space exploration
   c. Using machine learning techniques

8. Portfolio Risk
   a. Data structures for portfolio risk
   b. Basic risk metrics
   c. Applications to hedging and portfolio optimization