Welcome to the fifth issue of “Statistically Speaking...” - a publication designed for current and past students and staff of the Statistics Department at the University of Warwick. Thank you to all who contributed to this issue or participated in its production in any way.

Vassili Kolokoltsov, Eleanor Ingram

News and Events

The results of the 2014 REF (Research Excellence Framework) exercise have now been published, and Warwick Statistics and the Warwick Mathematics Institute together have been ranked 3rd in the UK with more than 90% of our research activity assessed as either internationally excellent or world leading.

Our research environment at Warwick is rated by REF 2014 as the very best in the UK for mathematical sciences (achieving the maximum possible score of 100% at 4*).

The University of Warwick as a whole is now ranked (among universities) 7th in the UK for our research, with 14 academic departments ranked in the UK top ten for their disciplines.

RSS working party on REF and league tables

Professor David Firth is part of an ad hoc working group formed in early 2015 by the Royal Statistical Society to examine the use of REF results in published research rankings and more general "league tables" of universities/departments.

Tom Nichols has received a 2 year grant from Warwick’s Brazil Partnership Fund to support continued collaborations with recent-PhD Lilia Costa. Now that Lilia has returned to her home in Brazil, this grant is vital for funding return her visits to Warwick. It will also fund visits for Tom & Jim Smith to Brazil to help organise a conference in Sao Paolo on Network Science.

Dr Heather Turner, statistical consultant and currently an Associate Fellow of Warwick Statistics, has been invited to give an intensive one-day course Introduction to Generalized Nonlinear Models in Zurich on 11 May 2015. The course is based on Heather’s work as a Senior Research Fellow at Warwick, which included the development of award-winning software package gnm.

Job Opportunities for Female Postdocs

Applications for the 2015 L’Oréal-UNESCO UK & Ireland For Women in Science Fellowships open 2nd February 2015

L’Oréal UK & Ireland, the UK National Commission for UNESCO and the Irish National Commission for UNESCO, with the support of the Royal Society have partnered together to provide a dedicated UK & Ireland For Women in Science Fellowship programme for women scientists at post-doctoral level to enable and/or facilitate promising scientific research in the life and physical sciences.

This year five Fellowships will be awarded to outstanding female postdoctoral scientists to assist them with their research. The Fellowships, each worth £15,000 (equivalent Euros for candidates in Ireland), are tenable at any UK or Irish university or research institute to support a 12-month period of research and for the first year we will be including maths, engineering and computer science.

The Fellowship money can be spent in any number of innovative ways to enable women scientists to pursue their careers and facilitate world class research - such as buying equipment, paying for childcare, or funding travel costs to an overseas conference.

**Key Dates:**

- Applications open – Monday, 2nd February
- Applications close – Friday, 13th March
- Shortlist published – Tuesday, 2nd June
- Awards ceremony – Tuesday, 23rd June

Visit [www.womeninscience.co.uk](http://www.womeninscience.co.uk) to apply
KAUST Undergraduate Poster Competition 2015

The Statistics department would like to extend their congratulations to Daniel Wilson-Nunn, a third-year student on the Mathematics and Statistics degree programme, for his selection for the King Abdullah University of Science and Technology (KAUST) Undergraduate Poster Competition 2015.

TRAVEL REPORT
WOLFRAM SCIENCE SUMMER SCHOOL 2014

“THE ROUGHNESS AND FRACTAL BEHAVIOUR OF BITCOIN COMPARED TO OTHER MARKETS”

Between 30th June and 18th July 2014, I participated in the Wolfram Science Summer School held at Bentley University, Boston, Massachusetts, USA. The Summer School, organised by Wolfram Science offers a group of international students from varying backgrounds the opportunity to produce a piece of research using the ideologies from Stephen Wolfram’s “A NEW KIND OF SCIENCE” and the software package “WOLFRAM MATHEMATICA”. My aim was to implement techniques in investigating randomness in financial products and examine methods of modelling financial products.

The majority of the Summer School consisted of lectures given by various members of the Wolfram Research community on various areas from enumeration of polynomials to image manipulation in MATHEMATICA. In addition to these lectures, “Live Experiments” were performed by Stephen Wolfram (founder of Wolfram Research and the Summer School), where an unsolved problem in Mathematics or Computer Science was examined using MATHEMATICA in front of the students, with input from the students as well as staff and instructors from Wolfram Research. Advanced MATHEMATICA training was given by senior programmers from Wolfram Research.

After meeting with Stephen Wolfram, Todd Rowland (academic head) and Hector Zenil, my instructor for the duration of the School, I decided that my project would involve visualising transactions of Bitcoin. After working on this, my project evolved to encompass studying the price history of Bitcoin and comparing it to precious metals, stock indices and exchange rates.

In studying the historical prices of Bitcoin, I utilised a number of techniques from the fields of Statistics, Finance, Computer Science and Mathematics:

- The correlation between movements of prices
- Analysis of the logarithm of daily returns and comparing to the normal distribution
- Techniques from Information Theory such as Entropy, Compression Ratio and Approximate Entropy (ApEn)
- Fractal dimension using Box-Counting Estimator and the Hall-Wood Estimator

Learning to use these different techniques allowed me to gain an insight into many different disciplines and has opened up new areas of interest for myself, namely fractal geometry and fractal analysis of financial investment products.

I am continuing with my project so as to author a paper with my instructor, Hector Zenil, with the above title. The results have led to a number of interesting conclusions regarding Bitcoin and its similarities to other investment products:

Correlation between movements of Bitcoin prices between 17/07/2010 & 03/07/2014 and gold prices between 03/01/1900 & 07/07/2014 when scaled to the same time period is 0.946. The same with silver prices gives a value of 0.907.

The logarithm of the daily returns of Bitcoin, gold and silver all follow a similar distribution which is very dissimilar to the normal distribution. This in contrast to the logarithm of the daily returns of the GBP/USD, CHF/USD and EUR/USD exchange rates, as well as the FTSE100 and the NASDAQ.

The fractal dimension - calculated using the Hall-Wood Estimator - of the price history of all 5 afore mentioned products when compared to both Bitcoin and Litecoin again grouped precious metals with cryptocurrencies.

2 http://www.hectorzenil.com/
In July 2013, I undertook a project with Professor David Hobson to study a specific topic in Mathematical Finance: robust arbitrage-free pricing of forward-start options. Specifically, we studied the following question: given probability distributions for the start value and terminal value of the underlying asset of a forward-start option, what are the lowest and highest prices of the forward-start option that do not admit an arbitrage (risk-free profit) in the market?

These highest and lowest prices depend only on the probability distributions of the value of the underlying asset on the start and terminal dates of the forward-start option; they do not require any assumptions on the movement of the asset value between these two dates (these prices are known as robust or model-independent prices). In theory, the probability distributions of the asset values on the two dates may be inferred from current prices of vanilla call and put option prices.

Identifying the robust prices involves solving a linear programming problem that is similar to a transportation problem. The task is to find ways of transporting probability mass from the starting distribution to the terminal distribution of asset prices that maximise or minimise the expected payoff of the forward-start option, subject to the constraint that the asset price process must be a martingale (i.e. the expected price of the asset at any future time must equal its current price).

I developed a MATLAB application that provides an approximate solution to the linear programming problem. The application reports the prices and provides a visualisation of the joint distributions of asset values on the start and terminal dates that produce the maximum and minimum prices. The application was used to study characteristics of the solutions of the problem, and it is intended that this work will enable the identification of analytical solutions for robust prices.

Edmund Wall

Keegan Kang - now in the second year of a Statistics PhD at Cornell, working on Big Data.

Warwick Statistics

What’s on

WDSI Workshops
Big Data in Cancer

Wednesday, 18th March
M5.01
Zeeman Building

For more information, including the registration form, visit:
http://www2.warwick.ac.uk/fac/sci/wdsi/events/yobd/cancer/

CRiSM Seminars
Seminars will be held in B1.01 (Maths)

Friday, 6 February
14:00—16:00
Leonard Held (ETH Zurich), Gareth Peters (UCL)

Friday, 20 February
14:00—16:00
Li Su (Cambridge), Marina Knight (York)

Other Statistics Seminars:

SF@W
Wednesday, 11 March (C0.08)
14:00—15:00
Tim Leung (Columbia)

RSS West Midlands Local Group Meetings
More information can be found via the group’s website
https://sites.google.com/site/rsswmlg/forthcoming-meetings

Young Researchers’ Meeting
Meetings take place on Tuesdays in C0.06

http://www2.warwick.ac.uk/fac/sci/statistics
Estimating Genetic Heritability

Tom Nichols has been published in *Proceedings of the National Academy of Sciences*. Based on work with former Warwick student Tian Ge, the work provides an accelerated method to estimate genetic heritability with unrelated subjects. **The new method is several orders of magnitude faster than existing methods and is suitable for use with high-dimensional** data like MR images of the brain. Ref:


Figure: These are the brain regions identified with statistically significant heritability of cortical thickness. This analysis, estimating heritability with unrelated individuals and computing P-values with resampling methods, is only practical due to the accelerated inference methods proposed in the paper.

Conveying geographical uncertainty

It is always difficult to communicate your uncertainty about something. Psychologists have long shown that misperceptions and misunderstandings abound when we talk about the likelihood of something happening, either qualitatively or probabilistically. Difficult though it is, we do have to communicate about and deal with uncertainties. This is particularly true in crises and rapidly evolving events. RISCU is working on a contract to help COBR, government’s crisis management group deal with geographical uncertainty in the event of a radiation accident. Our brief is to find ways of providing assessments of the likely spread of radiation in the event of an accident at a nuclear power plant.

Geographical uncertainty is particularly difficult to convey because it is so easy to confuse contours of the atmospheric plume of radionuclides with contours of probability on a map. We have to find a more action-oriented, less confusing way of presenting the information. Add to that the fact that government ministers are thankfully very unfamiliar with handling radiation accidents, and you begin to appreciate that the challenges that our project brings.

Simon French