Mathematical Finance & Data Science Certification Course

Overview

The aim of this course is to build the foundations for a non-computer engineer to secure jobs in the finance industry. The targeted fields are Quantitative Finance and Data Science. The focus of the course will be on software and analytical skills. Lectures have been arranged with several professionals from BMO, Scotiabank, Manulife, Nexx Consultants and RBC. More professionals from the same companies, as well as from Canada Pension Plan, Ontario Teachers' Pension Plan and IBM have also been invited. Different course subjects will be taught by these individuals. At the end of the course, Lussier Search, a professional recruiting agency that is specialized in the finance industry, will help students secure internships and jobs. Some of our invited lecturers along with Lussier Search will train students with interview skills. We are currently working on securing internships for all students in a financial organization.

Course Context

Data analysts need to use strong methods to extract quantitative information from large quantities of data. Particularly in financial markets, there is a strong interest in measuring investment risk using market and economic data. Fundamentals of Statistics, Time Series with applications in finance, Model calibration, Data analysis and statistics with applications in financial market, Numerical solutions to ODEs and Machine learning are typically sought after in many finance jobs.

More importantly, most engineers lack software skills. In this course, we put a great emphasis on teaching common software tools that are used in the finance industry. Also, specific tools for data science such as Hadoop Ecosystem, Hive, Spark and/or Sqoop will be introduced.

In this course, after covering basic statistics, probability, matrix calculation and regression analysis, we aim to discuss more advanced topics including multivariate distribution, VaR, expected shortfall, cointegration and financial risk factor modelling. R will be heavily used in this course to analyze financial data and estimate statistical models. Please see the tentative syllabus on the next page for more information.

The course will be approximately 100 hours in total that will be taught in less than 4 months. Students are expected to spend significant amounts of time on assignments and 2 to 3 projects that mimic actual projects in the finance industry.

Two Streams to choose

We offer two streams for this course. Stream 1 is mainly for students with undergraduate degrees and little programming background. Stream 2 is meant for students who have graduate degrees (Master/PhD) and have better background in computer programming. Each stream addresses different types of jobs. The tentative overall syllabus along with more detailed information is projected below.

Tentative Syllabus for Both Streams

	Topics	Hrs	Description	Lecturer	Addressing Jobs
General Training (70 hours) Required for all students	Fundamental of Statistics using R for practical data analysis	28	Covering Basic concepts of statistics such as interpreting data, probability distributions, and time series. Using R to solve practical data analysis problems such as regression analysis and feature selection	From RBC	
	Introduction to database and working with SQL querying	10	Introduction to the structure of databases and how to work with them such as knowing how to work with SQL querying and doing basic stuffs with data indexing, data storing, and data cleansing	From RBC	
	Introduction to Quantitative Finance	6	Covering basic concepts of finance such as risk management	From RBC	
	Big Data Tools	6	Introduction to big data tools such as Hadoop and Spark	From Scotiabank	
	Python programming	10		From Manulife	
	Soft skills and job landing	10	Interview Skills, Resume, cover letter, Networking etc.	From BMO	
Stream 1 (16 Hours) Undergraduate candidates with no solid programming skills	Data analysis and regression analysis using excel spreadsheet	10	Doing simple data analysis and regression analysis using excel and understanding excel tools such as pivot tables	From RBC	1) Data Analyst 2) Data Engineers 3) Junior Quantitative Analyst
	Data visualization using Excel and Tableau	6		From RBC	
Stream 2: (28 Hours) Graduate candidates with solid programming background	Advanced Python programming	10		From Manulife	1) Data Analyst 2) Data Scientist 3) Quantitative Analyst
	Financial Mathematics	18	*See below table for more information.*	From RBC	
Special Topics One topic to be chosen by Stream 2 students. (Stream 1 students can also take these courses, consult our staff)	Data Science and Machine Learning	20	*See below table for more information.* Learning data science tools and algorithms such as random forest, decision tree, clustering, and KNN, Learning advanced data science tools and algorithms such as SVM, neural networks, NLP, and Deep Learning.	From Scotiabank	
	SAS Programming and big data	10	This course can only be thought to students who can buy inexpensive license of SAS.	TBD	
	Java Programming	30	This course is to teach object-oriented programming to those who are interested in more advanced programming skills.	From NuPhysics	

Special Topics: Mathematical Finance

Session 1	Binomial trees	Value at risk
Session 2	Wiener processes and Ito's lemma Mechanics of options markets	Estimating volatilities and correlations
Session 3	The Black–Scholes–Merton model Put-Call Parity	The Greek letters. Volatility smiles
Session 4	Fixed Income and Interest rates	Bond Duration and Convexity
Session 5	Art of Term Structure Models (Drift and Volatility)	Interest rate derivatives: Models of the short rate Swaps
Session 6	Credit Risk Counterparty Credit Risk	Modelling Credit Risk Parameters Credit Derivate
Session 7	Credit Risk Exposure Default Probability, Credit Spreads, and Credit Derivatives	CVA
Session 8	Operational Risk	OSFI/Basel Requirements
Session 9	Portfolios and Investments	Monte Carlo Method

Special Topics: Introduction to Data Science

Subjects	Outline	Required Statistical Background
Spark (Big data tool)	• Introduction and basics of Scala programming	
	• Introduction on Spark • Hands on experience with Spark SQL	
	• Hands on experience with Spark MLlib (Machine Learning libraries) –	
	• Packaging Spark jobs using Scala Build Tool (SBT), spark parameter configuration, running job over Hadoop cluster	
Hive (Big data tool)	• Introduction • Creating Hive tables, and their different types • Basic queries: select, join, count, sort, group by, union, regular expressions, collections, etc.	
	• User defined functions (UDFs) in Hive	
Sqoop (Big data tool)	• Introduction to Sqoop and examples on bidirectional data transferring between DB2 and Hadoop databases	
Machine Learning (Fundamentals)	• Introduction to supervised and unsupervised learning • Feature generating • Feature selection and ranking	Some background on optimization, regularization and loss functions. Bayesian rules. Gaussian approximations, normality tests, model order selection, principal component analysis, etc.
	• SVM • Cross validation and general parameter tuning	
	• XGBoost • Random Forrest	
	• Recommender Systems and Market Basket Analysis	
	• Clustering • Outlier detection	