MASTER of SCIENCE PROGRAM
Mathematics in Finance

NEW YORK UNIVERSITY
Courant Institute of Mathematical Sciences

Class of 2019 Resume Book

Mathematics in Finance M.S. Program

Courant Institute of Mathematical Sciences
New York University

July 23, 2020

For the latest version, please go to
http://math.nyu.edu/financial_mathematics

Job placement contact: mthfinjobs@cims.nyu.edu

New York University
A private university in the public service

Courant Institute of Mathematical Sciences
Mathematics in Finance MS Program
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Dear Colleague,

We are pleased to provide you with the resumes of third semester students in the Courant Institute's Mathematics in Finance Master's Program. They are starting their last semester and will graduate from our Master's program in December 2019. We hope you will consider them for possible full-time positions at your firm.

We believe our students are the most elite, most capable, and best trained group of students of any program. This year, we admitted less than 8% of those who applied. The resumes you find in the resume book describe their distinguished backgrounds. For the past years we have a placement record close to 100% for both the summer internships and full-time positions. Our students enter into front office roles such as trading or risk management, on the buy and the sell side. Their computing and hands-on practical experience makes them productive from day one.

Our curriculum is dynamic and challenging. For example, the first semester investment class does not end with CAPM and APT, but is a serious data driven class that, examines the statistical principles and practical pitfalls of covariance matrix estimation. During the second semester electives include a class on modern algorithmic trading strategies and portfolio management. Instructors are high-level industry professionals and faculty from the Courant Institute, the top ranked department worldwide in applied mathematics. You can find more information about the curriculum and faculty at the end of this document, or at http://math.nyu.edu/financial_mathematics/.

Sincerely yours,
Leif Andersen, Industry Adviser
Deane Yang, Chair
Petter Kolm, Director

XINYU (MARK) BI

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EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance (Sep 2018– Dec 2019) **GPA: 3.97/4.0**

- ***Coursework:*** machine learning, regressions & time series, optimization, Black-Scholes & Greeks, Monte Carlo Simulation, interest rate & Fx model, Stochastic Calculus, market microstructure

PEKING UNIVERSITY Beijing, China
Guanghua School of Management / School of Mathematical Science
BA in Finance & BS in Mathematics (Sep 2014 – Jul 2018) **GPA: 3.84/4.0 Ranking: 5/171**

- ***Coursework:*** PCA, numerical methods, linear ODEs, OOP in C++, CAPM and APT models, VaR, mean-variance optimization, data structures and algorithms, Micro & Macroeconomics, accounting

EXPERIENCE

QUANTPORT, JEFFERIES New York, NY
Quantitative Research Analyst (Feb 2020 – May 2020)

- Applied Bayesian Machine Learning algo with Variational Bayesian inference (self-written in python) on analyst recommendations dataset to forecast US stocks returns
- Developed and back-tested market-neutral quant strategies for US stock based on analyst recommendations dataset; achieved low turnover rate of 11.7% and Sharpe ratio of 1.53

AIGEN INVESTMENT MANAGEMENT New York, NY
Quantitative Research Analyst (May 2019 – Aug 2019)

- Applied NLP/ML techniques (dictionary approach with customized wordlist and negation/adverb, doc2vec, logistic regression) to generate sentiment score for analysts' reports abstracts
- Examine the relationship between reports-generated sentiment signal and Barra residual returns to seek alpha, conditioning on factors including market cap, sectors, analysts rating etc.
- Developed NLP research tools and pipelines (whole package, 3000+ lines code) in python

UBIQUANT INVESTMENT Beijing, China
Quantitative Research Analyst (May 2017 – Nov 2017)

- Developed and back-tested market-neutral quant strategies for China A-share stocks using key financial terms in C++; achieved annualized return of 12.3% and annualized Sharpe ratio of 7
- Researched event-driven strategies in Python: Grouped A-share stocks based on analysis of indicators (e.g. market cap), calculated each group's abnormal return for further trading strategies

BEIJING CAPITAL FUTURES Beijing, China
Data Analyst (Jul 2016 – Aug 2016)

- Modeled volatility of commodity and financial futures through EWMA and GARCH model in R
- Calculated VaR using variance-covariance method for margin requirement determination
- Back-tested models for comparison and did t-test for validity
- Automated the volatility and VaR calculation from Excel sheets

PROJECTS

NEW YORK UNIVERTY New York, NY
Stock market prediction by Trump's Tweets

- Applied NLP analysis (sentiment analysis and LDA) on President Trump's Tweets to extract features and built regression models to explain/forecast S&P 500 index return and VIX change

NEW YORK UNIVERSITY New York, NY
Options Pricing

- Implemented Monte Carlo simulation with Geometric Brownian Motion and Heston model to price European, Asian options; Least-Square MC to price American options
- Adopted the antithetic variates and control variates as variance reduction techniques in MC

COMPUTER SKILLS/OTHER

Programming Languages/Software: C/C++, Python, Java, R, matlab, Microsoft Office
Languages: Mandarin (native), English (fluent)
Awards: 2012 second Prize in Beijing of China National High School Mathematics Tournament

JINGRAN CUI
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EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance (expected – January 2020)

- ***Risk management:*** VaR, backtesting, stress testing, credit risk
- ***Financial modeling:*** Monte Carlo Simulation, interest rate models (Vasicek, CIR, Hull and White), factor models
- ***Derivatives:*** Black-Scholes & Greeks, hedging, exotic options (Digital options, Asian options, Barrier options, Lookback options, Spread options, Basket options, Worst-Of and Best-Of options)
- ***Others:*** OOP in Java, mean-variance optimization, Stochastics Calculus (Brownian motion, martingales, diffusion process), market microstructure (tick test, Kyle model, quote test), Machine Learning (K nearest neighbors, decision tree, linear regression, tree-based regression)

UNIVERSITY OF ROCHESTER Rochester, NY
BS in Mathematics and BA in Statistics (2014 - 2018)

- ***Coursework:*** Calculus, probability and statistics, linear algebra, linear regression
- ***Awards:*** Dean's List, Phi Beta Kappa

EXPERIENCE and PROJECTS

CHINA SECURITIES CO., Ltd Beijing, China
Quantitative Researcher Intern (June 2019 – August 2019)

- Developed market timing strategy for sector indexes in Chinese stock market. Created linear regression model to calculate divergence within each industry and the change in sector index for that industry for market timing. A 10-year backtest produced a 40% annual return in electronics industry as highest annual returns among all 26 industries with 25.37% maximum drawdown
- Developed market timing strategy for A share index in Chinese stock market. Used the information in the price and volume of the stock market to predict the turning point for the market . A 10-year backtest, produced a 13.67% annual return with 26.73% maximum drawdown.

New York University New York, NY
Monte Carlo Option Pricing Approach in Java

- Built an extendable Java-based Monte Carlo option pricing framework
- Priced vanilla European and Asian options by Monte Carlo
- Applied ActiveMQ system and GPU programming to achieve faster convergence resulting in a speedup of 3

K-Means Clustering in Java

- Implemented Lloyd's algorithm for multi-dimensional points clustering
- Measured the efficiency with within-cluster distance variance and compared efficiencies with several metrics.

Mean Variance Portfolio Optimization in R

- Performed mean-variance optimization for a portfolio with six different types of funds
- Calculated the maximum Sharpe ratio portfolio and the weight allocation for a given set of subjective views

Comparison of VaR Calculation Approaches for Currencies and Commodities

- Implemented the covariance and historical simulation techniques to calculate one-day 99% VaR for major currencies and commodities over 2005-2012 in Excel
- Applied the Gaussian copula to the historical data and then implemented Monte Carlo simulations for VaR calculations; compared these three VaR methodologies

Model Validation of Heston Model

- Investigate the validity of Heston model for pricing European options, and compares the results with the actual market data.

COMPUTER SKILLS/OTHER

Programming Languages & Computer tools: Java, R, Python, Excel
Certificate: Actuarial Studies Certificate, Passed CFA Level I Exam
Languages: Mandarin (native), English (fluent)

JINGYUAN FENG

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EDUCATION

NEW YORK UNIVERSITY New York, NY, US
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance Sep. 2018 – Jan. 2020

- ***Topics:*** Java (data structure, K-means clustering); convex optimization; big data and decision trees; reinforcement learning; predictive analysis; hidden Markov models; tactical asset allocation

IMPERIAL COLLEGE LONDON GPA 3.7/4.0 London, UK
MSci in Mathematics Sep. 2013 – June 2017

- ***Awards:*** Associateship of the Royal College of Science (ARCS)

WORK EXPERIENCE

BEIJING MOOPLUS TECHNOLOGY Co., Ltd Beijing, China
Revenue Growth Consultant, Marketing&Sales Data **Scientist** Apr. 2019 – present

- Managing the business development of the medical products unit of the high-tech CPG startup (valued at $0.7+B)
- Driving sales by applying collaborative filtering algorithms (KNN, MF) to recommend stock items
- Partnered with 16 enterprises, providing digital branding channel in exchange of $7M series B investments
- Built metadata-driven PowerBI dashboards, improving return on sales by 6% to date

McDEVITT RESEARCH GROUP, NYU New York, NY, US
Project Moderator, (Incoming) Machine Learning Analyst Jan. 2020 – present

- Collaborating with 20 postgraduate students on data collection and model development for trauma treatment
- Scraped publication titles associated with 500+ trauma/biomarker combinations on PubMed in Python (WebDriver)
- Normalised error rate for each keywords combination and created heatmap to select the most important features in trauma management (prognosis and diagnosis)

JST CAPITAL New York, NY, US
Quant Strat, Data Analyst Jun. 2019 – Aug. 2019

- Facilitated effective communication between data architects, discretionary traders and institutional clients, writing ad-hoc Data Requirement Documents and integrating cryptocurrency data sources from CoinAPI
- Visualized the transaction cost for BTC/ETH/XRP with Seaborn scraping large TAQ datasets from SQL Server/ Coinbase, limiting the premium risk exposed to $50M block trades to 15 basis points
- Automated daily NAV reporting to stakeholders with limited guidance, lowering operational overhead by up to 20%
- Maintained trades data quality through unifying DateTime format across time zones and imputing unfilled trades

SHANGHAI STOCK EXCHANGE Shanghai, China
Product Analyst Jul. 2017 – Sep. 2017

- Led market research across commodities and fixed-income
- Analyzed the top liquid equity options products across CBOE based on trading volume, open interest (OI) and put/ call ratio and recommended the purchase of Petrobras ADR to senior managers, achieving a 30% return

LEADERSHIP & PROJECT

EARTH (InnoVention, NYU Future Labs 2020 cohort) New York, NY, US
Co-founder, Marketing Analyst, Product Manager Nov. 2019 – present

- Co-founded a startup offering customizable houseplant-care automation solutions and received $1K early seed fund
- Performed competitive analysis on B2C price dynamics and mapped out key consumer buying factors
- Delegated three electronic engineers on prototyping a set of indoor plants IoT sensors for propagation tracking

NORDIC PROBABLISTIC AI SCHOOL (NTNU, Norwegian Open AI Lab) Trondheim, Norway
Researcher June 2019

- Investigated the deep latent variable model (DLVM) and its connection to Bayesian neural networks
- Trained sparse variational dropout on ResNet-50 for ImageNet (tensor libraries: torch, torchvision, logger)

IAQF ANNUAL ACADEMIC COMPETITION 2019 New York, NY, US
Project Leader Jan. 2019 – Mar. 2019

- Set and tracked OKR's for each team meeting and ensured timely deliverables from each of 6 team members
- Predicted with 100% accuracy the direction of US corporate vs treasury bond credit spread movements using feature selection techniques and machine learning models (boosting, BART), trained on pre-cleaned time series data

SKILLS & INTERESTS

Technical: Python, C++, Java, Excel, Matlab, R, SQL, Hadoop, PowerBI, Tableau
Languages: Mandarin, English, Cantonese, Italian (B1)
Certificate/MOOC: CFA Level II candidate, fast.ai
Others: Division 3 (E-rated) professional foilist fencer (club affiliation with FC Manhattan)

YINAN (DAVID) HU
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EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance (2018 – 2019)

- ***Coursework:*** Portfolio optimization, CAPM, factor models, MBS, CLO, option pricing (binomial, risk neutral), interest rate & FX models, market impact, statistical arbitrage, Bayesian statistics

LONDON SCHOOL OF ECONOMICS (LSE) London, UK
BSc in Mathematics with Economics (2015 – 2018)

- ***Coursework:*** Probability, econometrics, corporate finance, fixed-income mathematics, algorithms
- ***Awards:*** First Class Honors; Top of the Bachelor of Science class in course Discrete Mathematics

EXPERIENCE

NEUBERGER BERMAN INVESTMENT ADVISERS LLC New York, NY
Long/Short Equity Group Portfolio Analyst Intern (2019)

- Researched and replicated fundamental factors in BQuant using Python; initiated, built and backtested factor-based model reflecting team's discretionary style preference for stock selection
- Developed factor dashboards for risk analysis, from portfolio level drilling down to single names; presented the framework to the team, which is then incorporated into routine investment process
- Maintained long/short positions, monitored risks and reported exposures to the team daily
- Conducted ad hoc quantitative investment research to support senior portfolio managers; specific data analytics included investigating asset class correlations and assessing market volatilities
- Automated analyzing fundamental metrics, P&L attribution and investor compositions using BQL
- Attended research and company management meetings; collaborated with colleagues across firm

FOUNDER SECURITIES CO., LTD. ASSET MANAGEMENT COMPANY Beijing, China
Investment Management Division Summer Analyst (2018)

- Computed bond yields analyzing pricing scenarios; calculated Altman Z-scores for credit analysis
- Researched policy effect on financing platforms; collected and processed industry data from Wind

RENAISSANCE ERA INVESTMENT CO., LTD. Beijing, China
Quantitative Division Summer Analyst (2017)

- Analyzed over 10 million alternative data of target snack brands using Python and MongoDB
- Wrote programs to compute market shares and generate word clouds for sentimental analysis
- Researched trend following strategies; implemented and backtested Dual Thrust CTA strategy

SINOLINK SECURITIES CO., LTD. Beijing, China
M&A Division Summer Analyst (2016)

- Conducted financial modeling including DCF and comparable valuations in CNY 3.5 billion deal
- Facilitated meetings with acquirer and target firm, tailored integration plan based on negotiations

PROJECTS

THE COURANT INSTITUTE OF MATHEMATICAL SCIENCES (NYU) New York, NY
Discretionary FX Investing

- Made consistent (20% annualized) profit with global macro strategy analyzing geopolitical affairs

Robust Portfolio Construction with Hierarchy Risk Parity Method (Python)

- Implemented mean-variance optimization to return portfolio weights with highest expected utility
- Applied hierarchy clustering for asset allocation overcoming instability in Markowitz framework

LONDON SCHOOL OF ECONOMICS (LSE) London, UK
MBP Capital, the LSE Student Investment Fund

- Composed market reports; pitched FX trades in multi-asset respect for portfolio diversification

SKILLS & INTERESTS

Languages: Python (3 years), R (2 years), Java (1 year); Chinese (native), English (bilingual proficiency)
Other Software: Bloomberg (BQL, BQuant), Microsoft Office (Excel), MongoDB, Stata, SPSS, Wind
Interests: Basketball (LSE Men's 2nd Team, CSSA G5 Tournament Champion), dance (Hip-Hop), ukulele

TIANHAO LU

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EDUCATION

NEW YORK UNIVERSITY **New York, NY**
The Courant Institute of Mathematical Sciences. Sep 2018 – Dec 2019 (Expected)
MS in Mathematics in Finance *GPA:3.85/4.00*

- ***Relevant Coursework:*** Time Series Analysis, Big Data and Econometrics, Brownian Motion and Martingales, Object-oriented Programming, Black-Scholes Formula and Applications, Interest Rate & FX models, Valuation Adjustment, Statistical Arbitrage

IMPERIAL COLLEGE **London, United Kingdom**
BSc and ARCS in Mathematics with Statistics for Finance Oct 2015 – Jun 2018

- ***Distinctions:*** Graduated with Ken Allen Prize (5/200); Dean's list for consecutive three years (top 10%)
- ***Relevant Coursework:*** Real Analysis, Differential Equations, Option Pricing, Probability and Statistics, Statistical Modeling, Applied Probability, Survival Modeling and its Applications

EXPERIENCE

COVENTURE **New York, NY**
Quantitative Analyst Intern May – Aug 2019

- Developed a trading strategy with predictive models by considering mean reversion and momentum for numerous crypto assets; significantly enhanced the profitability and improved cost-adjusted Sharpe ratio and Sortino ratio
- Challenged daily performance of individual crypto asset to refine insights into market behavior and improve the investment strategies

PARETO TECHNOLOGIES **New York, NY**
Quantitative Analyst – Part Time Mar – May 2019

- Implemented an arbitrage strategy using Python by synthesizing industry data and analytical techniques;
- Modeled the volume impact based on the market impact and the transaction cost; conducted backtesting to assess the capacity of the strategy

HUA AN FUND MANAGEMENT **Shanghai, China**
Quantitative Research Intern Jun – Aug 2018

- Developed an event-driven strategy to construct portfolios with 13% annual return and low leverage with machine learning methods by using Python and R
- Applied GARCH model and its extensions to model volatility of index of the market using R; evaluated the model performance and summarized its applications

IMPERIAL COLLEGE **London, United Kingdom**
Research Assistant: Modeling Pseudo Periodic Time Series. Jul – Aug 2017

- Fitted an Autoregressive model for pseudo UK monthly CO2 data by considering its spectrum structure
- Utilized Bayesian method to estimate the coefficients of the Autoregressive model; and outperformed the results generated with the built-in function in R, by comparing the QQ norm plots of the two methods

PROJECTS

- ***Deep Learning in Option Pricing:*** Used deep learning techniques to solve the high dimensional linear and non-linear option pricing pde and produce lower and upper bound for the price, greatly accelerated the speed of the algorithm compared to traditional finite difference method.
- ***Kalman Filter and Its Variants:*** Evaluated the performance of different variants of Kalman filter and applied them to non-linear mapping; initialized a trading backtesting algorithm by trading proportional European financial data with negative Z-score at a high frequency rate and obtained an average 0.1% higher daily return than the actual; won the "Best Project" of the year out of 50+ teams.

SKILLSETS

Technical Skills: Python, R, MATLAB, Java, MS Office Suite (Advanced), LaTex
Languages: Mandarin (native), English (fluent)

JUNQI (JUN) QIAN

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EDUCATION

New York University | The Courant Institute of Mathematical Sciences **New York**
M.S. in Mathematics in Finance 2018 – 2020

- **Mathematics and Statistics**: Mathematical Analysis, Time Series Analysis, Differential Equations, Linear Regressions
- **Finance**: Econometrics, Derivative Pricing & Hedging, Financial Mathematics, CAPM, PCA, Black-Scholes Formula and Greeks, Monte Carlo, Mean-Variance Portfolio Optimization, VaR, Interest Rate & FX Modeling

University of California, Berkeley **Berkeley**
B.A. in Mathematics 2016 – 2018

- **Relevant Courses**: Statistics and Probability, Linear Algebra, Partial Differential Equations

WORK EXPERIENCE

Spruce Investment Advisors **Stamford, CT**
Summer Intern July 2019 – Present

- Updated performance of portfolio and benchmarks by calculated max drawdown, sharpe ratio, capture ration etc. by Python
- Provided risk and return analysis based on mean variance approach to inform portfolio construction and risk-taking decisions

Haitong Securities **Shanghai**
Summer ECM Intern June 2019 – July 2019

- Implemented convertible bonds pricing model in Python to predict convertible bonds' issuing price in a 5 Yuan error range
- Generated simulated data for 2000+ allotment subjects by Python for system testing on price, quantity and eligibility
- Transaction Experience
    - Joint bookrunner for Suzhou TZTEK Technology Co., Ltd. on its $180mm IPO
    - Joint bookrunner for Advanced Micro-Fabrication Equipment Inc. on its $220mm IPO

PrinceTechs **Beijing**
Summer Data Analyst June 2017 – Aug 2017

- Resolved data anomalies, including out-of-range values, missing values, and data inconsistency issues
- Developed machine learning models, such as random forests, into firm platforms to predict Alipay's customer behaviors
- Used Lasso to select significant features from 19 to 5; eliminating multi-collinearity with 20% accuracy improvement

China Business Network **Shanghai**
Financial Manager Assistant May 2016 – Jul 2016

- Updated customized market information, such as opening price of select stocks, markets in Python
- Evaluated returns on ETF market through monitoring 20+ money market ETFs' trends in 2 months
- Coordinated with finance industry leaders and professors for real estate workshops to potential professional customers

Projects

Option Pricing with Monte Carlo Simulation (Java)

- Designed a generic Java option pricing framework for European and Asian options and used antithetic path method to speed up
- Implemented Middleware client-server structure to do multi-threading process and saved more than 40% running time
- Applied GPU programming to enhance whole framework and improved 200% efficiency with same accuracy

IR Curve Building (Python)

- Bootstrapped IR curve by using tension spline technique and applied iteration technique to reduce error
- Used Least-Square-Monte-Carlo to calculate American option price and found optimal execution boundary

VaR Models' Comparison (Excel)

- Applied Brownian Bridge, regression-based EM, and bootstrapping methods to fill missing data based on missing data length
- Estimated VaR results through V/CV, historical simulation, Monte Carlo techniques to assess risks of investment portfolios
- Implemented risk analysis for market portfolios by running stress tests to include possible loss under extreme conditions

SKILLS AND INTERESTS

Programming Languages: Python, Java, R, STATA, Fortran, Tableau
Other Software: Bloomberg, Excel VBA, Microsoft Office (Advance in Excel), Adobe Photoshop, Final Cut Pro, Logic Pro
Languages: Fluent in Mandarin, English, and Japanese (JLPT: N1)
Certificate: Passed SOA P Exam
Interests: Dance, Piano, and Violin

JIAHAO (NICK) REN
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EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance (Expected December 2019)

- ***Coursework:*** OOP in Java, Stochastic calculus, Black-Scholes model, PCA, Monte Carlo simulation, Market microstructure, VaR, Data Structure. Greeks, Derivative hedging
- ***Future Coursework:*** Interest rate & FX models, Time Series Analysis & statistical Arbitrage, Continuous Time Finance, Machine learning

UNIVERSITY OF CALIFORNIA SAN DIEGO San Diego, CA
BS in Joint Major Mathematics & Economics (2014-2018)

- ***Coursework*:** Numerical methods, OOP in Java, Probability and statistics, Linear algebra, Calculus, Regression analysis in econometrics, Vector calculus

EXPERIENCE

CONSTELLATION CAPITAL MANAGEMENT LLC New York, NY
Analyst, Summer Intern (June 2019 – August 2019)

- Implemented annual default probability calculation algorithm for EM Govt bonds that with same seniority to assist trader in bond selection work
- Studied and built the Ukraine GDP warrants' valuation using Monte Carlo method with CEE peer group comparison and macro outlook
- Conducted equity research on NYSE: MDR, with a stock pitch presentation to PM
- Automated prices updating process for trading information system

CITIC SECURITIES Beijing, China
Alternative Investment Division Summer Intern (June 2017 – August 2017)

- Built regression models to analyze market sentiment in Short-Term uptrend and downtrend market
- Specified the best condition to use Short-Term Reversal factor for A-shares
- Applied Roll model and tick test algorithm in Java to test stocks spread

CHINA GALAXY SECURITIES Beijing, China
Investment Management Division Summer Intern (July 2016 – September 2016)

- Researched on Event-leading abnormal returns of stocks, and summarized 16 types of events
- Categorized types into 5 groups by evaluating abnormal returns of 20 trading days before and after each event using T-test in R
- Built Event-driven strategy with 19.4% average annual excess return and 2.36 average annual IR ratio during 2011 to 2016 (use CSI 500 SSE Stocks Index as benchmark)

PROJECTS

NEW YORK UNIVERSITY New York, NY
Short-term Course Projects

- **Rolling Futures Strategy in Excel:** Used CME WTI future data to replicate USO using a rolling strategy that rolls at the middle of the month; Compared the roll yield and WTI spot return
- **Option Pricing with Monte Carlo Simulation in Java:** Valued European and Asian options with decorator pattern and GPU computing technique
- **K-Means Clustering in Java:** Implemented Lloyd's algorithm in standard rule and fixed-size cluster rule and compared efficiencies graphically using Python matplotlib

UNIVERSITY OF CALIFORNIA SAN DIEGO San Diego, CA
Gambling Strategy research

- Analyzed "Beat the Dealer" and other counting strategies through collecting game data in Excel
- Developed new counting strategy with 0.993 betting correlation (BC), 0.567 playing efficiency (PE) and 0.745 insurance correlation (IC) based on logical reasoning

COMPUTER SKILLS/OTHER

***Computer*:** proficient in Python / Java / Excel / R / SQL
Interests: Snowboarding, Reading, Board Games, Cooking

XIAOCEN (SHELLY) SHANG

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EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance (expected – December 2019)

- ***Coursework:*** Fixed Income Pricing, Black-Scholes Model, Greeks, Modern Portfolio Theory, Monte Carlo Simulation, OOP in Java, Stochastic Calculus, VaR
- ***Future Coursework:*** Time Series Analysis, Interest Rate and FX Models, Black-Litterman, Data Science in Quantitative Finance, Algorithmic Trading

UNIVERSITY OF CALIFORNIA, SAN DIEGO La Jolla, CA
BS in Mathematics & BA in Economics (September 2014 – June 2018)

- ***Coursework:*** Differential Equations, Probability, Linear & Logistic Regression, Statistics, Numerical Analysis, Operations Research, Micro & Macroeconomics, Econometrics, Java
- ***Honors:*** Summa Cum Laude, Provost Honors (4 years)

EXPERIENCE

STEPSTONE GROUP La Jolla, CA
Data & Analytics Quantitative Intern (June 2019 – August 2019)

- Predicted buyouts' exit time by utilizing Cox's proportional hazard model with factors such as regions, industries, GP qualities, and fund sizes (Python)
- Filtered, processed and visualized funds' data for further survival analysis and presentation (Python)
- Investigated funds' investment memorandums and presented the findings

PICC (PEOPLE'S INSURANCE COMPANY OF CHINA GROUP) Beijing, China
Actuarial Summer Intern (July 2018 – August 2018)

- Developed Copula-based pricing strategy in R and applied model to calculate YP, RP, and RPHPE loss ratios and premiums of insurance under different deductibles
- Adjusted prices according to CPI and policy-based index to get real prices from nominal prices and met risk management requirements with the adjusted prices
- Constructed and modified database of formal and informal names of over 46000 locations using Excel and R, to help insurance company capture keywords and locate the places

MOTORSKILL VENTURE GROUP Sugar Land, TX
Summer Analyst Intern (August 2017 – September 2017)

- Applied economic model to forecast impacts of investment such as placement opportunities produced, expected investment returns, and risks
- Back-tested and optimized model in R, by data cleaning, data visualization & regression analysis

PROJECTS

NEW YORK UNIVERSITY New York, NY
Short-term Course Projects

- **K-Means Clustering in java**: Implemented Lloyd's K-Means algorithm to perform multi-dimensional data point clustering based on Euclidean distance
- **Option Pricing with Monte Carlo Simulation in Java**: Priced the vanilla European and Asian options using Monte Carlo Simulation given error tolerance and confidence level
- **VaR's estimation and backtest**: Utilized variance/covariance, Monte Carlo simulation, and historical simulation to calculate daily VaR and backtested VaR's performance with prior day's PnL
- **Data Interpolation**: Infilled missing data using Brownian Bridge, Bootstrapping, and Regression-based techniques given differencing intervals and firm's assumptions

UNIVERSITY OF CALIFORNIA, SAN DIEGO La Jolla, CA
Multifractal Detrended Fluctuation Analysis (MF-DFA) Case Study

- Applied MF-DFA model into CSI 300 stock index on its realized volatility
- Constructed a trading model in MATLAB using results of obtained Hurst index based on 2015 performances and tested the model on A-Shares

COMPUTER SKILLS/OTHER

Programming Skills: Java, Python, R, MATLAB, Stata, Excel

MEIXI (MAYSIE) SUN
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EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
M.S. in Mathematics in Finance (expected – January 2020)

- ***Coursework:*** Derivatives pricing and hedging, factor models, stochastic calculus, portfolio and risk management, interest rate and FX models, VaR, OOP in Java, optimization in Python
- ***Expected coursework:*** machine learning, time series analysis, and statistical arbitrage

UNIVERSITY OF MICHIGAN Ann Arbor, MI
B.S. in Applied Mathematics & B.S. in Statistics (with Distinction) (2016-2018)

- ***Coursework:*** Probability, C++ programming, linear algebra, linear ODEs, Black-Scholes model, Monte Carlo simulation, applied linear and logistic regressions, LDA, QDA and KNN classification methods, ridge and Lasso regressions, SVM

ILLINOIS INSTITUTE OF TECHNOLOGY Chicago, IL
Majored in Applied Mathematics (2014-2016, then transferred to University of Michigan)

EXPERIENCE & PROJECTS

UNITED NATIONS JOINT STAFF PENSION FUND New York, NY
Quantitative Investment Summer Analyst (Jun 2019 – Aug 2019)

- Evaluated performance of external managers using stochastic dominance, regime shift and time series analysis, and implemented Monte Carlo simulation on their monthly returns to forecast future performance
- Monitored multi-asset allocation (AUM $67 billions) through Northern Trust platform and constructed optimal portfolios by minimizing their expected shortfall
- Researched on risk metrics in Real Estate and Private Equity investments by mapping quarterly data extracted from Burgiss database to ETF indices by sectors

NEW YORK UNIVERSITY New York, NY
Short term projects (OOP in Java, Python Programming, Microstructure, Risk Management, FX)

- Simulated the execution management system (EMS) of an exchange with order book mechanics in Java
- Priced Asian and European options using Monte Carlo simulation, and utilized Java Message Service and ActiveMQ to pass messages between publishers and clients
- Merged and Converted high frequency trading files using developed framework, then read the trading file and quote file simultaneously to classify each trade as buyer or seller initiated using Tick test and Quote test
- Calibrated the SABR foreign exchange smile model in Python using Market Convention
- Conducted back testing for returns, calculated VaR and maximum drawdowns, and applied regression and Brownian Bridge on missing data in Excel

CHINA SECURITIES Beijing, CHN
Investment Banking Summer Analyst (Jun 2018 – Jul 2018)

- Performed market, management, and risk due diligence on the target IPO company and evaluated their performance by analyzing financial statements from WIND
- Researched on annul reports of listed companies in the same industry to analyze their profit models

UNIVERSITY OF MICHIGAN Ann Arbor, MI
Data Analysis and Machine Learning (C++, R and SQL)

- Applied basic machine learning techniques, as well as binary search trees and the map data structure in C++ to identify and classify subjects of posts on an online class forum
- Implemented LDA, QDA, KNN classifications and Classification trees in R to predict Napa Valley red wine qualities from chemical components using historical data
- Used SQL select statements to sort and group data in rational databases by nested criterions

COMPUTER SKILLS/OTHER

Programming Languages: Java, Python, C++, R, Matlab, SQL, Excel VBA
Languages: Chinese Mandarin (native), English (fluent)

YINONG TANG

(917) 815-3877 ■ yinong.tang@nyu.edu

EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance (expected – January 2020)

- ***Coursework:*** One-factor interest rate models, two-factor Hull-White, Black-Scholes, credit risk and credit derivatives, dynamic asset pricing models, LMM, numerical linear algebra, Monte Carlo

UNIVERSITY COLLEGE LONDON London, UK
BSc in Mathematics (2015 - 2018)

EXPERIENCE

Lingjun Investment LLP Beijing, China
Options Intern (Jun 2019 – Aug 2019)

- Expanded existing trading models based on ARIMA; improved the IR by 10%
- Developed trading strategies on China ETF markets based on HMM and its variants; learned parameters by EM, BW algorithms and compared the efficiency
- Implemented and backtested volatility analysis algorithms over China A share based on GARCH (for forecasting), SABR(ARIMA forcasting SABR factors calibrating)
- Extracted trading signals by constructing linear models for YINN/YANG, SSE 50/FTSE-A50

MORGAN STANLEY CAPITAL INTERNATIONAL Beijing, China
Risk Management Analytics Intern (Aug 2017 – Oct 2017)

- Computed value of bonds/options in python and priced with Monte Carlo simulation
- Generated data sample that follows T distribution using python and designed corresponding code
- Calculated Monte Carlo Simulation based VaR for portfolio using python

HENTAICHANGCAI SECURITIES CO. LTD Beijing, China
Financial Market Intern (Jul 2016 – Aug 2016)

- Analyzed and audited financial statements by collating and sorting out financial data
- Followed-up supervision of Fixed-income products and compiled trustee reports

PROJECTS

UNIVERSITY COLLEGE LONDON London, UK
Algebra/Number Theory/Combinatroics

- Implemented QS/CF/NFS algorithms in finding generators and discrete logarithms in cyclic group
- Analyzed and synthesized best algorithm for factoring product of two primes

Molecular BioSystems Research

- Predicted ACTH-Secreting Pituitary Adenoma potential miRNA-disease associations in Matlab
- Performed Drug–target interaction prediction by random walk on the heterogeneous network to predicting prioritization of candidate targets for given drug in Matlab

NEW YORK UNIVERSITY New York, NY
Computing in Finance(Java)

- Designed Monte Carlo based simulation code to price European/Asian options with junit for unit testing and used importance sampling to perform variance reduction during simulations
- Implemented and improved K-means algorithm to demonstrate multi-dimensional point/fixed size clustering with followed up unit testing

Risk & Portfolio Management

- Computed excess returns for different funds by using money market fund as the risk free rate and construct the risk capital allocation model

COMPUTER SKILLS/OTHER

Programming Languages: Java, Python
Other Software: Microsoft office, MATLAB, Wolfram alpha, LaTex
Languages: Chinese (native), English (fluent)

GENG (ALEX) YAN

(646) 243-0002 ■ geng.yan@nyu.edu

EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences GPA: 3.9/4.0
MS in Mathematics in Finance (September 2018 – January 2020)

- ***Coursework:*** Black-Scholes, Greeks, derivatives pricing, measure change, Monte Carlo, PCA, curve building, local volatility, Hull-White model, data analysis, statistical learning

NANJING UNIVERSITY Nanjing, Jiangsu
BS in Mathematics (2014-2018) GPA: 4.5/5.0

- ***Coursework:*** Analysis (complex, real and functional), algebra and representation theory, ODE, PDE, topology, differential geometry, statistics, numerical analysis, data structures and algorithms
- ***Awards:*** First Prize in Chinese Mathematical Olympiad in Senior

EXPERIENCE

BITMART New York, NY
Quant Intern (Sept. 2019 – Jan. 2020)

- Built a whole market-making system for crypto-currency exchanges in Python framework
- Developed a trading strategy that have 270% annual return and 3.04 Sharpe ratio in Bitcoin market by backtesting about 1.5 million ticks of historical k-line data

HIFI TECHNOLOGY New York, NY
Financial Engineer Intern (May 2019 – Aug. 2019)

- Applied modern time series models ARIMA and seasonal decompose to predict users' next year income, and the overall back-tested accuracy achieved 76%
- Trained RNN and LSTM for time series prediction, and the back-tested accuracy reached 79%
- Built an automatic system to select useful part of data, the best model and parameters

PROJECTS

NEW YORK UNIVERSITY New York, NY
Deep Learning Method for Solving Differential Equations (Python, Tensorflow & Keras)

- Used fully connected neural networks to train the gradient functions of each discretized timestamp, and solved the backward stochastic differential equations by following the scheme of Feyman-Kac
- Applied this framework to determine prices of 100 dimensional European options, greatly accelerated the computational speed compared to traditional finite difference method

Derivatives Pricing and Model Fitting (Java & Python)

- Built generic Monte Carlo pricing framework for European, Asian options and other exotics, and improved this framework by using Middleware, OpenCL and multi-threading
- Applied importance sampling and other techniques to significantly reduce the variance
- Priced barrier options using trinomial tree and finite-difference scheme relatively
- Calibrated SABR model with FX spot and interest rates curves using market convention

NANJING UNIVERSITY Nanjing, Jiangsu
Machinery Fault Detection for Imbalanced Datasets based on Deep Learning (Python)

- Initiated idea of using CNN to extract features and EasyEnsemble.M to train imbalanced datasets
- Trained data to classify them into three different classes and compared with several algorithms
- Designed experiment to show its superiority for imbalanced datasets, and the accuracy reached 99.85% and 97.14% in bi-classification and multi-classification

COMPUTER SKILLS/OTHER

Programming Skills: C++, Java, Python, Tensorflow, SQL, R
Programming Awards: National First Prize in National Olympiad in Informatics in Provinces (NOIP)

TIANYU (WILLIAM) ZHANG

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EDUCATION

NEW YORK UNIVERSITY New York, NY

The Courant Institute of Mathematical Sciences

M.S. in Mathematics in Finance (Aug. 2018 – Dec. 2019)

- ***Coursework:*** Java and Python for computational finance, portfolio management, derivative pricing and hedging, machine learning, interest rate model, big data (Hadoop)*, nonlinear options pricing*, NLP*
  (denotes current coursework)*

WUHAN UNIVERSITY Wuhan, China

B.S. in Mathematics & B.A. in Finance, Ranked 1st, First-class Honor (Sep. 2014 – Jun. 2018)

- ***Coursework:*** Stochastic calculus, regression analysis, econometrics, algorithms, data structure, database (SQL), optimization, statistical inference, time series, deep learning (PyTorch & TensorFlow)

EXPERIENCE

BNP PARIBAS ASSET MANAGEMENT New York, NY

Machine Learning and Quant Research Project Leader (Sep. 2019 – Present)

- **Hidden Markov Model**: Performed HMM to detect economic business cycle anomaly in equity, currency, inflation rate and economic growth
- **Asset Allocation**: Constructed macroeconomy trading signals by monthly index data and further developed a mix trading strategy with other signals

FACTSET RESEARCH INC. (DEPT OF PORTFOLIO MANGT & TRADING) New York, NY

Data Scientist Intern (Quant Research) (May. 2019 – Aug. 2019)

- **Overall performance**: Boosted the out-of-sample score from 0.08 to 0.26 in models that predict the illiquidity and urgency signals in a 5-minute execution model; rebuilt features and enhanced performance from 435/1257 to 25/1257 in mutual information ranking
- **Data cleansing**: Fetched 24GB large hedge funds' data and market data on a cloud server
- **Feature construction**: Changed features into dimensionless ratios to rule out the effect of various scale; implemented transformation functions on dimensionless ratios to improve the performance
- **Feature filtering**: Performed KBins-discretizer to draw partial dependency plot of on bins; implemented mutual information, Goodness-of-power Fit, coskew and cokurtosis to rank the non-linear dependency
- **Backtests and predictions**: Filtered out noisy features by multiple metrics and implemented Random Forest, XGBoost and Neural Network for prediction of illiquidity and urgency signals
- **Day-level mkt impact model**: Selected best impact model from guesses and do statistical test on assumptions
- **Bayesian method on news importance:** Performed Bayesian method to estimate the probability of jumps conditional on various news; ranked news by the conditional probability and replace the one-hot encoder

FULKRUM (A REAL ESTATE INVESTMENT COMPANY) New York, NY

Data Scientist Intern (Part-time) (Apr. 2019 – Aug. 2019)

- **Marco Data analysis**: Used MSA as cuts of regions and performed one-hot encoder on categorical variables; detect multicollinearity between the macroeconomy data
- **Rent prediction model**: Trained Ridge Regressions and Random Forest regressors to predict the rent price around the American; optimized the model by linear searching the hyper-parameters and cross-validation

GUANGYUNQIANFAN ASSET MANAGEMENT Shenzhen, China

Quantitative Analyst & Financial Data Scientist (Aug. 2017 – Jul. 2018)

- **Trading signal construction**: Trained Random Forest classifiers to classify wise trading intervals from the price-volume data of equities; constructed signals based on the positions and actions of sophisticated traders
- **Reinforcement learning trading**: Built a reinforcement learning trading framework and adopted signals as the state-vectors in Q-learning on portfolios (the total return reaches 14%, the max drawdown reaches 10%)
- **Emotion signals from alternative data**: Utilized news headlines and financial comments (10G) as an alternative data source to do natural language processing (LSTM) by transfer learning on existing models
- **Noise reduction of price data**: Adopted B-spline for reducing the noise of mid-price data
- **Data pre-processing**: Judged outliers with the local outlier factor; handled missing data with decision trees

KPMG ADVISORY Shenzhen, China

Summer Intern (Jul. 2016 – Aug. 2016)

- **Risk-warning system**: Updated the risk-warning system and constructed a KMV-based model to determine the threshold of EDF (14.9bp) and adopted logistic regression to predict default risks

Zimo Zhao
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EDUCATION

NEW YORK UNIVERSITY New York, NY
The Courant Institute of Mathematical Sciences
MS in Mathematics in Finance (expected – December 2019)

- ***Coursework***: Black-Scholes option pricing, interest rate models, VaR & stress testing, Monte Carlo simulation, data structure and object-oriented programming

IMPERIAL COLLEGE LONDON London, United Kingdom
BS & MSc in Mathematics and Statistics (Oct 2014 – Sep 2018)

- ***Coursework***: statistics, probability, stochastics, OLS, and neural networks

EXPERIENCE

Axioma Inc. New York, NY
Quantitative Pricing and Risk Management Analytics Intern (Jun 2019 – Aug 2019)

- Built modularized neural-networks based backward stochastic differential equation (BSDE) solver in TensorFlow, Python, for general European & American option pricing and benchmarked against Monte Carlo in accuracy, variance and speed
- Priced customized index options with differential interest rates using the BSDE solver and reduced estimation variance 10 times by asymptotic-expansion based precondition method
- Priced Bermudan swaptions under LIBOR market model with optional volatility parameterization (LFM, CEV, LCEV) using the BSDE solver and derived swaption deltas over time
- Estimated speed up after parallelization and implemented neural networks (FC & ResNet) for different BSDE computational structures

EATech Xi'An, China
Data Analyst (Jul 2017 – Aug 2017)

- Designed scoring model (elastic net) on ingredient, ratings and other features selected by performing principle component analysis (pca) on Gaussian mixture model separated clusters
- Optimized regression outputs under constraints to meet custom nutrition requests and discussed practical executability on model suggested recipes
- Cleaned data and designed semantic structure for data storage in MongoDB database (NoSQL)

PROJECTS

NEW YORK UNIVERSITY New York, NY
Advanced Risk Management

- Simulated historical and Monte Carlo 1-day-VaR on multi-asset trading books over 5 years and back tested VaR at 95% / 99% levels
- Applied bootstrap, Brownian bridge, and EM algorithm to fill missing swap data over weekends and to join discrete treasure bill records for PnL and VaR calculation
- Validated LIBOR market model, produced report following SR 11-7 and SR 15-18, implemented the model in Python and checked model implied European caplet prices with Bloomberg

Computational Finance

- Designed mini-exchange that focused on fast order book sweeping and client operations and implemented efficient binary data merger for tick-level stock records
- Built Monte Carlo engines following decorator and observer (ActiveMQ) patterns for estimating European and arithmetic Asian option prices

COMPUTER SKILLS/OTHER

Programming Languages: Python, Java, C and CUDA
Languages: English (Fluent), Chinese (Native)

The Mathematics in Finance Masters Program
Courant Institute, New York University
Academic Year 2018-2019

The curriculum has four main components:

1. **Financial Theory and Econometrics**. These courses form the theoretical core of the program, covering topics ranging from equilibrium theory to Black-Scholes to Heath-Jarrow-Morton.

2. **Practical Financial Applications**. These classes are taught by industry specialists from prominent New York financial firms. They emphasize the practical aspects of financial mathematics, drawing on the instructor's experience and expertise.

3. **Mathematical Tools**. This component provides appropriate mathematical background in areas like stochastic calculus and partial differential equations.

4. **Computational Skills**. These classes provide students with a broad range of software skills, and facility with computational methods such as optimization, Monte Carlo simulation, and the numerical solution of partial differential equations.

		First Semester	Second Semester	Third Semester
Practical Financial Applications			Advanced Risk Management ___ Interest Rate and FX Models ___ Securitized Products & Structured Finance (1/2 Credit) ___ Energy Market & Derivatives (1/2 Credit) ___ Advanced Topics in Equity Derivatives (1/2 Credit) ___ Market Microstructure (1/2 Credit)	Fin. Eng. Models for Corp. Finance ___ Credit Analytics: Bonds, Loans & Derivatives (1/2 Credit) ___ Counter Party Credit: Valuation Adjustments, Capital, and Funding ___ Fixed Income Derivatives: Models & Strategies in Practice (1/2 Credit)

Financial Theory and Econometrics		Derivative Securities ___ Risk & Portfolio Mgmt. with Econometrics	Active Portfolio Management ___ Algorithmic Trading & Quant. Strategies ___ Continuous Time Finance	Project and Presentation ___ Time Series Analysis & Stat. Arbitrage ___ Adv. Econometrics Models & Big Data
Mathematical Tools		Stochastic Calculus		
Computational Skills		Computing in Finance	Scientific Computing in Finance	Computational Methods for Finance Data Science in Quantitative Finance

Practical Training. In addition to coursework, the program emphasizes practical experience. All students do Masters Projects, mentored by finance professionals. Most full-time students do internships during the summer between their second and third semesters.

See the program web page http://math.nyu.edu/financial_mathematics for additional information.

MATHEMATICS IN FINANCE MS COURSES, 2014-2015

PRACTICAL FINANCIAL APPLICATIONS:

MATH-GA 2752.001 ACTIVE PORTFOLIO MANAGEMENT

Spring term: J. Benveniste

Prerequisites: Risk & Portfolio Management with Econometrics, Computing in Finance.

The first part of the course will cover the theoretical aspects of portfolio construction and optimization. The focus will be on advanced techniques in portfolio construction, addressing the extensions to traditional mean-variance optimization including robust optimization, dynamical programming and Bayesian choice. The second part of the course will focus on the econometric issues associated with portfolio optimization. Issues such as estimation of returns, covariance structure, predictability, and the necessary econometric techniques to succeed in portfolio management will be covered. Readings will be drawn from the literature and extensive class notes.

MATH-GA 2753.001 ADVANCED RISK MANAGEMENT

Spring term: K. Abbott

Prerequisites: Derivative Securities, Computing in Finance or equivalent programming.

The importance of financial risk management has been increasingly recognized over the last several years. This course gives a broad overview of the field, from the perspective of both a risk management department and of a trading desk manager, with an emphasis on the role of financial mathematics and

modeling in quantifying risk. The course will discuss how key players such as regulators, risk managers, and senior managers interact with trading. Specific techniques for measuring and managing the risk of trading and investment positions will be discussed for positions in equities, credit, interest rates, foreign exchange, commodities, vanilla options, and exotic options. Students will be trained in developing risk sensitivity reports and using them to explain income, design static and dynamic hedges, and measure value-at-risk and stress tests. Students will create Monte Carlo simulations to determine hedge effectiveness. Extensive use will be made of examples drawn from real trading experience, with a particular emphasis on lessons to be learned from trading disasters.

MATH-GA 2798.001 INTEREST RATE AND FX MODELS
Spring term: F. Mercurio & T. Fisher
Prerequisites: Derivative Securities, Stochastic Calculus, and Computing in Finance (or equivalent familiarity with financial models, stochastic methods, and computing skills).
The course is divided into two parts. The first addresses the fixed-income models most frequently used in the finance industry, and their applications to the pricing and hedging of interest-based derivatives. The second part covers the foreign exchange derivatives markets, with a focus on vanilla options and first-generation (flow) exotics. Throughout both parts, the emphasis is on practical aspects of modeling, and the significance of the models for the valuation and risk management of widely-used derivative instruments.

MATH-GA.2799-001 SECURITIZED PRODUCTS & STRUCTURED FINANCE
Spring term: R. Sunada-Wong
Prerequisites: Basic bond mathematics and bond risk measures (duration and convexity); Derivative Securities and Stochastic Calculus.

This half-semester course will cover the fundamentals of Securitized Products, emphasizing Residential Mortgages and Mortgage-Backed Securities (MBS). We will build pricing models that generate cash flows taking into account interest rates and prepayments. The course will also review subprime mortgages, CDO's, Commercial Mortgage Backed Securities (CMBS), Auto Asset Backed Securities (ABS), Credit Card ABS, CLO's, Peer-to-peer / MarketPlace Lending, and will discuss drivers of the financial crisis and model risk.

MATH-GA.2800-001 ENERGY MARKETS AND DERIVATIVES
Spring term: D. Eliezer
Prerequisites: Derivative Securities and Stochastic Calculus.

This half-semester course focuses on energy commodities and derivatives, from their basic fundamentals and valuation, to practical issues in managing structured energy portfolios. We develop a risk neutral valuation framework starting from basic GBM and extend this to more sophisticated multi-factor models. These approaches are then used for the valuation of common, yet challenging, structures. Particular emphasis is placed on the potential pitfalls of modeling methods and the practical aspects of implementation in production trading platforms. We survey market mechanics and valuation of inventory options and delivery risk in the emissions markets.

MATH-GA.2801-001 ADVANCED TOPICS IN EQUITY DERIVATIVES
Spring term: S. Bossu
Prerequisites: Derivative Securities, Stochastic Calculus, and Computing in Finance or equivalent programming experience.

This half-semester course will give a practitioner's perspective on a variety of advanced topics with a particular focus on equity derivatives instruments, including volatility and correlation modeling and

trading, and exotic options and structured products. Some meta-mathematical topics such as the practical and regulatory aspects of setting up a hedge fund will also be covered.

MATH-GA.2802-001 MARKET MICROSTRUCTURE

Spring term: G. Ritter

Prerequisites: Derivative Securities, Risk & Portfolio Management with Econometrics, and Computing in Finance or equivalent programming experience.

This is a half-semester course covering topics of interest to both buy-side traders and sell-side execution quants. The course will provide a detailed look at how the trading process actually occurs and how to optimally interact with a continuous limit-order book market.

We begin with a review of early models, which assume competitive suppliers of liquidity whose revenues, corresponding to the spread, reflect the costs they incur. We discuss the structure of modern electronic limit order book markets and exchanges, including queue priority mechanisms, order types and hidden liquidity. We examine technological solutions that facilitate trading such as matching engines, ECNs, dark pools, multiple venue problems and smart order routers.

The second part of the course is dedicated pre-trade market impact estimation, post-trade slippage analysis, optimal execution strategies and dynamic no-arbitrage models. We cover Almgren-Chriss model for optimal execution, Gatheral's no-dynamic-arbitrage principle and the fundamental relationship between the average response of the market price to traded quantity, and properties of the decay of market impact.

Homework assignments will supplement the topics discussed in lecture. Some coding in Java will be required and students will learn to write their own simple limit-order-book simulator and analyze real NYSE TAQ data.

MATH-GA.2803-001 FIXED INCOME DERIVATIVES: MODELS & STRATEGIES IN PRACTICE

Fall term: L. Tatevossian and A. Sadr

Prerequisites: Computing in Finance (or equivalent programming skills) and Derivative Securities (familiarity with Black-Scholes interest rate models)

This half-semester class focuses on the practical workings of the fixed-income and rates-derivatives markets. The course content is motivated by a representative set of real-world trading, investment, and hedging objectives. Each situation will be examined from the ground level and its risk and reward attributes will be identified. This will enable the students to understand the link from the underlying market views to the applicable product set and the tools for managing the position once it is implemented. Common threads among products – structural or model-based – will be emphasized. We plan on covering bonds, swaps, flow options, semi-exotics, and some structured products.

A problem-oriented holistic view of the rate-derivatives market is a natural way to understand the line from product creation to modeling, marketing, trading, and hedging. The instructors hope to convey their intuition about both the power and limitations of models and show how sell-side practitioners manage these constraints in the context of changes in market backdrop, customer demands, and trading parameters.

MATH-GA.2804-001 CREDIT ANALYTICS: BONDS, LOANS AND DERIVATIVES

Fall term: B. Fleasker

Prerequisites: Derivate Securities and Computing in Finance (or equivalent familiarity with financial models and computing skills)

This half-semester course introduces the institutional market for bonds and loans subject to default risk and develops concepts and quantitative frameworks useful for modeling the valuation and risk

management of such fixed income instruments and their associated derivatives. Emphasis will be put on theoretical arbitrage restrictions on the relative value between related instruments and practical applications in hedging, especially with credit derivatives. Some attention will be paid to market convention and related terminology, both to ensure proper interpretation of market data and to prepare students for careers in the field.

We will draw on the fundamental theory of derivatives valuation in complete markets and the probabilistic representation of the associated valuation operator. As required, this will be extended to incomplete markets in the context of doubly stochastic jump-diffusion processes. Specific models will be introduced, both as examples of the underlying theory and as tools that can be (and are) used to make trading and portfolio management decisions in real world markets.

MATH-GA.2805-001 COUNTER PARTY CREDIT: VALUATION ADJUSTMENTS, CAPITAL, AND FUNDING

Fall term: L. Andersen

Prerequisites: Advanced Risk Management, Derivative Securities (or equivalent familiarity with market and credit risk models), and Computing in Finance (or equivalent programming experience)

This class explores technical and regulatory aspects of counterparty credit risk, with an emphasis on model building and computational methods. The first part of the class will provide technical foundation, including the mathematical tools needed to define and compute valuation adjustments such as CVA and DVA. The second part of the class will move from pricing to regulation, with an emphasis on the computational aspects of regulatory credit risk capital under Basel 3. A variety of highly topical subjects will be discussed during the course, including: funding costs, XVA metrics, initial margin, credit risk mitigation, central clearing, and balance sheet management. Students will get to build a realistic computer system for counterparty risk management of collateralized fixed income portfolios, and will be exposed to modern frameworks for interest rate simulation and capital management.

FINANCIAL THEORY AND ECONOMETRICS:

MATH-GA 2707.001 TIME SERIES ANALYSIS AND STATISTICAL ARBITRAGE

Fall term: F. Asl and R. Reider

Prerequisites: Derivative Securities, Scientific Computing, and familiarity with basic probability.

The term "statistical arbitrage" covers any trading strategy that uses statistical tools and time series analysis to identify approximate arbitrage opportunities while evaluating the risks inherent in the trades (considering the transaction costs and other practical aspects). This course starts with a review of Time Series models and addresses econometric aspects of financial markets such as volatility and correlation models. We will review several stochastic volatility models and their estimation and calibration techniques as well as their applications in volatility based trading strategies. We will then focus on statistical arbitrage trading strategies based on cointegration, and review pairs trading strategies. We will present several key concepts of market microstructure, including models of market impact, which will be discussed in the context of developing strategies for optimal execution. We will also present practical constraints in trading strategies and further practical issues in simulation techniques. Finally, we will review several algorithmic trading strategies frequently used by practitioners.

MATH-GA 2708.001 ALGORITHMIC TRADING AND QUANTITATIVE STRATEGIES

Spring term: P. Kolm and L. Maclin

Prerequisites: Computing in Finance, and Capital Markets and Portfolio Theory, or equivalent. In this course we develop a quantitative investment and trading framework. In the first part of the course, we study the mechanics of trading in the financial markets, some typical trading strategies, and how to work with and model high frequency data. Then we turn to transaction costs and market impact

models, portfolio construction and robust optimization, and optimal betting and execution strategies. In the last part of the course, we focus on simulation techniques, back-testing strategies, and performance measurement. We use advanced econometric tools and model risk mitigation techniques throughout the course. Handouts and/or references will be provided on each topic.

MATH-GA 2751.001 RISK AND PORTFOLIO MANAGEMENT WITH ECONOMETRICS
Fall term: P. Kolm. Spring term: M. Avellaneda
Prerequisites: univariate statistics, multivariate calculus, linear algebra, and basic computing (e.g. familiarity with Matlab or co-registration in Computing in Finance).
A comprehensive introduction to the theory and practice of portfolio management, the central component of which is risk management. Econometric techniques are surveyed and applied to these disciplines. Topics covered include: factor and principal-component models, CAPM, dynamic asset pricing models, Black-Litterman, forecasting techniques and pitfalls, volatility modeling, regime-switching models, and many facets of risk management, both theory and practice.

MATH-GA 2755.001 PROJECT AND PRESENTATION
Fall term and spring term: P. Kolm
Students in the Mathematics in Finance program conduct research projects individually or in small groups under the supervision of finance professionals. The course culminates in oral and written presentations of the research results.

MATH-GA 2791.001 DERIVATIVE SECURITIES
Fall term: M. Avellanda. Spring term: B. Flesaker
An introduction to arbitrage-based pricing of derivative securities. Topics include: arbitrage; risk-neutral valuation; the log-normal hypothesis; binomial trees; the Black-Scholes formula and applications; the Black-Scholes partial differential equation; American options; one-factor interest rate models; swaps, caps, floors, swaptions, and other interest-based derivatives; credit risk and credit derivatives.

MATH-GA 2792.001 CONTINUOUS TIME FINANCE
Fall term: A. Javaheri & S. Ghamami. Spring term: B. Dupire and F. Mercurio
Prerequisites: Derivative Securities and Stochastic Calculus, or equivalent.
A second course in arbitrage-based pricing of derivative securities. The Black-Scholes model and its generalizations: equivalent martingale measures; the martingale representation theorem; the market price of risk; applications including change of numeraire and the analysis of quantos. Interest rate models: the Heath-Jarrow-Morton approach and its relation to shortrate models; applications including mortgage-backed securities. The volatility smile/skew and approaches to accounting for it: underlyings with jumps, local volatility models, and stochastic volatility models.

MATHEMATICAL TOOLS:
MATH-GA 2706.001 PARTIAL DIFFERENTIAL EQUATIONS FOR FINANCE
Spring term: R. Kohn
Prerequisite: Stochastic Calculus or equivalent.
An introduction to those aspects of partial differential equations and optimal control most relevant to finance. Linear parabolic PDE and their relations with stochastic differential equations: the forward and backward Kolmogorov equation, exit times, fundamental solutions, boundary value problems, maximum principle. Deterministic and stochastic optimal control: dynamic programming, Hamilton-Jacobi-Bellman equation, verification arguments, optimal stopping. Applications to finance, including portfolio optimization and option pricing -- are distributed throughout the course.

MATH-GA 2902.001 STOCHASTIC CALCULUS
Fall term: P. Bourgade. Spring term: A. Kuptsov
Prerequisite: Basic Probability or equivalent.
Discrete dynamical models: Markov chains, one-dimensional and multidimensional trees, forward and backward difference equations, transition probabilities and conditional expectations. Continuous processes in continuous time: Brownian motion, Ito integral and Ito's lemma, forward and backward partial differential equations for transition probabilities and conditional expectations, meaning and solution of Ito differential equations. Changes of measure on paths: Feynman-Kac formula, Cameron-Martin formula and Girsanov's theorem. The relation between continuous and discrete models: convergence theorems and discrete approximations.

COMPUTATIONAL SKILLS:

MATH-GA 2041.001 COMPUTING IN FINANCE
Fall term: E. Fishler and L. Maclin
This course will introduce students to the software development process, including applications in financial asset trading, research, hedging, portfolio management, and risk management. Students will use the Java programming language to develop object-oriented software, and will focus on the most broadly important elements of programming - superior design, effective problem solving, and the proper use of data structures and algorithms. Students will work with market and historical data to run simulations and test strategies. The course is designed to give students a feel for the practical considerations of software development and deployment. Several key technologies and recent innovations in financial computing will be presented and discussed.

MATH-GA 2043.001 COMPUTATIONAL METHODS FOR FINANCE
Fall term: J. Guyon & B. Liang
Prerequisites: Scientific Computing or Numerical Methods II, Continuous Time Finance, or permission of instructor.
Computational techniques for solving mathematical problems arising in finance. Dynamic programming for decision problems involving Markov chains and stochastic games. Numerical solution of parabolic partial differential equations for option valuation and their relation to tree methods. Stochastic simulation, Monte Carlo, and path generation for stochastic differential equations, including variance reduction techniques, low discrepancy sequences, and sensitivity analysis.

MATH-GA 2046.001 ADVANCED ECONOMETRICS AND BIG DATA
Fall term: G. Ritter
Prerequisites: Derivative Securities, Risk & Portfolio Management with Econometrics, and Computing in Finance (or equivalent programming experience).
A rigorous background in Bayesian statistics geared towards applications in finance, including decision theory and the Bayesian approach to modeling, inference, point estimation, and forecasting, sufficient statistics, exponential families and conjugate priors, and the posterior predictive density. A detailed treatment of multivariate regression including Bayesian regression, variable selection techniques, multilevel/hierarchical regression models, and generalized linear models (GLMs). Inference for classical time-series models, state estimation and parameter learning in Hidden Markov Models (HMMs) including the Kalman filter, the Baum-Welch algorithm and more generally, Bayesian networks and belief propagation. Solution techniques including Markov Chain Monte Carlo methods, Gibbs Sampling, the EM algorithm, and variational mean field. Real world examples drawn from finance to include stochastic volatility models, portfolio optimization with transaction costs, risk models, and multivariate forecasting.

MATH-GA.2047-001 DATA SCIENCE IN QUANTITATIVE FINANCE

Fall term: P. Kolm and I. Dimov

Prerequisites: Risk & Portfolio Management with Econometrics, Scientific Computing in Finance (or Scientific Computing) and Computing in Finance (or equivalent programming experience.

This is a full semester course focusing on practical aspects of alternative data, machine learning and data science in quantitative finance. Homework and hands-on projects form an integral part of the course, where students get to explore real-world datasets and software.

The course begins with an overview of the field, its technological and mathematical foundations, paying special attention to differences between data science in finance and other industries. We review the software that will be used throughout the course.

We examine the basic problems of supervised and unsupervised machine learning, and learn the link between regression and conditioning. Then we deepen our understanding of the main challenge in data science – the curse of dimensionality – as well as the basic trade-off of variance (model parsimony) vs. bias (model flexibility).

Demonstrations are given for real world data sets and basic data acquisition techniques such as web scraping and the merging of data sets. As homework each student is assigned to take part in downloading, cleaning, and testing data in a common repository, to be used at later stages in the class.

We examine linear and quadratic methods in regression, classification and unsupervised learning. We build a BARRA-style implicit risk-factor model and examine predictive models for county-level real estate, economic and demographic data, and macro economic data. We then take a dive into PCA, ICA and clustering methods to develop global macro indicators and estimate stable correlation matrices for equities.

In many real-life problems, one needs to do SVD on a matrix with missing values. Common applications include noisy image-recognition and recommendation systems. We discuss the Expectation Maximization algorithm, the L1-regularized Compressed Sensing algorithm, and a naïve gradient search algorithm.

The rest of the course focuses on non-linear or high-dimensional supervised learning problems. First, kernel smoothing and kernel regression methods are introduced as a way to tackle non-linear problems in low dimensions in a nearly model-free way. Then we proceed to generalize the kernel regression method in the Bayesian Regression framework of Gaussian Fields, and for classification as we introduce Support Vector Machines, Random Forest regression, Neural Nets and Universal Function Approximators.

MATH-GA 2048.001 SCIENTIFIC COMPUTING IN FINANCE

Spring term: Y. Li and

Prerequisites: multivariable calculus, linear algebra; programming experience strongly recommended but not required.

A practical introduction to scientific computing covering theory and basic algorithms together with use of visualization tools and principles behind reliable, efficient, and accurate software. Students will program in C/C++ and use Matlab for visualizing and quick prototyping. Specific topics include IEEE arithmetic, conditioning and error analysis, classical numerical analysis (finite difference and integration formulas, etc.), numerical linear algebra, optimization and nonlinear equations, ordinary differential equations, and (very) basic Monte Carlo.