BALINT GERSEY

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EDUCATION

PhD in Financial Mathematics – ETH Zürich 09/2018-present
Zürich, Switzerland

I am doing my PhD under the supervion of Professor Patrick Cheridito at ETH Zürich. My main interests include quantitative finance, algorithmic trading, machine learning, data mining, big data, time series analysis and applied statistics.

Master of Advanced Study (Part III of the Mathematical Tripos) – University of Cambridge 10/2017-07/2018
Cambridge, United Kingdom - Grade: First class

Graduated with a first-class honour. Specialising in mathematical statistics and financial mathematics.

- Examined papers:
  - ❖ Statistical Learning in Practice (Tengyao Wang)
  - ❖ Modern Statistical Methods (Rajen Shah)
  - ❖ Advanced Probability (M Lis)
  - ❖ Advanced Financial Models (M.R. Tehranchi)
  - ❖ Astrostatistics (K. Mandel)

- Other courses:
  - ❖ Topics in Statistical Theory (Thomas B. Berrett)
  - ❖ Bayesian Modelling and Computation (Sergio Bacallado)
  - ❖ Stochastic Calculus and Applications (R. Bauerschmidt)

- Essay/thesis: Generative Adversarial Networks and its application for financial time series generation

Master 1 in Mathematics – University Pierre and Marie Curie (Paris VI) 09/2016-07/2017
Paris, France - Grade: 71%

- I was one of the ten laureates worldwide who was honored to receive a *Paris Graduate School of Mathematics* scholarship from the "Fondation Science Mathématique de Paris" in 2016
- Advanced Probability, Stochastic Calculus, Bayesian Statistics, Statistics Research Project with R, Functional Analysis, C++, ….

Bachelor of Science in Mathematics – Université Libre de Bruxelles (ULB) 09/2013-07/2016
Brussels, Belgium - Grade: 86% (*Magna cum laude* - Top 1%)

Graduated with the best results of my promotion

- Major: Pure and Applied Mathematics (Real and Complex Analysis, Linear and Abstract Algebra, Differential Geometry, Topology, Probability Theory, Statistics, Optimization, Numerical Computation, Discrete Mathematics, Fourier Analysis, Computer Science...)
- Minor: Physics and Computer Science (Ordinary and Partial Differential Equations, Lagrangian and Hamiltonian Mechanics, Special Relativity, Electromagnetism, Optics, MATLAB, Numerical Methods).
- *Best performance*: Highest grade achieved among all students

European Baccalaureate - European School of Brussels 1 09/2008-07/2013
Brussels, Belgium - Grade: 86%

RESEARCH EXPERIENCE

Generative Adversarial Networks – University of Cambridge 12/2017-05/2018
Supervisor: Prof. S. Bacallado

- My master thesis focuses on one of the dominant approaches to generative modelling, generative adversarial networks (GANs). After a brief description of fundamental notions of deep learning such as feed-forward, convolutional and recurrent neural networks, I review stochastic gradient descent and prove the convergence of it under the so called slowly decaying learning rates condition. In the main chapter about GANs, I review and discuss recent theoretical development and I present some pathological behaviours that occur when training a GAN in practice such as the problems of mode collapse and vanishing gradient. Finally, I briefly review various solutions to avoid these problems, including a shallow discussion of the Wasserstein GAN. I also implemented several GANs. I first train a GAN on sinusoidal curves. Then I train another GAN on the MNIST dataset. I also implement a DCGAN and train it on the CIFAR-10 dataset. For illustration purposes, I used different deep learning frameworks (Keras, TensorFlow and Pytorch) for each of them.
  Finally, in the last chapter, I propose a new way to generate artificial financial time series using Recurrent Generative Adversarial Networks. The idea is to replace usual Monte Carlo simulations (which have probabilistic assumptions which are not always met in reality) with simulations with a generator trained with a GAN on a financial dataset. The RGAN model and implementation is based on the method of Hyland et al. for generative modelling of time series. The RGAN using the Jenson-Shannon divergence seems to suffer from the problem of mode collapse. To overcome this issue, I implemented a version of the RGAN using the Wasserstein distance in the objective function. To ensure the Lipchitz constraints coming from the Kantorovich-Rubinstein dual formulation of the Wasserstein distance, I used the so-called gradient penalty method which penalizes the network for violations of the Lipchitz constraint (WRGAN-GP). The WRGAN-GP was trained on simulated dataset. The simulations were done a) via Monte Carlo methods and b) via stationary bootstrap method. The second approach is to be preferred as it puts less assumptions on the model. The optimal goal would be to train the WRGAN-GP on real dataset.
  The GAN internally encodes representations useful to simulate financial time series. By using an invertible version of the GAN network (such as BiGAN or ALI), one could study the representation the network creates. In particular, if one trained an invertible version of the WRGAN-GP network with inputs containing not only past prices but also several financial indicators used by traders in practice, then we could study the causal effects of these indicators on the price movements.

  My master thesis is available at
  https://www.researchgate.net/publication/326676131_Generative_Adversarial_Networks

Statistics Research Project – University Pierre and Marie Curie 01/2017-06/2017
Supervisor: Prof. Maud Thomas

- I worked on the ALARM research project. A key innovation challenge of the ALARM project was the application of existing mathematical methods both in statistics and numerical simulation to the analysis of natural risks. The research included data analysis with R.

  The results of the project are available (in French) at
  https://www.researchgate.net/publication/326957102_Analyse_de_donnees_de_glissements_de_terrain_sous-marins

Statistics Research Project (Bachelor Thesis) 01/2016-07/2016
Supervisor: Prof. Davy Paindaveine

- Prof. Paindaveine gave me two research papers to work on and I had to make a presentation about it. The two articles were
  - On the polygon generated by n random points on a circle by *Claude BELISLE*
  - Random circumscribing polygons and approximations of π by *Wen-Qing Xu*

Research Project on Information Theory 01/2015-07/2015
Supervisor: Prof. Christophe Ley

- I wrote a 50 pages introduction to Information Theory. My work was mainly based on Mathematical Foundations of Information Theory by *A. Ja. KHINCHIN*, but I also studied the following three research papers;
    - Entropy and the Law of Small Numbers by *Ioannis Kontoyiannis, Member, IEEE, Peter Harremoës, Member, IEEE, and Oliver Johnson*
    - Local Pinsker inequalities via Stein's discrete density approach by *Christophe Ley and Yvik Swan*
    - Thinning and the Law of Small Numbers by *Ioannis Kontoyiannis, Member, IEEE, Peter Harremoës, Member, IEEE, and Oliver Johnson*

TEACHING EXPERIENCE

Teaching Assistant – ETH Zürich 09/2018-present
Zürich, Switzerland

- In the autumn semester 2018, I am teaching assistant for the Mathematical Foundations for Finance course.
  This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance.
  Topics to be covered include:
    - *financial market models in finite discrete time*
    - *absence of arbitrage and martingale measures*
    - *valuation and hedging in complete markets*
    - *basics about Brownian motion*
    - *stochastic integration*
    - *stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem*
    - *Black-Scholes formula*

Teaching Assistant – Université Libre de Bruxelles (ULB)- 12 months 09/2015-08/2016
Brussels, Belgium

- Managed an international group of 15 students delivering weekly tutorials in Mathematics

SCHOLARSHIPS

Oxford University
- PhD (DPhil) scholarship from the Mathematical and Computational Finance Group at Oxford University. The scholarship was complemented by an additional support from InstaDeep a London based company offering a host of AI solutions, ranging from optimized pattern-recognition, GPU-accelerated insights, to self-learning decision making systems.

Fitzwilliam College, University of Cambridge
- I was elected a Senior Scholar of Fitzwilliam College, University of Cambridge, for achieving a first-class degree in Mathematics.

EPFL Excellence Fellowship
- I was accepted at EPFL's master's in financial engineering with an Excellence Fellowship. Unfortunately, to secure my place at the University of Cambridge, I had to refuse this scholarship

Fondation Sciences Mathématiques de Paris
- I am one of the ten laureates worldwide who was honoured to receive a Paris Graduate School of Mathematics (PGSM) scholarship. This award supported my Master 1 studies at the Pierre and Marie Curie (Sorbonne) University

Fondation Mathématique Jacques Hadamard
- I was selected by the" Fondation Mathématiques Jacques Hadamard", which is a network of excellence including Ecole Polytechnique and Université Paris Sud, for a scholarship

AWARDS

Solving problems allowed me to approach the activity of the researcher and to perceive mathematics as a living science. Additionally, because their resolution often requires more than routine, problems develop the ability to control new situations

Thatcher Prize from Fitzwilliam College, University of Cambridge June 2018

Problemath - Université Libre de Bruxelles 2013-2016

Kömal Hungarian Mathematics and Physics Competition 2011-2012

International Hungarian Mathematics Competition 2011

European School's Science Symposium

- Senior Poster and Presentation Grand Prize Winner 2011
- Senior Poster and Presentation Grand Prize Runner Up 2010

CONFERRENCES AND SEMINARS
ADDENTED

Topics in Mathematical Finance and Machine Learning Autumn 2018
The goal of the seminar organised by Professor Josef Teichmann is to understand applications of reservoir computing in mathematical finance
ETH Zürich

Talks in Financial and Insurance Mathematics Autumn 2018
ETH Zürich

Swissquote Conference on Machine Learning in Finance November 2018
Centre for Mathematical Science, Cambridge

Generative Adversarial Networks September 2018
Talk by Sebastian Nowozin (Microsoft Research Cambridge) at ETH Zürch

Artificial Intelligence in Industry and Finance September 2018
ZHAW, Winterhur

ETH Risk Day September 2018
ETH Zürich

Quantitative Research and Machine Learning at J.P. Morgan November 2017
Centre for Mathematical Science, Cambridge

Stochastic Control in FX e-Trading October 2017
Centre for Mathematical Science, Cambridge

The QuantFinance Conference October 2017
Bank of America Merrill Lynch, London

Machine Learning for Algorithmic Trading August 2017
MathWorks Webinar

A path through probability in honour of F.Thomas BRUSS September 2015
Université Libre de Bruxelles

Brussels Summer School of Mathematics August 2014
Université Libre de Bruxelles

ONLINE COURSES

Python for Financial Analysis and Algorithmic Trading (Udemy) 2017-2018

Machine Learning (Stanford University) 2017-2018

A complete guide to TensorFlow (Udemy) 2017-2018

SKILLS

Languages

- Native: **Hungarian** & **French** Fluent: **English** Basic: **Dutch** & **German**

Communication skills

- Outstanding verbal and written communication gained through my studies as well as my involvement in the Student Clubs
- Excellent explanatory skills regarding Mathematics which was gained during my assistantship at the Université Libre de Bruxelles (ULB)

Math-related skills

- Stochastic differential equations. Strong and weak solutions, notions of existence and uniqueness, Yamada-Watanabe theorem, strong Markov property, and relation to second order partial differential equations.
- Brownian motion and stochastic calculus. Stochastic integration. Girsanov's theorem. Ito's formula. Martingale representation theorem.
- Discrete time financial models. Filtrations and martingales. Arbitrage, martingale deflators and equivalent martingale measures. Attainable claims and market completeness. European and American claims. Optimal stopping.
- Continuous time financial models. Admissible strategies. Black–Scholes model. The implied volatility surface. Pricing and hedging via partial differential equations. Dupire's formula. Stochastic volatility models.
- Interest rate models. Short rates, forward rates and bond prices. Markovian short rate models.
- Parametric Statistics, Bayesian Statistics, Linear Models, Multivariate Statistics, Applied Statistics with R
- Generalised linear models for regression and classification
- Model selection and regularisation
- Mixed effects models and quasi-likelihood methods
- Linear discriminant analysis and support vector machines
- Neural networks
- Time series and spatial statistics
- Nonparametric Statistics: the basics of empirical process theory, Glivenko– Cantelli theorem, Dvoretzky–Kiefer–Wolfowitz theorem, order statistics, quantile estimation and associated asymptotic distribution theory.
- Kernel density estimation: histograms, bias and variance expansions, aymptotically optimal bandwidth, canonical kernels, higher order kernels, bandwidth selection, multivariate density estimation.
- Nonparametric regression: kernel nonparametric regression, bias and variance expansions. Cubic splines, natural cubic smoothing splines, choice of smoothing parameter, other splines, equivalent kernel. Classification problems, the Bayes classifier, nearest neighbour classifiers.
- Minimax theory: notion of information-theoretic lower bounds, distance and divergence between distributions, optimal rates, Le Cam's two points lemma.
- Extreme value theory: the extremal types theorem, domains of attraction, max-stability
- Kernel machines: the kernel trick, the representer theorem, support vector machines, the hashing trick.
- Penalised regression: Ridge regression, the Lasso and variants.
- Graphical modelling: neighbourhood selection and the graphical Lasso. Causal inference through structural equation modelling; the PC algorithm.
- High-dimensional inference: the closed testing procedure and the Benjamini–Hochberg procedure; the debiased Lasso

IT skills

- Good knowledge of Scikit-learn and TENSORFLOW
- Programming skills in C++, Python and R
- Minor experience with MATLAB and FORTRAN
- Very good command of Microsoft Office (Word, Excel and PowerPoint) and LATEX

REFERENCES

- Professor Rayen SHAH – R.Shah@statslab.cam.ac.uk
  Professor of Mathematical Statistics at the University of Cambridge

- Professor Rachel Camina SHAH – rdc26@dpmms.cam.ac.uk
  Director of Studies at Fitzwilliam College, University of Cambridge

- Professor Christophe LEY – christophe.ley@ugent.be
  Professor of Mathematical Statistics at the University of Ghent

- Professor Davy PAINDAVEINE – dpaindav@ulb.ac.be
  Professor of Mathematical Statistics at the Solvay Business School of Management and Economics (ULB)

- Professor Joel FINE – joel.fine@ulb.ac.be
  Researcher in Differential Geometry at the Université Libre de Bruxelles

- Professor Siegfried HORMANN – shoermann@tugraz.at
  Professor of Mathematical Statistics at the Graz University of Technology

EXTRA-CURRICULAR ACTIVITIES

Sports Club
Royal White Star Athletics Club (Brussels) & David Lloyd Tennis Club (Brussels)
Athletics and Tennis - Sports that have taught me high precision, determination and willingness to never give up