Student Research Proposal for South West University of Financial Economics

The present document outlines the areas of current research at the RiskLab of the University of Toronto which are appropriate to run a research program with undergraduate students.

Each project is an autonomous undertaking, with a designated project leader, instructor and dedicated collaboration team.

Timelines presented assume students are highly independent and are able to carry out tasks on their own once they have been introduced to the topics during a first introductory week. Still, each project will have a weekly update meeting amongst all members of the research theme team.

Program Delivery Format

This will be a program that will run for 5 weeks depending on the topic.

- Each project will start with a first week where a Professor or senior member will give 3x30 minute session introducing the topic, its significance, context and its relevance.
- There will be a one hour session to introduce participants to the Microsoft Teams collaboration environment.
- There will be a one hour session to introduce participants to the academic researching paper writing.
- Each week after the first one, a Professor or senior member will give a 45 mins lecture on topics of relevance to the research.
- Each week, a research lead will host a student session of 45 mins to answer questions.
- A research lead will go through students' interim reports and give feedback; this will occur halfway through the program.
- Prior to the end of the program, a Professor will provide feedback to the final student report draft.
- Prof or research lead will participate in the final defence of the research report.

Document coordination

Each project will use Microsoft Teams for project coordination, which allows concurrent updates with version tracking, together with a SharePoint to host the files.

Machine Learning for Dynamic Trading Strategies

This theme aims to harness the power of modern computational techniques to obtain a revision of the traditional portfolio theories, including

- Markowitz portfolio theory
- 1/N and risk parity
- Minimum variance
- Omega optimization

Students will be expected to be able to download and manage datasets, run algorithms on that data, and be able to obtain conclusions from the computational results obtained.

Skill sets needed

- Computational methods,
- Python programming
- Quantitative techniques to analyze data sets
- Some familiarity with investment concepts, such as risk and return
- Good communication skills

Timeline: 5 weeks

- Week 1 (3x1/2hr+2hr) of lectures to introduce participants to the status quo and vision for results
- Week 2 (20 hours) for participants to learn status quo, read relevant papers and have a practical sense. This week overlaps with the previous one.
- Week 3-4 (40 hours) to download relevant data, perform analysis on the data, to obtain conclusions
- Week 5 (20 hours) to present results in a carefully drafted document and slide deck

Machine Learning for Portfolio Optimization

The dominant approaches for financial portfolio construction are reliant on estimating sample covariance and correlations matrices, which serve as an input into a number of classical portfolio construction techniques. These classical approaches are not forward looking, constrained by the ability to estimate covariance and correlation matrices, and inflexible to incorporating additional information.

This research aims to produce a new approach of utilizing learned representations from deep learning networks to augment such classical techniques. This approach is able to incorporate learned estimates of future performance, and can be customized to create tailored representations best suited towards meeting varying financial objectives.

Research outcomes

The research will showcase examples of such an embedding, compare and contrast it with classical approaches to portfolio construction, and discusses additional possibilities for applying representation learning in quantitative finance

Students will be expected to be able to download and manage datasets, run algorithms on that data, and be able to obtain conclusions from the computational results obtained.

Skill sets needed

- Computational methods, statistics (Covariances, time series analysis)
- Python programming
- Advanced quantitative techniques, ML/AI
- Some familiarity with investment concepts, such as risk and return
- Good communication skills

Timeline: 5 weeks

- Week 1 (3x1/2hr+2hr) of lectures to introduce participants to the status quo and vision for results
- Week 2 (20 hours) for participants to learn status quo, read relevant papers and have a practical sense
- Week 3-4 (40 hours) to download relevant data, perform analysis on the data, to obtain conclusions
- Week 5 (20 hours) to present results in a carefully drafted document and slide deck

Investment Scoring and Artificial Intelligence

This theme aims to introduce techniques from natural language processing to train machines in human interpretation processes that result in the classification of investment instruments or portfolios. A key focus of this machine learning research is natural language processing for ESG. Current ESG ratings are limited by data, primarily focusing on internal company disclosures, as well as by ability to respond to new information quickly. Our research focuses on filling this gap by automatically processing social media and news data.

Using a state-of-the-art NLP technique, Bidirectional Encoder Representations from Transformers (BERT), the RiskLab NLP model can be incorporated to improve the accuracy of assessing relevance and content of documents in as ESG context, a capability that can be used for automating the construction of ESG indexes. The research could then be extended to also deal with popular trends and warning signals.

Skill sets needed

- Computer algorithms that analyze lexicons, implementations and basic tools
- One programming language
- ability to run those algorithms on datasets arising from documents (text), web sites or social media elements.
- Quantitative knowledge of neural networks, BERT methods
- Good communication skills

Timeline: 5 weeks

- Week 1 (3x1/2hr+2hr) of lectures to introduce participants to the status quo and vision for results
- Week 2 (20 hours) for participants to learn status quo, read relevant papers and have a practical sense
- Week 3-4 (40 hours) to download relevant data, perform analysis on the data, to obtain conclusions
- Week 5 (20 hours) to present results in a carefully drafted document and slide deck

BlockChain based finance

Blockchains are often used to create transactions which allow for decentralized verification systems. The research opportunity allows to extend the blockchain techniques to the following application areas:

- Lending and credit platforms
- Manufacturing
- Agriculture, and other economic sectors

Students are expected to have a strong grasp of economic issues and a technology base to understand complex databases and perform operations on them.

Skill sets needed

- Knowledge of databases, familiarity with BlockChains
- Python programming
- Database implementations
- Some familiarity with (smart) contracts
- Good communication skills

Timeline: 5 weeks

- Week 1 (3x1/2hr+2hr) of lectures to introduce participants to the status quo and vision for results
- Week 2 (20 hours) for participants to learn status quo, read relevant papers and have a practical sense
- Week 3-4 (40 hours) to download relevant data, perform analysis on the data, to obtain conclusions
- Week 5 (20 hours) to present results in a carefully drafted document and slide deck

Business intelligence

The use of data to understand businesses coupled with the ability to visualize it and draw conclusions, has opened a new research area of great relevance; challenges are varied, and at RiskLab we focus on the ability to draw conclusions from complex data structures and creating the ability to draw conclusions from them.

Students will be expected to have a solid analytical foundation and strong business analysis skills.

Skill sets needed

- Business, some economics
- Programming in a modern language
- Knowledge of data bases and analysis
- Good communication skills

Timeline: 5 weeks

- Week 1 (3x1/2hr+2hr) of lectures to introduce participants to the status quo and vision for results
- Week 2 (20 hours) for participants to learn status quo, read relevant papers and have a practical sense
- Week 3-4 (40 hours) to download relevant data, perform analysis on the data, to obtain conclusions
- Week 5 (20 hours) to present results in a carefully drafted document and slide deck

Climate, Carbon and new commodities trading

This project will address the new markets which are being created in relationship with the environment, carbon trading, water and climate issues. Students are expected to have a broad set of skills, as the challenges that may arise are numerous and of different types. Some of the areas of activity are:

- Sustainable Finance, Circular Economies
- ESG Credit Ratings
- Carbon Neutrality - European Green Deal
- Integration of ESG Criteria into Corporate Strategy

Skill sets needed

- Business, some economics
- Programming in a modern language
- Knowledge of data bases and analysis
- Good communication skills

Timeline: 5 weeks

- Week 1 (3x1/2hr+2hr) of lectures to introduce participants to the status quo and vision for results
- Week 2 (20 hours) for participants to learn status quo, read relevant papers and have a practical sense
- Week 3-4 (40 hours) to download relevant data, perform analysis on the data, to obtain conclusions
- Week 5 (20 hours) to present results in a carefully drafted document and slide deck