



Warwick Centre for Complexity Science

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MathSys Stakeholders day on Friday 12th December 2014

On Friday 12th December we will be holding the MathSys Stakeholders day for 2014. On this occasion, our external partners join us in Warwick to discuss and to explore areas of mutual interest. It is a core aspiration of our Centre to engage proactively and productively with our external partners. The partners so far engaged with MathSys are the following: Thales, Public Health Wales, Pirbright, Polymaths, BT, Jaguar Land Rover, Simpact, Sciteb, University Hospital Birmingham, University of Birmingham - School of Cancer Sciences, Public Health England, National Grid and Warwick Analytics. Our partners have varying aspirations for their engagement with the centre. Some are looking to directly co-fund a number of PhD studentships on projects that they see as having relevance for their business, while others are hoping to offer masters projects or engage more broadly.

Real-world problem solving can be a rewarding undertaking and, in many respects, is just an extension of the scientific method to different sets of problems. Many of the technically complex problems that our partners face can be posed in mathematical language and we believe that many of these might be amenable to imaginative mathematical approaches that could yield real impact. Our partners are involved in different areas of the real world but not all of them are up to date with cutting edge techniques. This suggests that a strong collaboration with students and, more generally, with

staff in the Centre can provide unprecedented insight into real problems and make a remarkable and genuine difference. It is also a matter of fact that, statistically speaking, many of our graduates will go into a career in the real world rather than academia. Managing to engage with one of our partners can then be the beginning of a fruitful experience of interaction with the real world.

The Stakeholders day will start with an introduction from the CDT's director, followed by a session in which the partners will provide a short description of the problems they are facing and that they want to pose to students in the Centre. The first challenge is, then, to interpret these problems and translate them into a mathematical fashion. After a break for lunch, the day will continue with various breakout sessions where students and external partners will have the unique chance to discuss ideas and share views on the different challenges that have been posed in the morning. The results of these discussions will be presented to the whole Centre at 4pm, when there will be a session to sum up the projects and possible approaches that may have been discussed. To conclude the day, the Centre will offer some drinks and snacks to enhance a more personal and relaxed discussion between attendees. The stakeholders day is organised by Professor Matthew Turner, a member of the Centre.

Syndromic Surveillance

By Elizabeth Buckingham-Jeffery, 2nd year PhD student

Google tries to know everything. From my browsing history the search engine has (successfully?) classified me as a 35-44 year old male with interests in parenting, East Asian music and dogs in order to better target its advertisements. Google has also tried to estimate how many of us have flu. In 2008 Google started using some of the five billion web searches it records every day to estimate the prevalence of flu based on the number of flu-related searches taking place, in what is called Google Flu Trends.

What Google has tapped into is the increasingly widespread use of syndromic surveillance - the collection and analysis of symptom data as a proxy for confirmed lab or clinical diagnoses in order to enable earlier detection of infectious disease epidemics.

Following the September 11th terrorist attack and the subsequent anthrax cases, the US Government increased its use of syndromic surveillance to try and gather (close to) real-time information on outbreaks of infectious diseases with the aim of identifying any further bioterrorist attacks. One system they use takes nightly data from ambulance patient records of syndromes, patient demographics and ZIP codes. This data is analysed to look for clustering, and if any cluster exceeds a pre-defined threshold an electronic alert is sent out to health care providers.

Additionally, during the 2012 Olympics in London the Health Protection Agency (HPA) realised that having 17,000 athletes and officials from all over the world live in close quarters in the Olympic village, along with the many other travellers who were visiting London in this period, was the perfect recipe for an infectious disease outbreak. The HPA brought together data from many different sources including records from emergency departments, GPs and health-care hotlines like NHS Direct in their syndromic surveillance system. These examples of syndromic surveillance systems use different and varied data sources. The data footprints that we each leave on the internet, when we buy over-the-counter medicines and when we have any interaction with health care professionals all contribute to big electronic datasets, increasing the ease and viability of syndromic surveillance. Ideally, the data used should be available in as near real-time as possible, and be automatically generated as to not impose an additional burden on data providers.

Current syndromic surveillance systems show varying levels of success in predicting the prevalence of disease and in issuing epidemic alerts. Most analysis and alert systems look for incidences over a certain pre-defined threshold. This is susceptible to false positives - an alert being issued simply due to

noise exceeding the threshold. Additionally, there is also the question of suitability of using data that was initially collected for other purposes. Google Flu Trends uses searches of key words relating to flu to estimate prevalence, and as with its classification of users for advertising purposes, its conclusions are not always correct. Google Flu Trends drastically overestimated peak flu levels of the winter flu season in the United States in 2012. The flu season was unusually early in the US in 2012, causing more serious illness and increased media coverage. The increased number of searches of flu-related terms by healthy people looking for news, rather than sick people looking for information could explain the over prediction by Google.

There is potential for improved analysis of syndromic data in many areas, in particular with the investigation of different ways to define the baseline over which cases must exceed in order for an alert to be issued. As data collection and collation improves, the potential for this surveillance just increases.

Liz Buckingham-Jeffery is a 20-24 year old female with interests in rock climbing, electro-swing music and baking. She is a second year PhD student working with the Real-Time Syndromic Surveillance Team at Public Health England during her PhD.

Complexity Students have Big Hopes for Big Information



By Marcus Ong, Director of Spectra Analytics and former PhD student

The past couple of decades have seen an explosion in both processing power and data storage. As a result many institutions have amassed a wealth of data, leading many to coin this as the era of 'Big Data'. The possibilities of 'Big Data' have been widely debated in academia, industry and governments with both David Cameron and Barack Obama espousing the possibilities in recent speeches.

Unfortunately, extracting useful information can be a challenging task. Simply applying basic methods can lead to little or no useful information; regardless of data size. Hence, what is really important is 'Big Information' rather than 'Big Data'. 'Big Information' requires utilising the most appropriate and sometimes most sophisticated data analysis techniques currently being developed in academia. This is where the interdisciplinary nature of Complexity Science, with its focus on mathematical modelling and statistics, has the opportunity to revolutionise the area.

To this end, an entrepreneurial group of Complexity Science DTC students have established a new data analysis and research consultancy. Spectra Analytics

aims to deliver cutting-edge analysis to clients, to allow them to make informed decisions about their businesses. They bridge the gap between academia and industry. The firm is managed by Marcus Alexander Ong and Daniel Sprague who are just completing the Complexity Science PhD programme.

Spectra Analytics works across a broad range of business sectors but it is particularly strong in the fields of finance and healthcare. In these fields, the firm is able to leverage Marcus' experience as a derivatives trader for Citigroup and Dan's experience as a consultant for USAID. The duo also recognises the importance of the 'social contract' and plan to continue conducting academic research and hope to supervise mini-projects within the Centre for Complexity Science.

If you are interested in finding out more about Spectra Analytics, visit their website (www.spectraanalytics.com) and follow them on Facebook, LinkedIn and Twitter.

You may also contact them directly via info@spectraanalytics.com or call 020 7426 2790.

Recent publications from our staff and students:

- Beller DA, **Machon T**, Copar S, Sussman DM, **Alexander GP**, Kamien RD, Mosna RA. Geometry of the cholesteric phase, *Physical Review X* 4, 031050 (2014)
- Boccaletti S, Bianconi G, Criado R, **Del Genio CI**, Gomez-Gardenes J, Romance M, Sendina-Nadal I, Wang Z, Zanin M. The structure and dynamics of multilayer networks, *Physics Reports* 544, 1-122 (2014)
- **Taschler B**, Ge T, Bendfeldt K, Muller-Lenke N, Johnson TD, Nichols TE. Spatial modelling of multiple sclerosis for disease subtype prediction, *Medical Image Computing and Computer-Assisted Intervention- MICCAI 2014*, LNCS 8674, 797-804 (2014)
- Black AJ, **House T**, **Keeling MJ**, Ross JV. The effect of clumped population structure on the variability of spreading dynamics, *Journal of Theoretical Biology* 359, 45-53 (2014)
- **Pellis L**, Ball F, Bansal S, Eames K, **House T**, Isham V, Trapman P. Eight challenges for network epidemic models, *Epidemics* (2014)

MathSys Open Day: 3rd December

On the 3rd of December the Centre for Doctoral Training in Mathematics of Real World Systems will be holding an open day for prospective students. The day is an excellent opportunity for potential applicants to meet staff and the current students and discuss with them their experiences of the Centre. MathSys is a collaboration of Warwick scientists in three existing centres that have excellent records of world-leading research involving application of mathematics to real-world problems: the Centre for Complexity Science, Warwick Systems Biology, and Warwick Infectious Disease Epidemiology Research (WIDER) centre.

The day will consist of a welcome from the Centre director Robert MacKay with the opportunity for questions, there will be a buffet lunch provided and in the afternoon there will be a forum talk followed by informal interviews for the prospective students.

Warwick Award for Teaching Excellence

Congratulations to our very own Federico Botta! Each year The University of Warwick presents awards recognising excellent teaching by postgraduate students and this year a student from the Centre for Complexity Science, Federico, received a commendation for teaching he performed during the first year of his PhD.

More details can be found on the webpage of the award:

http://www2.warwick.ac.uk/insite/news/intnews2/watepgr_winners_2014/

The award ceremony was held on 4th November 2014 in the Teaching Grid in the Library.

Welcome to the new students

We are pleased to welcome our first intake of 15 MathSys students and a total of 13 Erasmus Mundus masters students to Warwick this year. In particular, these include a good proportion of women: 5 on MathSys and 6 Erasmus Mundus.

Change in the Editorial Team

Elizabeth Buckingham-Jeffery, one of the members of the editorial team for previous issues of this newsletter, had to leave the team due to a new commitment in her PhD. We wish Liz all the best in her PhD and we are very thankful for all the work she has done to set up the newsletter.

We also welcome Neil Foster, an MSc student of the new MathSys CDT, as new member of the editorial team!

Events coming

soon:

Some upcoming Warwick events that may be of interest:

- 2nd December 2014, Institute of Physics NCPG Yuletide Complexity Lecture, "Nonlinear physics of viscous fingering", Museum of Science and Industry in Manchester
- 3rd December 2014, MathSys Open Day
- 9th-11th December 2014, Centre for Research in Statistical Methodology, "Workshop on Statistical System Biology"
- 12th December 2014, MathSys Stakeholders day
- 15th December 2014, Warwick Data Science Institute, "Big Data and Google Flu"
- 16th-17th December 2014, Warwick Mathematics Institute, "Mathematical Challenges for Long Epidemic Time Series"
- 28th January 2015, MathSys Open Day
- 2nd February 2015, MiR@AW Day, "Uncertainty in Complex Computer Models"
- 9th February 2015, MathSys Study Group Problem Presentations
- 16th-27th February 2015, NTU-Warwick Winter School, "Introduction to Complexity Science"
- 11th March 2015, MathSys Open Day
- 18th March 2015, Warwick Data Science Institute, "Big Data in

Editors:

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Additional Online Content:
complexity/newsandevents/newsletter