

INI Director John Toland retires



Professor John Toland being presented with an Honorary Fellowship by Professor Valerie Isham, Chair of the Scientific Steering Committee and Howard Covington, Chair of the Management Committee

On Tuesday 20 September 2016 an event was held at the Isaac Newton Institute to mark the retirement of John Toland as Director of INI, and to celebrate all that he achieved during the five years of his tenure.

An outstanding mathematician in his own right (a Fellow of the Royal Society and recipient of their prestigious Sylvester Medal in 2012) the academic reputation of INI soared under his leadership. With ground-breaking programmes covering topics as diverse as group theory, mathematical biology, quantum theory, fluid dynamics, and statistical network analysis, the throughput of field leaders including Fields Medalists and Nobel, Wolf and Abel Prize winners, was remarkable.

Against the backdrop of the financial crisis John secured the next tranche of Research Council funding and also generous donations for INI's fellowship schemes from the Simons Foundation and from the Turner-Kirk Foundation, as well as funding from Clive Humby and Edwina Dunn, and from Old Mutual for the 2014 programme on Systemic Risk.

A passionate photographer and voracious reader, John nurtured the cultural side of the Institute welcoming Turner Prize winner Grenville Davey as Artist in Residence in 2012 and Professor John Kinsella as Poet in Residence from 2014.

John was Chair of the 2014 Research Excellence Framework (REF) Mathematics Panel and is on the Executive Committee for the International Mathematics Union.

When asked about his plans for the future, he invariably claimed that his intention was just to potter around the garden and clear drains, previously a weekend hobby. We have no doubt that the mathematical sciences community won't let him out of their clutches that easily!

A word from the new Director, David Abrahams

It is my privilege to have been in post for some four months now and to have seen first-hand the breadth and scale of mathematical activity taking place within the Isaac Newton Institute. Due to increased demand from the community, INI has been piloting the running of three programmes in parallel over an eighteen month period. The first three programmes finished at the end of December and I can vouch for their success in engaging the community. We have three new programmes now, all in pure mathematics, on Homology Theories in Low Dimensional Topology, Operator Algebras: Subfactors and their Applications, and Non-Positive Curvature Group Actions and Cohomology.

I would like to thank my predecessor, John Toland, for his remarkable achievements during his term as Director. He has overseen a significant increase in the quality and scale of activity at INI, has broadened the scope of the programmes, and increased interdisciplinarity. He has improved the environment and services offered to participants, including overseeing the introduction of the bespoke database ISAAC.

As to the future, I plan to continue to expand INI activities to meet the substantial demands. I am keen to ensure that all members of the UK mathematical sciences community have equal access to our facilities and so will be embarking on visits in coming months to conferences and universities to spread the word about what we have to offer. It is fair to say that INI programmes can change the direction of whole areas of mathematics, and routinely change the research focus of INI participants. I am also keen for the Turing Gateway to Mathematics to continue its excellent work in increasing knowledge exchange between mathematicians and researchers outside academe, or in other disciplines. This will continue to be done both through the scheduled programmes and one-off workshops, and also via a number of new initiatives.

I am happy to speak to anyone who is interested in undertaking an event at the Institute. Please check out details on our website or drop me an email.

See inside for:

- **Current programmes**
- **Emmy Noether Society**
- **Three Rothschild talks**
- **Visitors from Poland**
- **TGM Success of Soft Matter event**



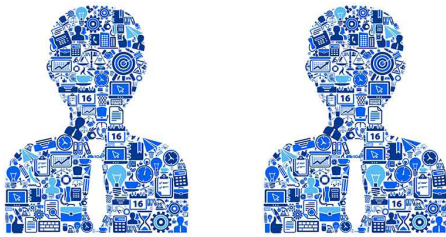
George Auckland and Tim Rowlett of Grand Illusions demonstrating numerous mathematical toys at John's retirement celebration

Current Programmes Update

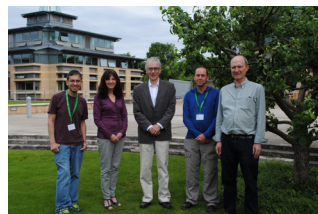
Data Linkage and Anonymisation

by organiser Peter Christen (Australian National University)

With the ever-increasing importance of data about people, two basic methodological problems are linkage (how to link or merge multiple databases) and anonymisation (how to protect confidentiality and privacy when sharing data). These are key challenges in the social and health sciences, in government statistics, and in the use of consumer data in business, among many fields of application. There is increasing recognition of the potential of the mathematical sciences to offer innovative solutions to some of the fundamental problems in these areas and to embed approaches in rigorous scientific frameworks.



The field is fundamentally multi-disciplinary and a key aim of the programme has been to promote cross-disciplinary discussion and cooperation, most prominently between computer science and statistics.



Data Linkage and Anonymisation organisers

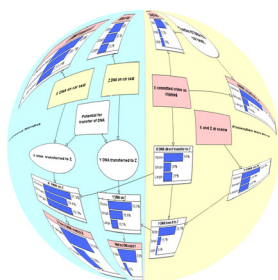
Examples of how this aim has been addressed include speed-networking break-out sessions at a data linkage workshop, highlighting challenges across disciplines, and a workshop focussing on the interface between computer science and economics in research on privacy.

Key areas of focus emerging on the programme have been: differential privacy, including applications to government statistics where particular challenges include sparse data and household structure; synthetic data, where a working group plans to pilot a synthetic data challenge for evaluating alternative approaches to producing synthetic data; data linkage methods, including privacy-preserving linkage integrating the two aspects of the programme; and the development of a data repository, as a basis for future methodological development and evaluation.

Probability and Statistics in Forensic Methods

by organiser Leila Schneps (Institut de Mathématiques de Jussieu)

This programme, devoted to applying cutting-edge mathematical methods to the study of crime evidence, attracted not only mathematicians but also forensic scientists specialising in DNA, fungi and soil analysis, and psychologists studying such phenomena as jury behaviour, paradoxes and risk. Judges, lawyers and members of the police force attended workshops to hear the newest results.



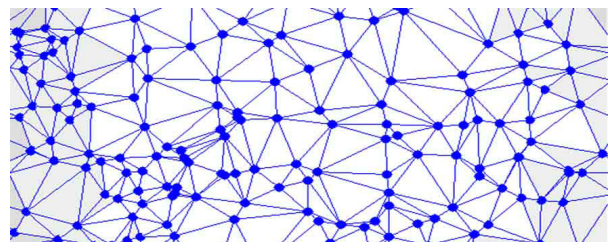
A considerable amount of time was devoted to the detailed analysis of specific criminal cases, with the purpose of testing the robustness of the most recent methods, including software created by the programme participants for the purpose of “deconvoluting” mixed DNA samples.

Another focus was the global analysis of crime evidence using Bayes nets, a method for assessing the weight of a collection of pieces of evidence which are not independent from each other. Specific working groups used Bayes nets to analyse complex well-known cases such as the Amanda Knox case, chosen for bearing features typically known to be confusing and difficult for juries to assess. It is unlikely that any other programme at INI has given rise to as many heated arguments and emotional fireworks!

Dissemination was key to the success of this programme and as it drew to a close, the participants drafted a set of guiding principles intended to help all phases of criminal investigation to use with confidence scientific methods that will be robust, unchallengeable on appeal and accepted by all sides.

Progress in Establishing Theoretical Foundations of Network Analysis

by organiser Patrick Wolfe (University College London)



Understanding and quantifying mathematical structure in networks is a key open problem, spanning many domains of mathematics and its applications. Beginning in July 2016 at the Isaac Newton Institute, researchers have come together from disparate branches of the mathematical sciences to combine expertise and make progress in this timely area.

The programme opened with a workshop attended by over 120 researchers, coinciding with the announcement of multiple programme participants as winners of the 2016 George Pólya Prize in Combinatorics. The workshop merged ideas from combinatorics, probability and mathematical statistics with algorithms, starting from recently developed connections between the notions of graph limits and nonparametric network models. This brought several new ideas to the fore, largely focused on closing the gap between simple, well-understood models and real networks observed ‘in the wild’.

Follow-on workshops in July and August focused on computation and data analysis, bringing together researchers studying a wide range of applications and mathematical models in the context of networks. Organisers announced the start of the European Cooperation for Statistics of Network Data Science (COSTNET), a major European initiative to promote cross-disciplinary collaboration in this important area.

Emmy Noether Society and Women in Maths

Emmy Noether was a German mathematician and theoretical physicist who is widely regarded as the most important woman in the history of mathematics. The Cambridge University Emmy Noether Society aims to promote women studying mathematical sciences and INI is working closely with the organisers to maintain and promote the work of women in Mathematics. Khyla Kadeen-Miller, an undergraduate at Cambridge, is President of this Society; she is an energetic young mathematician working hard to promote women in Maths.



November saw four INI programme participants give talks to the society: Professor Natalie Schlomo gave a talk on *'Assessing disclosure risk in sample microdata'*, Professor Sofia Olhede spoke about *'Big data and structured patterns'*, Dr Lelia Schneps spoke about *'Bayesian Networks in crime evidence analysis'* and Professor Cynthia Dwork spoke about *'Big data and privacy'*. Also Professor Valerie Isham (Chair of INI Scientific Steering Committee) spoke on highlights of a career in stochastic modelling.



Finally, INI held a 'Women in Data Science' day in December as part of the New Developments in Data Privacy workshop. Field leaders, who just happened to be all female, spoke to a seminar room packed full of both men and women.

INI update user database

INI recently sought help from its past participants (some going back many, many years) to prepare for its proposal for the next round of Research Council funding. EPSRC requires requesters to include numbers of previous attendees to enable them to look forward and judge what will be required to run INI. The participants, most of whom are based in universities, are extremely mobile and move from one position to the next with great regularity. However, having up-to-date data on the research areas (broadly interpreted) of its participants was very important and to this end, INI contacted over 14000 participants with the reassurance that any information gathered would not be passed on and would be used only during the funding process.

Three Rothschild Lectures



Rothschild Visiting Distinguished Fellow, Professor Peter Bickel, University of California at Berkeley, touched on many themes from the Statistical Network

Analysis programme in his public lecture, *'From Small Data to Big Data and Back: Statistics and Data Science'*, placing the programme within the context of the progress of modern statistical theory and methods. He shared a personal view of some of the key results from the programme to date, most centrally the fundamental role that sparsity plays in both helping and hindering the analysis of real networks and their mathematical structure.

Rothschild Visiting Distinguished Fellow, Professor Gerd Gigerenzer of the Max Planck Institute for Human Development, gave a talk on *'Helping Doctors and Patients Make Sense of Health Statistics'*.



This talk, attended by a diverse population of academics from many fields and many departments across the University discussed how efficient health care requires informed doctors and patients. However, some studies show that physicians have great difficulties understanding health statistics. This widespread innumeracy makes informed decision-making difficult. He reported on the efforts of the Berlin Harding Center to help professionals and laypeople to understand evidence, and stamp out the use of misleading statistics in pamphlets, journals, and the press. Raising taxes or rationing care is often seen as the only viable alternative to exploding health care costs. He reported on a third option: by promoting health numeracy, better care can be had for less money.



Rothschild Visiting Distinguished Fellow, Professor Cynthia Dwork, Microsoft Research, spoke for the DLA programme. The rise of big data has been accompanied by an increase in the twin risks of spurious scientific discovery and privacy compromise. During her talk she reviewed the definition of differential privacy, describing some basic algorithmic techniques for achieving it, and seeing that it also prevents false discoveries arising from adaptivity in data analysis.

There is a large amount of literature on privacy-preserving data analysis spanning several disciplines. However, many attempts have proved problematic either in practice or on paper.

Success of Soft Matter in Industry Event Leads to Five Year Edwards Symposium Collaboration

A three day research workshop, delivered by the TGM, took place at INI on 7-9 September and attracted over 100 people from around the world. A key aim of this event was to highlight developments in theoretical physics and mathematical frameworks for the modelling and simulation of soft matter systems, with particular emphasis on how these models can inform industrial processes, materials, and design.

The inspiration for this event emanated from the life and work of Professor Sir Sam Edwards FRS, who was one of the great scientific minds of the 20th Century and played a pivotal role in bringing advances in the physical sciences to bear on major industrial problems. Sir Sam's scientific contributions ranged from fundamental theoretical work on polymer melts, through gels, colloids, granular materials and glasses to optimisation theory.

The programme of talks included sessions on polymers, functional complex fluids, granular materials and interfacial materials. It also featured five Industry Challenge talks from Croda, Schlumberger, Mars Chocolate, the National Physical Laboratory and Unilever. More information is available on the web page, including a link to the programme, where you can access some of the recorded talks and presentations.
<http://www.turing-gateway.cam.ac.uk/event/tgmw36>

Following the success of this first Edwards Symposium, Unilever has agreed to support a series of further Edwards Symposia for the next five years. TGM are also pleased that the EPSRC-funded Centre for Doctoral Training on Soft Matter and Functional Interfaces, directed by Professor Tom McLeish of the University of Durham, will be a partner organisation for future Symposia. The Edwards Symposium format brings together theorists and experimentalists from the soft matter research community, with industrialists seeking solutions to existing or new problems across multiple applications areas.

At the first Edwards Symposium the lead academic organiser, Professor Mike Cates, also announced formation of a new Edwards Centre for Soft Matter Research, a virtual laboratory that will bring together soft-matter researchers from six departments across the University of Cambridge.

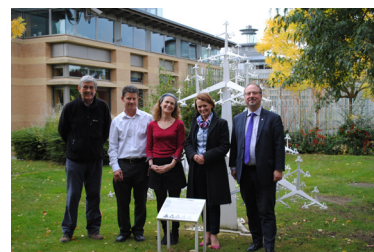
The next event will take place at the Centre for Mathematical Sciences, Cambridge on 6-8 September 2017. For further information, please contact Jane Leeks at the TGM.



INI welcomed Polish visitors to the Sierpiński tree

In May 2015, the University of Cambridge marked its close bonds with Poland by planting the Sierpiński Tree in the grounds of INI. The Sierpiński Tree is based on the geometric figure devised by Polish mathematician Waclaw Sierpiński who did pioneering work in the early 20th Century on the field of fractals. The original "planting" was to celebrate the achievements of Polish science and the launch of the initiative in Polish Studies at the Department of Slavonic Studies.

Visitors from Poland returned recently to continue the relationship with Cambridge and the Sierpiński tree in particular. Christie Marr and Nigel Peake (Head of DAMTP) gave them a short tour of other artworks in the grounds.



Upcoming events

25 March 2017

Cambridge Science Festival Andrew Fitzgibbon (Microsoft Research) on '*Where maths collides with Holograms and special effects*'

27 - 31 March 2017

Workshop Subfactors, higher geometry, higher twists and almost Calabi-Yau algebras. The workshop focuses on the interaction between subfactor theory and categorification or higher categories, higher geometry, functorial field theories, factorisation algebras, higher twists and pre-projective or almost Calabi-Yau algebras.

10 April- 13 April 2017

Workshop Physics and knot homologies. This workshop will explore developments in string theory and quantum field theory related to categorification and the topology of knots and 3-manifolds.

8 May - 12 May 2017

Workshop Approximation, deformation, quasification. Studying how a mathematical object or theory is affected by small perturbations is a technique that is used to improve understanding.

A full listing of all scientific events at INI is available on the web at www.newton.ac.uk/events