

MIE 479 Capstone Course

Engineering Math, Statistics, & Finance Option

Sept. 12, 2016

Coordinator: Roy H. Kwon and Minho Lee

Location: BA 1235

Idea of Capstone (CEAB)

- “The engineering curriculum must culminate in a significant design experience which is based on the knowledge and skills acquired in earlier course work and which preferably gives students an exposure to the concepts of team work and project management.”
- “A research project may be interpreted as engineering design provided it can be clearly shown that the elements of design, as noted in the definition, are fulfilled of the project.”

General Engineering Design Process

- Major Steps
 - (1) Define Need
 - (2) Problem definition
 - (3) Conceptual Design
 - (4) Detailed Design (may need to iterate to (3) for correction)
 - (5) Analysis and Evaluation (may need to iterate to (4))
 - (6) Final Design (Communicate results)

Idea of Capstone (CEAB)

- Engineering design integrates mathematics, basic sciences, engineering sciences and complementary studies in developing elements, systems and processes to meet specific needs.
- It is a creative, iterative and often open-ended process subject to constraints which may be governed by standards or legislation to varying degrees depending upon the discipline.
- These constraints may relate to economic, health, safety, environmental, social or other pertinent inter-disciplinary factors.

MIE 479

- This course will be a group project oriented course that focuses on the development of tools for solving a practical financial engineering problem.
- *In particular, a decision support system will be developed that integrates both the mathematical, statistical, and financial modeling techniques learned in the EMSF major along with relevant computing technologies.*
- An important goal of the capstone is the articulation of the requirements to non-specialists as an exercise in communication with non-technical members of an organization. **This will be manifested through your written reports and final presentation.**

Projects

- The problem/project will be open ended i.e. There is not an obvious easy solution for the problem. Could have many possible approaches.
- The experience of the project should be a “mind expander”.
- Teamwork and communication is essential.

Project Supervisor

- I will be the faculty supervisor for all projects.
- ***I expect great effort in this course and all groups need to be as self-sufficient and independent as possible! I will suggest ideas and give tips, but I will not micromanage!!***
- Team members will grade each other as to the level of effort and contribution towards to the project.

Project #1: Decision Support for Portfolio Optimization

- Create a software system that allows a user to create multiple portfolios given a set of assets and associated data. For example, the system can create MVO portfolios as well as CVaR portfolios for different risk aversion levels. Also, the system should allow ad hoc side constraints for all model types e.g. portfolio limits
- An important element of the system is that it is user friendly in terms of entering data, choosing portfolio model types, and displaying results (should be able to have multiple portfolios qualities depicted on the same graph simultaneously for different portfolios)

Project #2 – Personal Finance Management

- Implement an optimization-based decision support system for individual asset-liability management based on the paper by Medova et al. in the journal Quantitative Finance.
- Core problem: integrate the assets and liabilities of an individual based on using optimization. This means finding the best investment strategies under uncertainty that meets liabilities and financial goals of an individual.
- This will be an important emerging functionality for FinTech.

Project #3 - Generic Backtesting Tool

- Backtesting is one of many processes of validating your trading or rebalancing strategy on relevant historical data
- Here, you will be building a generic backtesting tool for portfolio management
- You are to come up with a few rebalancing or trading strategies and test your strategies with the backtesting tool that you build
- There can never be a tool that is very generic! Identify what you need in order to narrow your scope

Major Dates

- Sept 12 - Kick off
- Sept 16 – Deliverable #1
- Sept 19 – Workshop #1 (on mandatory technologies – see section *technologies* in this PPT and walk through of a rough prototype)
- Sept 26 – Workshop #2 – Of your choice
- Oct 3 – Team Meeting #1 (with Minho)
- Oct 10 – Deliverable #2 Due

Major Dates

- Oct 17 – Team Meeting #2 (with Minho)
- Nov 7 - Team Meeting #3 (with Prof. Kwon & Minho)/ Deliverable #3 Due
- Nov 21 - Team Meeting #4 (with Prof. Kwon & Minho)
- Dec 5 – Deliverable #5 Due (Demo/Final Presentation)
- Dec 9 – Deliverable #6 Due (Final report)

Team Meetings

- Each group **must** meet with me and Minho according to the schedule (see Major Dates) so that we can check progress and effort of group.
- **ALL** members of the group must be present.
- In the team meetings you will:
 - Present your progress
 - Discuss what to work on until the next team meeting
 - Ask any questions
- Groups can e-mail rkwon@mie.utoronto.ca and mminho.lee@mail.utoronto.ca to set up the meetings

Deliverable #1

- Form a group of 3-4 people and select a project.
- Groups of less than 3 are forbidden.
- Delegate a person responsible for the front-end, backend, and business logic. If you have four people, identify how the last person will play a role in the team.
- 1st Deliverable: Each group must notify Prof. Kwon and Minho of the team members and selection of project by **Sept. 16 (5PM)** an e-mail will suffice. If you are in a group that has a custom project then you **MUST** meet Prof. Kwon before **Sept. 16** so he can determine whether the problem is good enough.

Deliverable #1 – Cont.

- Front-end's responsibilities:
 - Wireframe/Sketch of the interface
 - Hooking up business logic
 - Gather user input
 - Display computed data (e.g. Graph, numbers)
 - Identify the users' needs/Gather feedback from the user

Deliverable #1 – Cont.

- Back-end's responsibilities:
 - Cleaning data/ Dealing with missing data
 - Choice of the database/ data source for raw data
 - Storage of both raw and computed data
 - Setup of Data Access Layer for both computed data and raw data, and REST api (If needed)
 - Hosting if needed

Deliverable #1 – Cont.

- Business Logic (Model Generation)'s responsibilities:
 - Estimation of the parameters
 - Analytics (e.g. Portfolio, backtest, data, etc.)
 - Provide a thorough understanding of the models and methodologies used through literature review
 - Computation of the final outcome (e.g. for portfolio management it would be the optimal trade list or an optimal portfolio)

Deliverable #2 / Team Meeting #1

- **Team Meeting #1 (Oct. 3)**
 - Walk through preliminary version of deliverable #2 with prior to the submission (Oct. 10). Minho will provide feedback and discuss team specific milestones
- **Deliverable #2 (Oct. 10)** - a report consisting of:
 - Front-end: Sketch/Design prototype, Decisions on the technologies
 - Back-end: Decisions on the technologies and flow chart
 - Business Logic: Literature Review on the models
- **Due Oct. 10 (by 5PM)** E-mail both Prof. Kwon and Minho a softcopy and put a hardcopy in Professor Kwon's MIE mailbox.

Deliverable #3 / Team Meeting #3

- **Team Meeting #3 (Nov 7.)**
 - Implementation process will be examined. The team will present the code in the team meeting. This is not a complete version of your code.
- **Deliverable #3 (Nov. 7)**
 - Intermediate progress report: A write up that describes what has been accomplished and what remains to be completed, and should clarify any changes made to the original plan.
- Due **Nov.7 (by 5PM)** E-mail both Prof. Kwon and Minho a softcopy and hand in a hardcopy of the intermediate progress report (put in my MIE mailbox).

Deliverable #4

- **Deliverable #4 (Dec. 2)**
 - A draft of the final report. This must be well written with a nice introduction and motivation of the problem with a good literature review as well. All techniques used to generate data must be clearly documented and use diagrams and visual aids in addition to tables to show your results.
- **Due Dec. 2 (5PM).** Each group will e-mail me a softcopy and put a hardcopy in my MIE mailbox.

Deliverable #5

- **Deliverable #5 (Dec. 5)**
 - Group presentation: Each group will demo their project (approx 20 minute presentation & 5 min Q&A.)
- On **Dec. 5** from noon-3PM in BA 2135. Speaking order TBA, but ALL students should be in attendance from the start to end. Roll will be taken.

Deliverable #6

- **Deliverable #6 (Dec. 9)**
 - Final Project Report: Submit both a hard copy and softcopy. Also, include any code and data used and comment all code nicely. You must be very clear in how all parameters and data were obtained and generated. Must be very polished.
 - Due **Dec.9** (5PM) Hand in hard copy in Prof. Kwon's MIE mailbox and e-mail me and Minho a softcopy along with code and data used in the project.

Technologies

- Version Control: GitHub (Mandatory) – You must make Minho a collaborate of your project
- Business Logic: Python (Mandatory)
- Package Manager: Anaconda (Mandatory)
- Backend: Your choice
 - Web/Mobile application: Django, Flask with REST api, Android, etc.
 - Desktop application: SQLAlchemy, etc.
- Frontend: Your choice
 - Web/Mobile application: AngularJS, React, Android, etc.
 - Desktop application: Excel, python GUI, etc.
- Database: Your Choice (e.g. MySQL, PostgreSQL, MongoDB, or even DaaS like Parse)
- Data Source: Your Choice (e.g. Google Finance, Yahoo Finance, etc.) but the data needs to be stored in your own database
- Host: Your Choice (e.g. Heroku, Amazon Web Service, Google Cloud Platform, etc.)

Document Alternative Designs

- Have a section in the final write up that documents alternative approaches that were not chosen and justify your strategy and design. Failure to do this will result in an automatic one grade step penalty e.g. from A to A-.

Marking

- Will determined by the quality of the deliverables and my sense of the effort of a group.
- In addition, I will be looking for the extent of serious computational (mathematical, statistical, financial) design content in your project and the extent to which you were able to achieve good results or generate interesting insights into trying to solve the problem e.g. When does your design work well?.
- Also, your project must demonstrat good integration of different functionalities through the use of computing technologies taught in this course.

Contacts

- Prof. Kwon: rkwon@mie.utoronto.ca
- Minho Lee: mminho.lee@mail.utoronto.ca / chris9110@gmail.com (You can contact me for any questions or even for a chat!)