

# COMPUTATIONAL BIOLOGY: STRIVING FOR EXCELLENCE

– p17



## WELCOME PROFESSOR SIR TIM BERNERS-LEE:

Inventor of the World Wide Web, joins us – p3



## SURVEILLING SURVEILLANCE:

Examining how smartphone apps track people – p26



## KEEPING SOCIAL MEDIA SOCIAL:

New video launched – p16



DEPARTMENT OF  
**COMPUTER  
SCIENCE**

## Inspired Research

is a twice-yearly newsletter published by the Department of Computer Science at the University of Oxford.

If you would like to learn more about anything you read in these pages, please get in touch: [editorial@cs.ox.ac.uk](mailto:editorial@cs.ox.ac.uk)

To subscribe to future issues, e-mail: [editorial@cs.ox.ac.uk](mailto:editorial@cs.ox.ac.uk)

To download previous issues, visit [www.cs.ox.ac.uk/inspiredresearch](http://www.cs.ox.ac.uk/inspiredresearch)

## Editorial board

Suzanna Marsh (Editor)

Kiri Walden (Sub-Editor)

Suvarna Designs (Designer)

Benjamin Neal

Daniel Marsden

Emma Dunlop

Faris Abou-Saleh

Jason RC Nurse

Leanne Carveth

Martha Lewis

Maureen York

Megan Schaible

Peter Jeavons

Sarah Baldwin

Seyyed Shah

Sharon Lloyd

Varun Kanade

Will Smith

## Contributors

Alex Rogers

Arnau Erola

David Gavaghan

Emma Espinosa

Gabriel Inelus

Helena Webb

Ioannis Agrafiotis

Jassim Happa

Jim Davies

Jun Zhao

Katherine Fletcher

Laura Jones

Maria Sueiro

Max Van Kleek

Michael Goldsmith

Michael Wooldridge

Sir Nigel Shadbolt

Paul Harrenstein

Prince Abudu

Reuben Binns

Sadie Cresse

Seyyed Shah

Thomas Gibson-  
Robinson

Cover image: Blanca Rodriguez

# Letter from the Head of Department

It's official: Oxford is the best! At least, according to the 2016 *Times Higher Education* world university rankings. Oxford is the first UK university to achieve first position in this ranking, a huge coup for the whole institution, and a wonderful boost for our new Vice Chancellor, Professor Louise Richardson. The announcement made headline news in the UK, but the following week the *THE* gave us news that, to us in the Department of Computer Science at least, was even more important. For the first time, the *THE* published a subject ranking of computer science departments, and according to this, Oxford is ranked third in the world (and first in the UK). Perhaps that might not sound so impressive, but when one considers that our competition in the USA includes giants like MIT and Berkeley, this is a huge achievement.



I am delighted to be able to confirm that Sir Tim Berners-Lee, inventor of the World Wide Web, joins the Department of Computer Science as a Professor. More on that on page 3.

One of my main goals when I took over as Head of Department two years ago was to increase our undergraduate intake, which in practice means persuading more colleges to admit Computer Science students. This process has to be done on a college-by-college basis, and there is no simple way to affect a step change. It is therefore very gratifying that I am able to report that Lady Margaret Hall, Christ Church, Hertford, and Jesus Colleges have all agreed to admit undergraduate computer scientists in the years to come. This is but a step – we still have a long way to go!

Whenever one writes an article of this type, there is a natural temptation to simply list all the wonderful things that have happened to us since the last report, and you will have guessed that this is indeed the rule of thumb I use for the most part (see above!). However, it would be criminally negligent of me to write a report on the life of the department over the last six months without mentioning Brexit. Whatever one's views on the rights and wrongs of Brexit, the simple truth is that research-led universities in 2016 must be international in their outlook. We seek to attract the best students, irrespective of their origins, and the best academics, wherever they may be found. Anything that impedes this makes it harder for us to be as excellent as we can be. And quite apart from this, about 40% of our research income derives from EU sources – in particular, the wonderful European Research Council (ERC), which funds large scale pure research projects on the sole basis of scientific excellence. Our department has been the recipient of twelve ERC grants in total, a total which I believe exceeds that of any other UK Computer Science department. The ERC has been, in my opinion, the most important development for European science of the last century. It is painful indeed to contemplate a future without it: there are challenging times ahead for UK universities. But amidst all the doubt and uncertainty,

*continued on next page* ►



from previous page ►

there is one thing that I am quite certain about: the University of Oxford will not just continue but will prosper in the years to come. And there is no institution, anywhere in the world, that I would rather work for – Brexit or no Brexit!

We are very much looking forward to celebrating the department's 60th anniversary in 2017. (See page 8.)

#### DEPARTMENT REVIEW 2016

One of the big changes in academic life since the 1980s is the ever increasing scrutiny of our activity. As well as national activities such as the Research Excellence Framework, universities typically organise their own internal assessments, and Oxford is no exception. Our last such evaluation, in 2010, made recommendations that have changed the department dramatically – the establishment of an algorithms research group being the most obvious example. In June 2016 we underwent the latest such assessment. With a panel of external assessors, we submitted 130 pages of self-evaluation reports, critically assessing all aspects of our activity. This was followed by two visits by the panel, over 3 days in total, where the panel had the opportunity to meet with staff and students. Despite the incredible amount of work that such reviews entail, and the stress that they inevitably generate, I am pleased to report that the review was an extremely positive event, with praise – and, of course, suggestions for further improvement – offered across the whole spectrum of our activities.

**Professor  
Michael Wooldridge**  
November 2016



## Sir Tim Berners-Lee joins the University of Oxford's Department of Computer Science

Professor Sir Tim Berners-Lee, inventor of the World Wide Web, has joined the Department of Computer Science at the University of Oxford as a professor. Sir Tim, who has become a member of Christ Church, will be undertaking research. Sir Tim is also a full-time professor at the Massachusetts Institute of Technology (MIT), in Massachusetts, USA, where he is based, and where he leads the Decentralized Information Group research. He will continue to shape the future of the Web as Director of both the World Wide Web Consortium (W3C) and the World Wide Web Foundation.



Named as one of *Time* magazine's 100 Most Important People of the 20th Century, Sir Tim is best known as the inventor of the World Wide Web. In 1989 he wrote a memo called 'Information Management: A Proposal' in which he married up hypertext with the Internet, to create a system for sharing and distributing information globally. He also created the first web browser, server and editor, and ensured that the technology was made freely available to everyone.

Sir Tim graduated from the University of Oxford with a first-class degree in Physics in 1976, and we are very glad that he has returned 40 years later to become a member of the Department of Computer Science. Sir Tim is also pleased to join, at Oxford, his long time research collaborator Sir Nigel Shadbolt, who was recently appointed Principal of Jesus College, and with whom he co-founded the Open Data Institute, London.

'Few living individuals have changed our world as profoundly as Tim did, with his invention of the World Wide Web', said Head of Computer Science Professor Mike Wooldridge. 'We are delighted and honoured to welcome Tim back to Oxford, and are tremendously excited about what we will be able to do together in the years to come.'

The Dean of Christ Church, the Very Revd Professor Martyn Percy, said: 'we are delighted that Professor Sir Tim Berners-Lee will be joining us. As one of the most significant innovators and scholars of our time, his work with us here in Oxford will continue to consolidate our standing as the world's top university. Christ Church also intends to appoint a new Associate Professor in Computer Science to enhance our collaboration with the Department, and hopes to offer at least three undergraduate places per year in the subject.'

## News in brief

Max Whitby, first year DPhil student, won the Best Student Paper Award at the DNA22 conference for the paper titled 'Chemical Reaction Network Designs for Asynchronous Logic Circuits'. The paper proposed the first design for an asynchronous computing device using chemical reaction networks.

Anna Muszkiewicz has been awarded an EPSRC Doctoral Prize. During her DPhil project, Anna has constructed multi-scale models of human atrial muscle cells and whole atria to investigate the role of the nNOS protein in human atrial electrophysiology. During the EPSRC Doctoral Prize project, Anna will design and conduct *in silico* drug trials for atrial fibrillation using a population of human whole-atria computer models.

Oxford DPhil student Martin Strohmeier has been awarded an EPSRC Doctoral Prize. During his DPhil project, Martin analysed the changing technological environment that threatens the security of wireless communication in air traffic control and aviation.

Computer Science DPhil student Bushra AlAhmadi has been awarded a 2016 Google Anita Borg Memorial Scholarship. She has received a €7000 scholarship, and attended the Google Scholarship Retreat in July in Zurich, Switzerland. She is one of only two students in the UK to receive an award. Bushra is undertaking her doctorate in the field of cyber security, where her research explores malware detection using software-defined networks (SDN).



## Grant awarded for research into cardiotoxicity

The National Centre for the Replacement, Refinement & Reduction of Animals in Research (known as NC3Rs) has just awarded £500k to Professor Blanca Rodriguez and co-lead investigator Alfonso Bueno Orovio. The award is focused on Blanca's team's research into cardiotoxicity – a major cause of drug attrition in pharmaceutical development and an area where many thousands of animals are used in safety assessment for drug screening purposes or for *in vivo* studies.

The aim of this award is to accelerate the use of computer simulation in the research of cardiotoxicity and specific cardiac diseases such as myocardial infarction and heart failure. The team includes an impressive list of collaborators from 11 countries including industry and academic scientists, clinicians and regulators.

Using data provided by this international network, a database of human cardiac electrophysiology and contractility in computer models will be created. Research evaluation will compare computer model-based human predictions to clinical outcomes, animal data and *in vitro* models, with the overall aim of building confidence and capacity in computer modelling.

## Funding awarded to remove the need to use animals in pain research

Oliver Britton and Professor Blanca Rodriguez have been awarded funding for a project that aims to develop and validate new computational models of human sensory neurons that are involved in pain signalling. By making human-specific neuronal models and the software to use them openly accessible and usable by providing training and teaching materials, the research team hopes to enable the replacement of certain types of animal experiments in pain research.



## Oxford rises in global Computer Science rankings

In new subject-specific rankings, compiled by the *Times Higher Education (THE)* Oxford University has been ranked as top in the UK and 3rd in the world for Computer Science.

The *Times Higher Education* World University Rankings previously included Computer Science degrees in the engineering and technology subject ranking, but this year, for the first time, there is a dedicated league table for Computer Science.

The University of Oxford, which became the first UK university to top the overall World University Rankings, makes the top five in seven of the individual subject rankings – more than any other institution.

Read more about the Computer Science rankings here: [goo.gl/FLXJ6h](http://goo.gl/FLXJ6h)

## Prize for PRISM

Professor Marta Kwiatkowska is part of a research team that has been given the 2016 Haifa Verification Conference (HVC) award for the invention, development and maintenance of the PRISM probabilistic model checker. The HVC award is given to the most influential work in the last five years in formal verification, simulation, and testing. PRISM is a software tool for modelling and studying the behaviour of real-life systems whose behaviour exhibits uncertainty or randomness. The tool has been in continuous development for over 15 years.



## Computer-aided verification award

Professor of Computer Science Hongseok Yang is part of a team that won the highly regarded CAV (Computer-Aided Verification conference) 2016 Award. The award recipients have been honoured for the development of the theory of separation logic, which includes the key notion of separating conjunction, the work showing its applicability in the analysis of non-trivial programs, and the tool development that culminated in Facebook Infer.

## News in brief

Professor Leslie Ann Goldberg was honored at an event on 11 October at Bletchley Park, which saw the launch of the Medical Research Council (MRC) Clinical Sciences Centre's initiative to celebrate women in maths and computing. This will be a new development of the Suffrage Science scheme, which aims to encourage women into science, and to reach senior leadership roles. Leslie was one of 12 women to receive awards to celebrate their scientific achievements and ability to inspire others. The awards themselves are science-inspired pieces of jewellery, designed by students at the renowned arts college Central Saint Martins-UAL. After two years, the 12 winners will hand on their jewellery to a recipient of their choice, at another awards ceremony – thus extending the thread of recognition to more women within the maths and computing field. Read more about the awards, and an interview with Leslie here: [goo.gl/DI5a0W](http://goo.gl/DI5a0W)

The Grace Hopper Celebration of Women in Computing is the largest gathering of women in computing. It aims to shed the light on research by women in computing and technology as well as provide them with workshops and career opportunities. The Oxford Women in Computer Science society (OxWoCS) and the Department of Computer Science have initiated an annual scholarship for students to attend the celebration. This year DPhil students Bushra Alahmadi, Mariam Nouh and Paula Fiddi were awarded full scholarships to attend the celebration which took place in October, in Houston, Texas.

## Emanuele D’Oswaldo wins 2016 BCS/CHPC Distinguished Dissertation Award

The Council of Professors and Heads of Computing (CPHC), in conjunction with BCS, The Chartered Institute for IT, annually selects for publication the best British PhD/ DPhil dissertations in Computer Science. Emanuele D’Oswaldo has won this prestigious distinguished dissertation award for his DPhil thesis ‘Verification of Message Passing Concurrent Systems’.

## L’Oréal-UNESCO Women in Science Fellowship award granted

Maria Bruna has been awarded one of the 2016 L’Oréal-UNESCO UK & Ireland For Women in Science Fellowships (FWIS). The winning scientists, selected from nearly 400 applicants, were announced at a prestigious ceremony hosted at the Royal Society. Maria [pictured centre] received recognition for her research developing methods to represent systems of interacting particles that can capture phenomena at multiple scales.

For Women in Science Fellow  
Dr Maria Bruna  
University of Oxford



## Undergraduate numbers grow

This October saw the biggest ever intake of undergraduate computer scientists into the department. We made a record-breaking 82 offers to students across the Computer Science, Maths & Computer Science and Computer Science & Philosophy degrees.

Early figures indicate that competition for places on undergraduate Computer Science courses starting in 2017 will be particularly fierce. Already some of the most competitive courses at Oxford, applications across the three degrees have risen about

18% compared to last year’s figures.

The number of colleges offering Computer Science courses is also increasing. From Michaelmas term 2017, Lady Margaret Hall and Christ Church will join the rank of colleges where students may read Computer Science. Jesus College is planning to offer courses from 2018 onwards, with Hertford College beginning to offer single honours Computer Science, alongside the Philosophy & Computer Science course it already offers. Keble, St Anne’s and St Catherine’s colleges have all recently increased their provision, with the addition of a second Computer Science tutor in each college.



## Turing and Strachey’s musical recordings restored

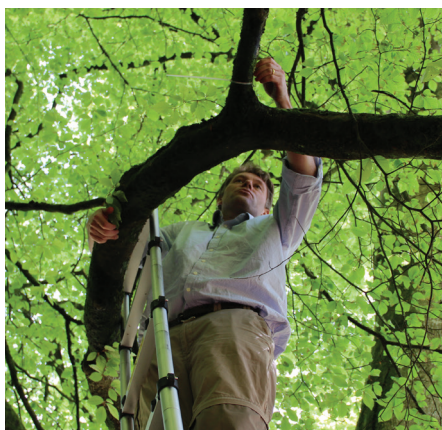
Researchers in New Zealand have succeeded in restoring the first recording of computer-generated music, made by Alan Turing and Christopher Strachey when they were working together in the early 1950s. Christopher Strachey (1916–1975) was a pioneering computer scientist and the founder of the Programming Research Group, now part of the Oxford Department of Computer Science.

If you would like to know more about Strachey and his work with Turing, come along to the Strachey 100 Conference, which has been organised on the centenary of Strachey’s birth to celebrate his life and research. To read more about the work to restore Turing and Strachey’s music visit [goo.gl/dnfi9e](http://goo.gl/dnfi9e)



## Cicada – tracking in the New Forest

Professor Alex Rogers, members of his research team (and Charlie the dog) visited the New Forest in May to deploy 80 smart acoustic sensors in areas where the New Forest cicada has previously been found. The sensors worked as expected but unfortunately there was no sign of the cicada. Updated versions of the sensors have since been used to survey for bats in Maderia (in collaboration UCL), and will be used by the Zoological Society of London to search for the endangered Cuban greater funnel-eared bat in January. For more details see [newforestcicada.info](http://newforestcicada.info) and [soundtrap.io](http://soundtrap.io).



## Students program themselves to competition victory

Department of Computer Science students were part of the St Catherine's College team that won the UK/Ireland round of the International Collegiate Programming Contest.

The team was made up of Hristo Venev, Mihail Jianu and Sauyon Lee, with Nick Hu as organiser/student coach. Hristo and Mihail are first year Computer Science students; Sauyon and Nick are in their second year. The team won by a considerable lead in a competition round that had 171 teams, from 26 universities competing at 13 sites, all substantial increases on last year.

The ACM International Collegiate Programming Contest (ICPC) is a multi-tier, team-based, programming competition. The contest involves a global network of universities hosting regional competitions that advance teams to the ACM-ICPC World Finals. Participation has grown to several tens of thousands of the finest students and faculty in computing disciplines at almost 2,736 universities from over 102 countries. For more details, see [nwerc.eu](http://nwerc.eu)

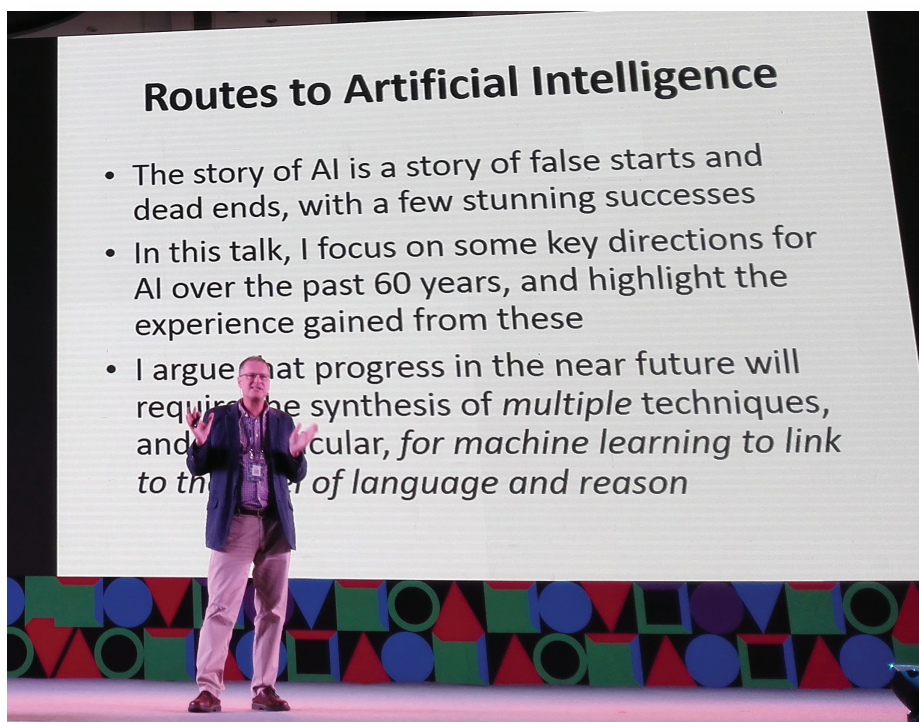
## News in brief

'Ada Lovelace and the abstract machine' is the title of Professor Ursula Martin's article, recently published in *The Times Literary Supplement*.

You can read the full article here: [goo.gl/kTTwna](http://goo.gl/kTTwna)

## Routes to Artificial Intelligence

- The story of AI is a story of false starts and dead ends, with a few stunning successes
- In this talk, I focus on some key directions for AI over the past 60 years, and highlight the experience gained from these
- I argue that progress in the near future will require the synthesis of *multiple* techniques, and, in particular, *for machine learning to link to the synthesis of language and reason*



Head of Department Professor Michael Wooldridge visited Shenzhen, China where he was invited to give the key-note speech at the Global Artificial Intelligence & Robotics Summit. There were 2000 tech entrepreneurs and investors in the audience.



# A letter from the Development and Alumni Manager



It has been a very exciting start of the term for our department as we look forward to a full year of events and milestones ahead. It is my pleasure to share the most recent activity with you, and to formally announce our upcoming celebratory year with the 60th anniversary of Computer Science at Oxford in 2017.

## Alumni Weekend

Many thanks to those of you who came to Oxford to celebrate the 2016 Alumni Weekend. A highlight of the annual festival included Professor Nigel Shadbolt's lecture 'Artificial Intelligence: Fact and Fiction' in which the latest developments in Oxford's cutting-edge research were used to address and discuss the perceived threat of AI on humanity. Details of a full weekend of lectures and celebrations over

Alumni Weekend 2017 will follow in the next issue of *Inspired Research*. Save the date now for 15-17 September 2017 to make sure you don't miss out on a very special 60th anniversary celebratory weekend.

## Forthcoming events

We are once again hosting an Alumni Christmas Drinks event at the iconic Royal Society on 7 December 2016 from 6:30pm to 9:30pm. We do hope you will join us to hear the latest news about exciting developments in the department as part of our ambitious plans for the next 60 years of computing at Oxford, hosted by Professor Michael Woolridge. We look forward to welcoming you in London!

## Upcoming 60th anniversary

Our next issue of *Inspired Research* will be a special edition, focusing on the 60th anniversary of Computer Science at Oxford, which we will celebrate in 2017. As we look forward with excitement and nostalgia to this year ahead, we are keen to involve our ever-growing community of alumni around the world to share their memories and hopes for the future with us

as part of our shared anniversary celebration.

What was your most inspirational moment during your time as a student? How has your time in the Oxford educational environment impacted your career beyond these walls in a way that is perhaps unique amongst your peers and colleagues? In a broader context, as the world becomes more interconnected and dependent on technology in this digital age, what is your greatest hope to impart on the next generation of innovators at Oxford?

## Building our Future

In the previous issue of *Inspired Research*, you read about the department's need for space as we have outgrown our current building to the point of bursting. The solution to these issues is a new Computer Science building that will form a collaborative central hub in Oxford to bring together our research teams, students and staff in a state-of-the-art environment that will enable us to reach our full potential for contribution and impact both within the University's academic community, and in the wider world. We will have some major

*continued on next page* ►





Nigel Shadbolt



from previous page ►

developments and concrete(!) details on this in the very near future. In the meantime, if you would like to find out more about this project or have an interest in contributing to the future of Computer Science at Oxford, please don't hesitate to email me.

### And finally – keep in touch!

We'd love to hear your news and find out what you've been up to. Please also let us know if you have any suggestions or comments about our Alumni programmes – we really want to make sure that we are providing the kind of events and opportunities to engage with the community and department that works best for your interests and needs. Your feedback really does make a difference.

If you would like more information on any of the above please contact me:

Megan Schaible,  
Development and Alumni Manager at [megan.schaible@cs.ox.ac.uk](mailto:megan.schaible@cs.ox.ac.uk)

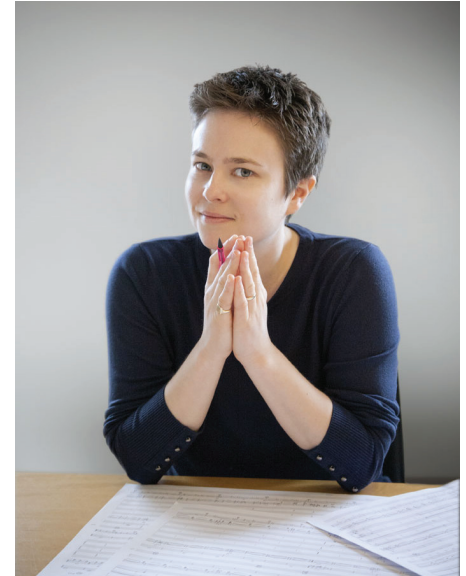


# Computer Science alumna Emily Howard premieres new piece at Proms

Emily Howard, composer, Senior Lecturer at the Royal Northern College of Music, and Oxford Computer Science alumna, premiered a new piece, *Torus (Concerto for Orchestra)*, at the BBC Proms on 25 August.

Emily was a member of Lincoln College and completed a BA in Maths and Computer Science before switching to musical composition for her postgraduate education and becoming a successful classical composer. The late Sir Geoffrey Hill, former Professor of Poetry, described her work as 'austerely sensuous and sensuously austere' and *Classical-music.com*, whilst *BBC Music Magazine's* website picked out *Torus*, as one of six 'don't miss' premiere highlights in the 2016 Proms season.

Emily's early interest in maths and science has influenced her musical career and many of her pieces make reference to this, with titles including *Calculus of the Nervous System*. A



©SamFairbrother

piece about Ada Lovelace called *Ada Sketches* which was performed in Oxford under her direction in December 2015, forming part of the celebrations of the 200th anniversary of Ada Lovelace's birth. Emily enjoys ongoing collaborations with the University, including with the Mathematics Institute and the Oxford e-Research Centre (OeRc).

## Alumni news in brief

Edward Molyneux is the Chief Executive Officer of FreeAgent, a cloud-based accounting software designed specifically to help 'micro-businesses' of fewer than 10 employees. The hugely successful company is just about to be floated on the stock market. Edward studied for his degree in Engineering and Computer Science whilst also learning to fly with the RAF. He became an RAF pilot then left the military to become a consultant for defence technology businesses, before deciding to launch his own venture.

Alumnus Toby Abel (Computer Science, Keble College, 2008) is the co-founder of Krzana, a search engine which enables users to filter vast amounts of data from news channels, social media, RSS feeds and blogs in 'real time'. Toby has coordinated the development of the technology behind Krzana, which has an agile system of filters that have been proving especially useful to those working within the fast-paced financial markets. Read more at [krzana.com](http://krzana.com)

## Alumni news in brief

OpenRent is a success story for alumnus Darius Bradbury (Computer Science, St Catherine's, 2004). Darius co-founded OpenRent as a way to improve the property rental experience for both tenants and landlords, cutting out the cost and bother of using a high-street estate agent. OpenRent is an online service that connects tenants and landlords via a secure platform, using SMS and cloud messaging to ensure a speedy tenancy creation process. The system is cloud based, with enquiries from across the web all entering a centralised system. In 2015, OpenRent became the largest letting agent in the country, and now lets over 50,000 properties annually.

[openrent.co.uk](http://openrent.co.uk)



Well done to department alumna Anne-Marie Imafidon, named by *Computer Weekly* as one of the top 50 most influential women in UK IT 2016. Anne-Marie founded volunteer organisation Stemettes to inspire the next generation of women into science, technology, engineering and mathematics via a series of panel events, hackathons and through the media.

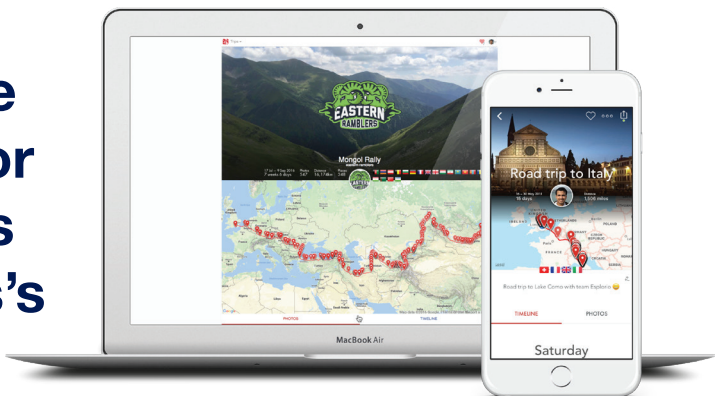
The 2016 Gödel Prize has been awarded to Oxford alumnus Stephen Brookes — and co-winner Peter W. O'Hearn — for their invention of Concurrent Separation Logic. The Gödel Prize recognises their major contributions to mathematical logic and the foundations of Computer Science.



### Well done Paul!

We were delighted to congratulate alumnus Paul Bennett (front, right) at the 2016 Olympics. Paul, who graduated with an MSc in Computer Science, won a gold medal as part of the Men's Eight rowing team.

## Oxford Software Incubator supports alumnus's start up



Department of Computer Science alumnus Son 'Sean' Pham is one of the founders of Esplorio, a tech start-up which is beginning to make name for itself in the travel app market. The Esplorio iOS app lets travellers automatically check in to favourite places, map out routes via GPS, and upload photos in order to create a digital travel journal.

Co-founder Essa Saulat explains, 'Our app doesn't require roaming data to record journeys, so users can travel the world without having to worry about racking up roaming charges.

We want people to enjoy their travels, so instead of them having to manually log their journey, Esplorio automatically checks you in at each place you visit.'

The company was founded in December 2015 and received funding from several sources, including the European Space Agency Business Incubator, and the London TravelTech lab, plus support from the University of Oxford Software Incubator. [esplor.io](http://esplor.io)



# UnBias project: Are 'fair' algorithms possible?

Algorithms are a fundamental part of our browsing experience – even though many of us may be unaware of their existence or know what exactly they do. Algorithms provide the rules or processes through which online sites and platforms operate. They assist us in sifting through the vast amounts of content available online and can help us to find content that is personally relevant.

However, algorithms are rarely transparent and public concerns have been raised about their ubiquity. Some concerns relate to the adequacy of the algorithms used to shape our browsing experience. For example, in August 2016 Facebook replaced human staff on its trending news team with an automated system that used algorithms to determine what news items would be put into users' feeds. This was an attempt

to address perceived problems around human decision-making after complaints about political bias in the types of item chosen. However, this led to other kinds of problem as the new system allowed false news items to be promoted alongside items containing offensive terms and images.

Other concerns over algorithms relate to issues of fairness. Some argue that particular algorithms are not designed as neutral or that the datasets they are trained on are not neutral; both instances might then produce results that are biased. We have seen these concerns arise through complaints that the results of searches put into Google Images reinforce racial prejudices by depicting black and white people differently and that enquiries in LinkedIn promote male names ahead of female ones.

Concerns over the adequacy and fairness of algorithms, combined with their typical lack of transparency, mean that algorithms become an ethical issue of societal concern. How fair is it that our browsing behaviours are shaped by processes we know so little about? Is it possible to design algorithms that can be fair and visible to all? These questions are taken up by the 'UnBias' project – a collaborative EPSRC funded research study led by the University of Nottingham

**Members of the Human Centred Computing (HCC) group are collaborating with the University of Edinburgh in two exciting initiatives that explore the implications of new technologies for our social lives.**

in partnership with Oxford and Edinburgh. The project, full title 'UnBias: Emancipating Users Against Algorithmic Biases for a Trusted Digital Economy', runs from September 2016 to 2018 and will look at users' experiences of algorithm-driven internet services and the process of algorithm design. Work will include user-group studies to understand how citizens conceptualise matters of bias and fairness in relation to algorithms. We particularly focus on the browsing behaviours of young people and their understandings of fairness and transparency when online. UnBias will provide policy recommendations, ethical guidelines and a 'fairness toolkit'. This toolkit will be co-produced with young people and other stakeholders and will include resources to support understanding about online environments.

# Anthrobotics: the growing role of intelligent machines and social robots

The rapid pace of contemporary technological innovation suggests an ongoing development and deployment of intelligent machines and social robots that will induce radical changes in our lives. How can we understand the relationships between humans and artificial cognitive systems?

Members of the Human Centred Computing (HCC) group at Oxford are collaborating with the Anthrobotics Cluster at the

University of Edinburgh to explore these issues through a series of workshops. The Anthrobotics Cluster was created by PhD student Luis de Miranda; its aim is to reflect on the becoming of social automata from an interdisciplinary perspective. Its activities include reading group sessions, the first of which was held in Edinburgh and led by the HCC's Mark Hartswood. The group discussed definitions of robots as 'enablers'. Enablers have both positive attributes – the facilitation

of tasks and alleviation of human labour – as well as negative ones – co-dependency, addiction and loss of responsibility. Among the issues discussed in the session were: identity in social groups and the processes through which identity is constituted; symbiosis between humans and intelligent machines; fairness and bias in multi-agent systems, safety by design and collective agency. Further reading group sessions are planned.

# The 2020 Science programme

2020 Science is an ambitious research programme that has the dual aims of developing novel computational approaches to tackling fundamental problems in the natural sciences, whilst taking an innovative approach to supporting the career development of the young scientists who are actually undertaking that research. Designed from the outset as a fellowship programme, 2020 Science has focused on developing appropriate training and support mechanisms aimed at ensuring that the fellows have the right skills and knowledge to engage with genuinely rewarding but difficult problems at the interface between the mathematical and physical sciences and the life sciences. Head of the Computational Biology theme in the Computer Science Department, and Principal Investigator of the project, Professor David Gavaghan discusses the 2020 programme.



Informing our approach right across the 2020 Programme is the increasingly apparent dichotomy faced by individual (particularly young) researchers in computational science to balance the necessity to further their own careers through dissemination of their results through traditional channels (such as journal papers), against the competing demand to make work available in less traditional formats (typically online and open source) that promote the re-use of their work.

2020 Science was funded through EPSRC's (The Engineering and Physical Sciences Research Council) Cross-Disciplinary Interface Programme 'Landscapes' call as an experiment to test whether the cohort-based approach to training introduced through its Centres for Doctoral Training (CDT) might be extended favourably to post-doctoral training. Our proposal was submitted jointly with the Microsoft Research Laboratory in Cambridge (MSRC), the CoMPLEX CDT at University College London (UCL), and the Systems Biology and Life Sciences Interface CDTs at the University of Oxford. Funding of £4m from EPSRC was awarded in September 2010, supplemented by a direct grant from MSRC to Oxford of £0.5m.

In developing our programme, we recruited a cohort of outstanding early career researchers who had already demonstrated research excellence in their own domain. By bringing them together and providing appropriate individually-tailored training, we have facilitated the formation of a substantial research network. Each individual research fellow uses the network not only to inform their own research directions, but also to explore new research avenues as a collective. This has allowed the programme as a whole to utilise the expertise of the individual to inform larger multi-disciplinary projects, resulting in the development of new and innovative computational methods, approaches, and tools that are being applied to important research questions in computational systems biology and ecology.

The complexity of natural systems in general results in quantitative models that are either computational from the outset or that are analytically intractable, so computational solution methods are essential. This complexity often (and increasingly) requires that models are built by composition of sub-models describing processes at differing levels of biological organisation or differing spatio-temporal scales. These properties of natural systems mean that the development of reliable and reusable software, the development of infrastructure to support routine model composition, and the comparison of differing (mathematical and) computational

approaches to the modelling of particular natural systems are critical to future progress. Our work in this area has looked to address these issues by focusing on the dissemination of the outputs of our research, in particular our computational models and software, in a manner that makes it as easy as possible for the wider research community to re-use or build upon our work.

Our new approach to research dissemination builds largely on existing software development efforts in the Computer Science Department at Oxford in the area of functional curation. Our aim is to provide an online environment within which other researchers can gain access not only to our open source software but also to all of the data and meta-data required to fully replicate, and hence build upon, our results. To date we have built web repositories in cardiac cell modelling, species distribution modelling, and uncertainty quantification. Our ultimate goal is that these research communities will be able not only to access all of the information necessary to repeat the results in our own publications in these areas, but will also be able to upload their own software and models, and compare them against other, competing computational models, algorithms and approaches. Researchers will also be able to 'validate' their approach against any experimental data that we can make available or link to.

*continued on next page ►*





from previous page ►

The 2020 Science project is now nearing its conclusion and has been tremendously successful in each of its primary goals. Of the seventeen fellows employed over the course of the programme, ten are already in permanent academic posts. All remain in research positions in academia or industry. The programme has developed several large suites of software that are available and widely used within the academic and industrial research communities, and collectively the fellows have published almost 300 papers in leading journals and conference proceedings over the lifetime of the programme.

Our recent final meeting with our external advisory board was attended by representatives of the Wellcome Trust, and the EPSRC, BBSRC (Biotechnology and Biological Sciences Research Council), MRC (Medical Research Council), NERC (Natural Environment Research Council), and ESRC (Economic and Social Research Council). A lively and positive discussion on the merits of this new approach to post-doctoral career development was chaired by Lesley Thompson (Director of Academic and Government Strategic Alliance at Elsevier), and our hope is that some of the innovative directions developed during 2020 Science will feed into policy changes within the major research funders.

For more information see [www.2020science.net](http://www.2020science.net) or contact [david.gavaghan@cs.ox.ac.uk](mailto:david.gavaghan@cs.ox.ac.uk)

## Genome sequencing progress

The University of Oxford is playing a leading role in the delivery of a project that will change the way in which diseases are diagnosed and treated within the UK National Health Service (NHS), and around the world. This is the 100,000 Genomes Project, an ambitious programme, funded by the UK Department of Health, in which DNA will be extracted from 100,000 samples of blood and tissue provided by NHS patients and 'sequenced' to reveal the information it holds.

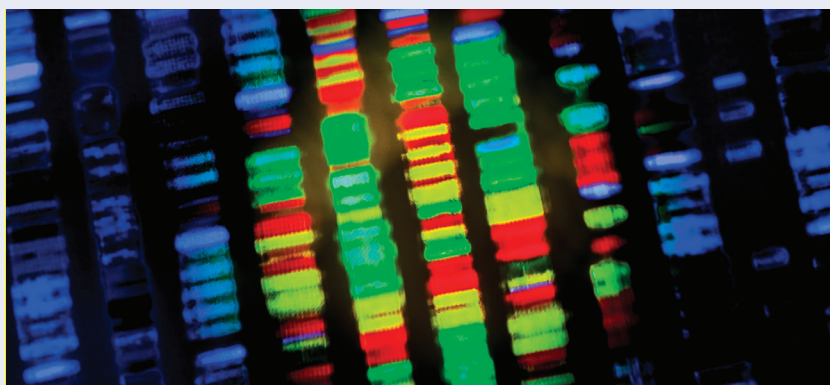
The information held in a genome helps to determine susceptibility to disease and response to treatment. Using this information in diagnosis and treatment planning can lead to significant improvements in care. Before we can do this, we need to obtain and analyse data on a large number of cases, to help us to understand how variations in the genome are related to disease, treatment, and outcomes. At the same time, we need to ensure that the results of this research are translated into clinical practice.

A team of researchers from the Department of Computer Science, led by Professor Jim Davies, has designed and developed the software used for data acquisition and management, as part of a model-driven architecture

for translational research. Colleagues from the Medical Sciences Division in Oxford have developed the procedures for sample management and processing, organised initial pilot studies, and advised on scientific and ethical foundations.

More than 17,000 samples have been collected so far, and more than 13,000 of these have been sequenced. The results of analysis, based upon existing knowledge, are being validated and fed back to the patients and their families by a network of Genomic Medicine Centres (GMCs), commissioned by NHS England. The Oxford NHS GMC has provided samples from more than 350 patients with cancer and more than 300 patients with rare, inherited disorders.

Some of these patients will get a new diagnosis: a more precise, scientific explanation for their condition, which may lead to a change in treatment. Others will have the satisfaction of knowing that they have contributed samples and data to a world-leading programme of collaborative research, including many clinical researchers and data scientists from Oxford, aimed at developing new understanding, new diagnostics, and new treatments that will benefit others with the same condition.



# Sentiment analysis of OUP's Children's Corpus

**123,436 stories. 54 million words. A unique window into the inner world of children and an opportunity to discover what they care about and what makes them happy, sad or anxious.**

Earlier this year, children from all over the UK submitted stories for BBC Radio's '2,500 Words Competition'. In association with the Oxford University Press (OUP), department spin-out TheySay was invited to analyse the children's writing in order to provide valuable insights into the sentiment and emotions detected in the stories for the first time in the competition's history.

Using advanced computational linguistics and machine learning techniques TheySay was able to unearth fascinating information on the emotional signals detected in the stories and highlight how these change in different age groups and locations. The text from all submitted stories was analysed and data was collected around the positive, neutral, and negative sentiment as well as the emotional content of every story. TheySay also determined what entities, ideas, or opinions appeared most frequently in a positive or negative context in the entire set of submissions.

Overall, the stories submitted were complex tales that contained both negative and positive sentiment,

**'There were more mentions of scary or unpleasant aunts in stories from Northern Ireland than any other region; aunts in other parts of the UK were presented as mostly harmless.'**

with happiness and fear being the most common emotions. There was a significant drop of average positive sentiment with age. In fact, a 20% drop of average positive sentiment was detected from the youngest age group to the oldest one, showing that older children submitted stories that on average were darker, more complex, and multi-layered.

Happiness peaked in stories submitted by 7-year-old children, with a noticeable drop after that. The detected levels of fear and anger rose in stories submitted by children in the older age groups, perhaps a result of teenage angst.

There was also a small difference between the sentiment levels in stories submitted by girls and those submitted by boys. On average, girls' stories contained slightly higher levels of positive and neutral sentiment than those written by boys. Similarly, there was variation observed in the levels of related emotions: boys' stories expressed more fear and anger while girls' stories had higher levels of happiness and surprise.

Perhaps surprisingly, the words 'school' and 'teacher' were among those used in a positive context most frequently. Schools were often mentioned in association with happiness and excitement. The words 'adventure', 'heart', and 'chocolate' were also very popular words associated with positive sentiment and happiness. On the other end of the spectrum, the word 'door' was used most often in a highly negative context; many of the submitted stories talked about 'locker' or 'creaky doors', or doors behind which scary creatures like



dragons or monsters were hiding.

Intriguing differences appeared between stories submitted from different parts of the country. There were more mentions of scary or unpleasant aunts in stories from Northern Ireland than any other region; aunts in other parts of the UK were presented as mostly harmless. The word 'maths' was used in a highly positive context much more frequently in stories submitted in Scotland compared to those submitted elsewhere. In stories written by English children, the words 'refugees' and 'Syria' were among those most frequently used in association with positive sentiment. Interestingly, these words appeared most often in stories that expressed high levels of hope and happiness, with the children's attitude towards refugees being largely positive and empathetic.

Finally, TheySay was able to provide a heat-map of happiness, showing how happiness in the children's stories varied by post-code. The highest average happiness levels were detected in stories submitted in Llandudno, Wales.

The insights provided by TheySay around the sentiment and emotions contained in the children's stories gave a new layer of understanding of children's language and a unique look at how age, gender, and location can affect children's writing.



# Five go to...



*Five Department of Computer Science academics made a successful debut at the Hay Festival in May 2016.*

Their topics ranged from algorithms and Artificial Intelligence to security in social media, covering a variety of the research undertaken at the department.

Professors Mike Wooldridge, Ursula Martin, Leslie Ann Goldberg and Dr Jason RC Nurse gave lectures to packed-out and enthusiastic audiences, while Professor Peter Millican ran a programming workshop for teenagers. Quite a brave undertaking when you are relying on technology to work in a marquee.

Ursula explored the earliest foundations of Computer Science, talking about Ada Lovelace in a sold-out lecture, while Peter hopes that his children's workshop on programming for beginners might inspire Computer Science pioneers of the future.

Artificial Intelligence is one of the more obvious topics that crosses over from the realities of scientific research into the distorted fantasies of science fiction. The news is full of stories about robots taking our jobs, but in his lecture Head of Department Mike Wooldridge helped audience members see past this paranoia, explaining the reality of AI today: what makes AI work after half a century of effort, what is possible, and what the implications are for all of us.

Jason's talk 'Social Media: The use of your online information for the good, the bad, and the ugly' keyed into the fear we all have about the negative potential of social media. Leslie explained a little of what we know about the limitations of algorithms, and also explored the famous P vs NP problem.

Lecturing in a Welsh field is quite a change from the kind of environment our academics are used to working in, and at a festival you must always expect the unexpected – from challenging audience questions and celebrity involvement (Dara Ó Briain asked a question from the back row of Ursula's lecture), to the rather un-Welsh sunshine. The very smart department fleece jackets we took with us were just too warm to wear!

The development of Computer Science has an impact on so many aspects of our day to day lives, by taking part in the Hay Festival, computer scientists at the cutting edge of research had the opportunity to explain how things work today, and how they might work in the future.

The academics who took part all had a great time and we certainly hope that our first 'Five go to Hay' adventure won't be our last.





# Media wall

## *Our pick of the latest podcasts and vodcasts that feature Computer Science research at Oxford*

- Oxford Sparks and a group of Oxford researchers have commissioned a new animation about 'Keeping Social Media Social'. The video aims to increase awareness of how social media may be used as a tool for good purposes while making people aware that it is being used for bad purposes. It explores ethical questions relating to social media, and raises questions about how we document ourselves on social media, leaving not only our friends and relatives to explore our lives, but undesirables, and how this can also be a force for good if utilised effectively by security services. The academics involved, Jason RC Nurse, Helena Webb and Professor Marina Jirotko, hope that the video will encourage and enlighten younger students on the topics of Computer Science and mathematics as well as show the possibilities of change with new algorithm creation.  
[goo.gl/y8q33q](http://goo.gl/y8q33q)
- The Networked Quantum Information Technologies (NQIT) project has just released an animation about quantum computing which was created using funding awarded by the Engineering and Physical Sciences Research Council (EPSRC). The NQIT Hub, part of the UK National Quantum Technology Programme, is led by the University of Oxford and involves 9 UK universities and over 30 companies all working together to develop a quantum computer demonstrator.  
[goo.gl/FZ1Ztv](http://goo.gl/FZ1Ztv)
- The Group Design Practical projects are an important element of the second year for our undergraduate students. The group design practicals encourage teamwork and allow students to put their recently gained knowledge to practical use. This year the end of project showcase day was filmed, and the results can be seen here:  
[goo.gl/u4qQU4](http://goo.gl/u4qQU4)



**These videos, and many others are available on the department's Media Wall:** [www.cs.ox.ac.uk/mediawall](http://www.cs.ox.ac.uk/mediawall)

## Funding awarded for personal technologies for active health research



Professor Marta Kwiatkowska and her team have been awarded EC funding for AffecTech – a project to develop 'Personal Technologies for Affective Health'. Affective (or mood) disorders are predicted to be the highest ranking cause of disease by 2020. This project advances the state-of-the-art of personal health technologies for affective disorders such as depression and anxiety. Current wearable technologies can capture emotional responses but understanding this data usually requires a physician's input. AffecTech will see a shift to low-cost self-help technologies which will enable the individual to visualise, explore and regulate emotional responses.

## Quantum group has a new 3-year EPSRC funded project

Professor Samson Abramsky (University of Oxford) and Simone Severini (University College London) are co-inventors of the two leading frameworks for understanding contextuality: the notion that the

observable properties of a system cannot be assigned predetermined outcomes in a manner independent of the method of observation. The main themes of the project involve synthesising and developing the various frameworks for nonlocality/contextuality towards a structural understanding of the role contextuality plays in achieving quantum advantage in information processing and towards applications of these tools in both concrete models of quantum

computation (ie magic state distillation and measurement-based quantum computation) and more abstract models of computation.

The team will work in collaboration with international experts in theoretical computer science, quantum information and computation, and quantum foundations, including with Researcher Co-Investigator Nadish de Silva (UCL) and Researcher Rui Soares Barbosa (Oxford).



# A Centre of Excellence in Computational Biomedicine

Professor Blanca Rodriguez is the Oxford University Principal Investigator in a collaborative scheme that has established a new Centre of Excellence in Computational Biomedicine (CompBioMed).

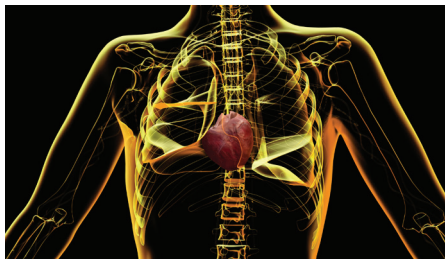
CompBioMed is a user-driven Centre of Excellence in computational biomedicine, intended to nurture and promote the uptake and exploitation of high performance computing (HPC) within the biomedical modelling community. The users come from academia, industry and clinical practice.

The Centre of Excellence will provide a focal point for the development and sustainability of software tools and services which are capable of delivering modelling and simulation of all aspects of the human body, from the genomic level to the whole human and beyond, in health and disease.

## Dancing with robotlets at the Being There showcase

In September the Watershed digital creativity centre in Bristol hosted the 'Being There' showcase – a celebration of three years of collaborative EPSRC funded research exploring the opportunities and challenges that arise when humans and robots share public space.

Being There is a four-year project funded by the Engineering and Physical Sciences Research Council (EPSRC), which brought together five collaborative teams of researchers from the Universities of Exeter, Bath, Oxford, Cambridge and the Bristol Robotics Laboratory, to explore some of the current themes in robotics.



Computer-based modelling and simulation is well established in physical sciences and engineering, where the use of HPC is now routine. Research will focus on three key areas, cardiovascular medicine, molecularly-based medicine and neuro-musculoskeletal medicine.

Lead by a group of 15 'core partner' universities and companies, the centre will also support and facilitate modelling and simulation activities, and provide education and training for a diverse set of communities, spreading knowledge, tools and best practice to students and researchers across this domain.

The showcase featured presentations from the Being There robotics researchers, and quick-fire sharing sessions with the project leads spanning technology, engineering, psychology and security. There were opportunities to play with some robot games, and even dance with 'robotlets'. The showcase culminated in a robot cabaret featuring three fantastical robot performances, hosted by Bill Thompson of *BBC Click*.

Department of Computer Science academics are involved in two projects, Happilee and Localisation System. Read about them here: [goo.gl/xMyuHq](http://goo.gl/xMyuHq) [goo.gl/SeylLy](http://goo.gl/SeylLy)

Read more about Being There: [being-there.org.uk](http://being-there.org.uk)

## Oxford-Emirates Data Science Lab to streamline air travel

The Department of Computer Science is involved in a new Data Science Lab which Oxford University has opened in collaboration with Emirates. It will see experts from around the University use cutting-edge analysis to help the airline make its services more efficient and customer-focused.

Academics will work with the airline's ever-growing datasets to help it understand its processes and customer preferences in greater detail.

## Staff appointments and changes

Since the last edition of *Inspired Research*, there have been some changes. The following people have joined the department:

- **Anthony Lin:** Assistant Professor of Programming Languages
- **Christoph Haase:** Departmental Lecturer in Theoretical Computer Science
- **Milos Nikolic:** Departmental Lecturer in Databases
- **Professor Sir Tim Berners-Lee:** Professorial Research Fellow
- **Tim Muller:** Departmental Lecturer in Security.

Congratulations to Edith Elkind and Dan Olteanu who have been awarded the title of Professor in Oxford University's 2016 Recognition of Distinction exercise. Edith is a Non-Tutorial Fellow at Balliol College. Her research is focused in the area of algorithmic game theory and computational social choice. Dan is a Fellow of St Cross College, teaching and researching in the area of databases.

## News in brief

Associate Professor Standa Živný has been awarded a European Research Council (ERC) Starting Grant totalling over €1.4m over



5 years. Standa's work on the Power of Algorithms in Discrete Optimisation project (PowAlgDO) is tackling one of the fundamental questions in algorithms: the power of convex relaxations.

In July, Google Vice President and 'Chief Internet Evangelist' Vint Cerf gave a talk in the department on Internet evolution. The talk took a historical view of the Internet from the ARPANET period of the late 1960s to some speculation about the year 2036. Widely known as one of the 'Fathers of the Internet,' Cerf is the co-designer of the TCP/IP protocols and the architecture of the internet.

Professor Samson Abramsky is one of the co-organisers of a new programme, 'Logical Structures in Computation' at the Simons Institute, Berkeley, University of California. The aim of the program is to bring together researchers from selected areas of logic in Computer Science, hopefully resulting in a significant and lasting impact in advancing the field, bringing different communities together and stimulating the fruitful cross-fertilization of ideas.

Emeritus Fellow Bernard Sufrin has been involved in the Oxford Students Refugee Campaign. The campaign aims to get every student at Oxford University to pledge a monthly £1 contribution for two years. If every student took part, the funds could provide as many as 20 fully funded scholarships for asylum-seeking and refugee students.

Read more:

[oxfordrefugeecampaign.org](http://oxfordrefugeecampaign.org)

# Sir Jonathan Ive receives an honorary degree

Sir Jonathan Ive, the Chief Design Officer at Apple, Inc., received an honorary degree from the University of Oxford at the University's annual Encaenia ceremony on 22 June 2016. Sir Jonathan's nomination from the Department of Computer Science recognises his iconic, hugely influential, and incredibly successful contributions to industrial design.



Bob Coecke

## Funding granted for Quantum research

Associate Professor Jonathan Barrett and Professor Bob Coecke of the department's Quantum Group are part of a new John Templeton Foundation funded project called Quantum Causal Structures, worth US\$3.7m. Besides Oxford, the consortium includes the Perimeter Institute, Canada, and the Universities of Vienna, Pavia, Hong Kong, Queensland and Western Ontario. The project concerns the study of causality as the scaffolding underlying the fabric of space and time, accounting both for quantum theory and general relativity, towards a theory of quantum gravity as well as quantum-relativistic technologies.

## Samson Abramsky awarded honorary degree by Middlesex

Professor Samson Abramsky FRS has been awarded an honorary degree by Middlesex University. Samson has been recognised for his work in game semantics, an approach to formal semantics which uses game-theoretic concepts to analyze the structure of computation in terms of interaction between a system and its environment.





# Strachey Lectures:

## The once and future Turing

The most recent Oxford Strachey Lecture was given on 31 October, to a sold out audience of over 700 people at the beautiful Sheldonian Theatre. The lecture was given by Oxford's Professor Andrew Hodges on 'The Once and Future Turing'.

In 1951, when Christopher Strachey – former Head of the Department of Computer Science – began his career, his colleague Alan Turing had already made far-reaching and futuristic innovations, from the definition of computability and the universal machine to the prospect of Artificial Intelligence. Andrew's talk described the origins and impacts of these ideas, and how

wartime codebreaking allowed theory to turn into practice. After 1951, Turing was no less innovative, applying computational techniques to mathematical biology. His sudden death in 1954 meant the loss of most of this work, and its rediscovery in modern times has only added to Turing's iconic status.

Andrew Hodges authored *Alan Turing: The Enigma* (1983), which inspired the 2014 film *The Imitation Game*. If you missed the lecture, a recording is available at [goo.gl/tFfLJk](http://goo.gl/tFfLJk)

The event was generously supported by OxFORD Asset Management.



## Quantum supremacy

In May, Scott Aaronson delivered a Strachey Lecture on quantum supremacy. In it he discussed three proposed 'quantum supremacy experiments'.

In the near future, it will likely become possible to perform special-purpose quantum computations that, while not immediately useful for anything, are plausibly hard to simulate using a classical computer. These 'quantum supremacy experiments' would be a scientific milestone – decisively answering quantum computing skeptics, while casting doubt on one of the foundational tenets of Computer Science, the Extended Church-Turing Thesis. At the same time, these experiments also

raise fascinating questions for computational complexity theorists: for example, on what grounds should we believe that a given quantum system really is hard to simulate classically? Does classical simulation become easier as a quantum system becomes noisier? And how do we verify the results of such an experiment? The examples of quantum supremacy experiments discussed were: BosonSampling, IQP / commuting Hamiltonians, and random quantum circuits.

The Strachey Lectures are generously supported by OxFORD Asset Management.

Watch the lecture here: [goo.gl/7Zf584](http://goo.gl/7Zf584)

## News in brief

The Foundational Questions Institute (FQXi) has released a list of their top ten most popular articles, videos, podcasts, and essays from the past decade. The list features an article about Professor of Quantum Foundations, Logics and Structures, Bob Coecke. The article, titled 'The Quantum Linguist' explores how Bob has developed a new visual language that could be used to spell out a theory of quantum gravity – and help us understand human speech.

Postdoctoral researcher Efthymia Tsamoura has become an Alan Turing Institute (ATI) Research Fellow. Efi's research interests lie in the fields of databases, knowledge representation, query answering under constraints, distributed systems and multi-objective query optimization. In collaboration with researchers from ATI, Intel, the University of Oxford, and the European Bioinformatics Institute (EBI), she will create tools and techniques enabling scientists to more easily integrate web-based data into their activities. Oxford is one of the founding universities involved in the Alan Turing Institute, which was launched in 2015.

The Queensland government has confirmed a AU\$0.4m funding agreement with Open Data Institute Queensland (ODIQ) for the first Australian node of the UK-headquartered Open Data Institute Global Network. The Open Data Institute was founded in 2012 by Sir Nigel Shadbolt and Sir Tim Berners-Lee, now both Professors at Oxford's Department of Computer Science. The intention of the institute is to bring together commercial and non-commercial organisations and governments around specific sectors to address today's global challenges.

# The world outside

The department's students and academics are not only accomplished computer scientists. Below are some other achievements by members of the department.

Matthew Smith, a DPhil student in security, took part in the Oxford Shield Regatta. This was held in the All Japan University Championships as part of a rowing exchange with the University of Tsukuba. His team, the St Catherine's college boat club made it to the semi-final, missing out on a final spot by half a length.

Elisa Passini, a departmental Research Assistant, gained her first level teaching certificate of the Royal Scottish Country Dance Society during the summer, in St Andrews. The certificate includes assessments on the music, formations, general appearance and techniques, as well as the history of the dance. Elisa will be doing some teaching practice in Oxford over the next few months to gain experience for the full certificate, in order to teach her own class.

Leanne Carveth, the Deputy Academic Administrator, ran her first half marathon. This event was held in Oxford on 9 October, and saw 7,000 competitors weave their way through Oxford's historic buildings, finishing in Broad Street.

This year the department once again took part in the annual charity Dragon Boat race. Our team, 'The Floating Points', dressed as bumble bees, came second in the fancy dress category and rowed their way roughly half way up the leader board of 21 competing teams.

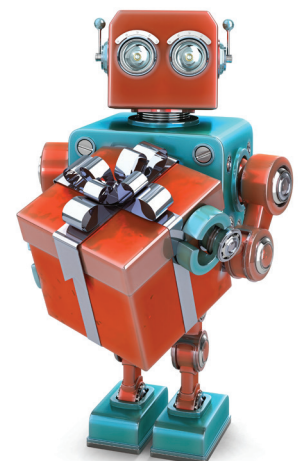


# Happy Birthday to our Head of Department

It was Monday, September 5 — the end of the holiday season, and Head of Department Professor Michael Wooldridge was all set for what promised to be a productive day, starting with a meeting with his predecessor Professor Bill Roscoe...

Mike encountered a rather cheerful Bill, and a sign saying 'Workshop in Honour of Michael Wooldridge: 50 Years of Human and Artificial Intelligence.' Many of his colleagues and friends had gathered from all over Europe for a surprise event to celebrate his 50th birthday. The day was devoted to talks highlighting his extensive contributions in the past decades to Artificial Intelligence and Computer Science. Topics included Mike's importance in developing the Liverpoolian Department of Computer Science, plus his research on areas including reasoning about computational economies (the RACE project), computational aspects of cooperative game theory, and dynamic epistemic logic.

by Paul Harrenstein.



# Making a SPLASH

Members of the Software Engineering group hosted a full-day workshop on Semantic Aware Model Driven Engineering (SA-MDE) at SPLASH 2016. The conference is a premier venue for programming, languages, and software engineering, and was held this October in Amsterdam. The workshop highlighted progress on the ALIGNED Horizon 2020 funded project for quality-centric, software and data engineering. The project applies the expertise of computer scientists from Oxford, Dublin and Leipzig with a broad range of data intensive applications from archaeology and anthropology to jurisprudence and encyclopedic data management.

The Oxford team have been exploring how the rich data-domain schemas can be used to automatically derive high-quality software. This will lead to cost and overhead reduction in the development of tailor-made data management systems. The workshop involved talks and a series of interactive sessions on Booster and The Model Catalogue. These tools form part of the data and schema-aware software generation pipeline. Participants had a chance to try out the tools and to generate their own systems, first hand.

One of the co-organisers of the workshop, Christian Dirschl from Wolters Kluwer Germany commented 'This workshop has shown that data-intensive applications gain importance in the field and that they require schema-aware software tools like Model Catalogue or Booster, in order to address the challenges of complexity, scale and inconsistency'.





## Congratulations to the 2nd year undergraduates!

Industry representatives formed part of the judging panel that chose the winners in the second year students' group design practicals. Teams of four to six undergraduates presented their projects in May, having chosen a topic to work on in January from a set of 13 different challenges. Project topics were presented as outline design briefs. Part of the work was to undertake a requirements analysis, working with the project mentor. The practicals have been designed to allow students to develop and apply theory learnt on the course. Some challenges were set or sponsored by the industry partners, which this year, in addition to the prize sponsors, included OxFORD Asset Management and Bank of America. The judging panel consisted of one representative from each of the other

sponsors – GResearch, Bloomberg and Metaswitch – plus University experts. Each industry partner awarded the teams a prize of £500 per winning team, based upon their own criteria.



## Oxford Computer Science Conference winners announced

Congratulations to everyone involved in this year's Oxford Computer Science Conference. Especially to William Rathje who was awarded best presentation for 'On the Fly Construction of Perceptually Uniform Color Spaces from User Surveys'. Best abstract went to Meredydd Williams for 'The Privacy Paradox and the Internet-of-Things', and Nathalie Cauchi who received best poster for 'Modelling Smart Buildings Dynamics'.

The Oxford Computer Science Conference is a forum for department members to gain experience with the all-important practice of research community participation. Established in 2004, the conference was originally held biennially and has since become an annual event.

## Student prizes

Across different year groups our most successful undergraduate students have received awards and prizes to recognise outstanding performance in their studies.

### Prelims (end of first year) prizes:

- Alexander Rice (M&CS, St John's) & Long Pham (CS, Keble) – Gibbs Prize
- Catalin-Andrei Ilie (CS, Oriol) – BCS Prize for best overall performance

### Third year prizes:

- Dominic Kennedy (M&CS, Balliol) – BT Prize for best overall performance and the Junior Maths Prize for outstanding performance in Maths papers
- Victor Porras (CS, Balliol) – Gibbs Prize for best performance in Computer Science papers
- Dan-Andrei Gheorghe (CS, Somerville) – G-Research Prize for Best Third Year Project
- Anthony Guo (CS, Somerville) & Christopher Kew (CS, New) – Hoare Prize for best performance in Computer Science

### Fourth year prizes:

- Benjamin Dawes (CS&P, Hertford) & Matthew Pickering (CS&P, Oriol) – Hoare Prize for Best Performance in Computer Science and Philosophy
- Angus Tayler (M&CS, St John's) – Hoare Prize for Best Performance in Maths and Computer Science
- Ashok Menon (CS, Oriol) – Hoare Prize for Best Performance in Computer Science
- Matthew Sjodin (CS, Worcester) & Jakub Sliwinski (CS, St Hugh's) – The Microsoft Research Prize for Best Project
- Pui Yiu Carol Mak (M&CS, St Catherine's) – G-Research Prize for Best Project in Maths and Computer Science.

Prizes ranged between £100 - £200.

CS = Computer Science.  
M&CS = Maths and Computer Science.  
CS&P = Computer Science and Philosophy.

# Emergination – a project to mentor students in Africa



Prince Abudu began his DPhil this year having previously studied at Morehouse College, USA. Prince grew up in Zimbabwe, where his mother struggled to get him access to education. However, he won a Higher Life Foundation scholarship to study at Morehouse, where he was one of 10 inaugural Ambassador Andrew Young International Scholars. This group of students from Zimbabwe and Burundi all previously lost one or both parents, but were among the top students in their nations.

Prince decided to try and help children in Zimbabwe to access educational e-mentoring, by founding Emergination Africa (EA) in 2012 with a Morehouse colleague. 'My motivation to start the program came from my background and upbringing. I attended my secondary education at Kutama College. As a single parent, my mother struggled to pay for my education. I had to miss a lot of classes as I would

constantly be asked to leave the school until my fees were paid. Given those dynamics, I had to work harder and strive to harness any opportunity that came my way.

Reflecting upon that experience, I realised that there are more than 20,000 high school students in Zimbabwean high schools who are seeking opportunities to attend university or college, but have no idea how they can get those opportunities. Furthermore, these students lack the knowledge required to make informed decisions about their future studies and careers,' he explains.

EA is pioneering Zimbabwe's first e-mentoring service, in partnership with a tech company in Boston, USA. As a co-founder, Prince has been engaged from the start working as the Chief Operations Officer and Operations Lead for the EA programme. EA uses an online platform to host mentor and mentee

accounts and modules – connecting Zimbabwean high school students with American college students for advice and assistance with college applications and career development. Mentees learn skills in SAT preparation, college applications and get general career guidance. Students can also talk to college admissions officers directly.

The project has so far been working with 13 high schools in Zimbabwe. Sixty students will initially be enrolled on the online platform to receive mentorship, attend classes on various topics and access professional panel sessions. EA is currently in talks with the Ministry of Primary & Secondary Education in Zimbabwe to bring this ambitious program to all the Primary and Secondary schools in the country.

[emerginationafrica.org](http://emerginationafrica.org)

[Pictured above]: Global mentoring: the key to the Emergination project.



# Analysing online personae

Today more than ever, people across the world are exploiting the internet for work and pleasure, utilising a vast variety of devices (eg computers, mobile phones, smart devices) and services to do so. Exploitation of cyberspace results in conscious information-sharing of personal and corporate data, and, inevitably, the creation of persistent data that many users may be unaware of – this is perhaps as metadata or as old data thought to be removed or put out of reach. While there are undoubtedly many benefits to our interaction in cyberspace, the quantity of threats, risks and general peril constantly grow, with data breaches, hacks and identity-fraud almost commonplace. Jason RC Nurse, Arnau Erola, Thomas Gibson-Robinson, and Professors Michael Goldsmith and Sadie Creese discuss their work.

Over the last two years, we have been conducting research into these online risks, and specifically into the problem of fake (or unnatural) online identities, and their increasing use to manipulate, deceive and defraud people and organisations. Within the academic literature, there has been considerable work in the space of detecting fake accounts and bots. Proposed approaches include using unsupervised machine-learning to detecting anomalous user behaviour, assessing social-graph properties to rank users' likelihood of being fake, and a range of other techniques. One key weakness which these approaches suffer from, however, is their failure to consider complete online personas as opposed to single individual profiles. This therefore limits their utility for the detection of well-crafted fake identities, such as those used in catfishing for instance.

Our research has sought to significantly advance existing work on addressing this problem through the in-depth analysis of a complete online persona; this includes all of its data elements, identity characteristics, and how these are naturally used across multiple websites. We interpret the naturalness as the extent to which a persona of interest (eg a potentially fake online identity) shows characteristic features similar to those expected for comparable personae online. To attain this full range of



identity characteristics and data points, we draw on our established data reachability model for online and offline identity data.

The approach we propose has two main phases: the definition and characterisation of naturalness, and the measurement of a newly identified persona to determine whether it might be natural or fake. In the first phase, we utilise our identity model to create a conceptual persona structure for each natural individual. We rely on natural individuals for a baseline, and build the persona structure based on what online profiles the individual maintains, how they are used, and the data they share on them. Next, we examine a set of natural personae to define what might be naturally expected for this group of individuals (ie a naturalness template). For instance, academics are likely to have a university webpage and teenagers are more likely to share certain types of information online. The second phase uses a range of analytical methods to examine the extent to which a new persona conforms to the natural template. These methods are

based on similarity metrics and likeness thresholds to ascertain whether the persona of interest is real or fake (ie, unnatural).

To evaluate our approach we have engaged in an initial case study involving 35 individuals, with data spanning over 41 online sites and networks. We found that our method to conceptualise an individual's complete online presence was very successful. This was undoubtedly linked to its detailed consideration of how cyberspace is typically used, while also building on our existing model of identity which has been used to aid law enforcement in identification tasks. In terms of developing effective analytics for naturalness however, improvements in our approach (eg features selected and nuanced metrics) are required. We now aim to conduct further assessments on the criteria through which naturalness is defined, and refine our analytics and combinatorics to measure a persona's naturalness. We will also explore clustering approaches based on complete online personae, as a means to complement our identification of naturally occurring personae groups in large datasets. It is expected that the outcome of this research will be a system whereby individuals can better identify fake personae, and thus be more cautious in their interactions online.

More information available at: [goo.gl/OmTS9M](https://goo.gl/OmTS9M)

## News in brief

In October, Professor Sadie Creese was a speaker at the first WIRED Security conference. This new event aims to explore, explain and predict new trends, threats and defences in cyber security. Read more at: [wired.co.uk/article/sadie-creese-threat-to-enterprise](http://wired.co.uk/article/sadie-creese-threat-to-enterprise)

The collaboration between Oxford's Global Cyber Security Capacity Centre (GCSCC) and the Government of Victoria, Australia, is now officially underway, following the launch of the new Oceania Cyber Security Centre (OCSC) in Melbourne. The new facility, the first international regional partnership for the GCSCC, is intended to be the focal point for cyber security capacity building in the Oceania region.

## New government funding for Cyber Security Training Centre

The Centre for Doctoral Training (CDT) in Cyber Security has been awarded £3.5m in government funding, starting from October 2016.

The centre admits up to 16 students each year to undertake advanced study and research in cyber security. Students come from all over the world to study on this four-year programme, and graduate with a DPhil degree, having made a significant research contribution towards addressing one of the many challenges which arise in this fast-moving area of study. The government funding, together with university funding, will support 12 of these students, paying their full fees and a stipend.

The new grant was awarded after a review from industry leaders and academics from outside the University. It is part of the funding for the UK government's new Cyber Security Strategy.

## Scholarships awarded for part-time MSc in Software and Systems Security

As announced by the Chancellor in November 2015, the UK Government is investing £1.9bn over the next five years to protect the UK from cyber attack. Some of this investment focuses on an ambitious skills programme to grow the UK's cyber capable workforce, as our ability to defend ourselves in cyber space relies on a strong skills and knowledge base. The department has been awarded a grant as part of a pilot programme, seeking to retrain individuals in cyber security. The grant will cover the payment of half the tuition fees for up to four students undertaking our GCHQ-certified MSc in Software and Systems Security.



## Cybersecurity Early Careers Researchers Symposium update

The 2nd Annual Cybersecurity Early Careers Researchers Symposium took place on 30 September 2016 at the Oxford e-Research Centre (OeRC). This event was organised by Cyber Security Oxford as an opportunity for Oxford students, Research Assistants and Postdoctoral Researchers to showcase their work and make new connections, including guests visiting from the University of Johannesburg and Columbia University. Submissions were encouraged from across the University and the range of talks spanned human-computer interaction,

machine learning, authentication, security analytics, international relations, insurance, maths, law, medical research, sociology, and the University's own IT systems. The keynote speaker was Professor Basie von Solms, Director of the Centre for Cyber Security at the University of Johannesburg, who started with a barnstorming talk on research ethics. Prizes were awarded to Grace Leung (Johannesburg: 'Protecting Cybersecurity Machine Learning'), Laurie Pycroft (Nuffield Department of Surgical Sciences: 'Brainjacking: Risks of Neurological Implants'), and Mike Davies (Computer Science: 'Are we managing the risk of sharing Cyber Situational Awareness? A UK public sector case study').



## Assessing Estonia's online voting system

Online voting is becoming an increasingly popular option in today's heavily connected world. As a part of a collaboration with the Cyber Studies Programme at Oxford's Department of Politics and International Relations, academics at the Department of Computer Science have engaged in an analysis of one of the most well-known electronic voting systems.

The I-Voting system that was designed and implemented in Estonia in 2005 is the first internet voting system to have been fully adopted anywhere in the world. Since its inception, it has been met with both praise and scrutiny. Concerns include in-person election

observations, code reviews, and adversarial testing on system components. As a result of these concerns, some parties have concluded that there are various ways in which insider threats and sophisticated external attacks could compromise the system's integrity and thus the voting process.

The full text article, titled 'An Independent Assessment of the Procedural Security Components of the Estonian Internet Voting System', that outlines the groups' findings and recommendations, can be accessed here: [goo.gl/5tMGqp](http://goo.gl/5tMGqp)

Computer Science academics involved in the project include Jason RC Nurse, Ioannis Agrafiotis, Arnau Erola, Meredydd Williams, and Professors Michael Goldsmith and Sadie Creese.



## PROTECTIVE: cyber security grant awarded

Jassim Happa and his co-investigators, Jason RC Nurse, and Professors Michael Goldsmith and Sadie Creese are part of a consortium that have been awarded an EC project (H2020) on 'proactive risk management through improved cyber situational awareness' (PROTECTIVE)

The PROTECTIVE system is designed to provide solutions for public domain cyber security incident response teams (CSIRTs) and small and medium-sized enterprises (SMEs) who both have needs outside the mainstream of cyber security solution provision. Public CSIRTs needs arise in part because commercial tools do not address their unique requirements, while SMEs are vulnerable to cybercrime as they have limited resources to protect themselves and often a limited understanding of what needs

to be done. Oxford's task is to document current practices and propose means to improve them for the PROTECTIVE system, as well as contribute to the assessment of the system. The project is being coordinated by the Athlone Institute of Technology, and joined by Synyo, Poznan Supercomputing and Networking Center, Clean Communications Limited, Technische Universität Darmstadt, RoEduNet, GMV, CESNET and ITTI SP ZOO.



Michael Goldsmith

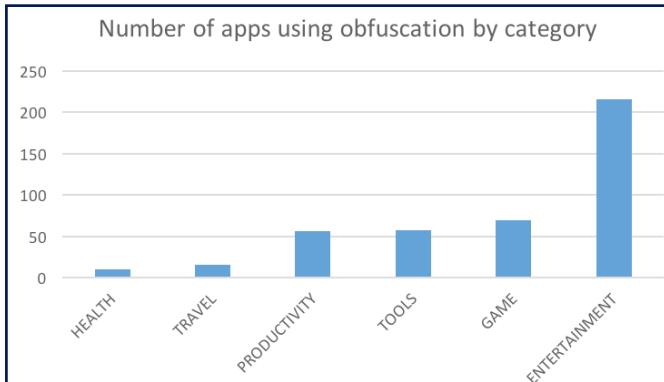


# Surveilling surveillance: examining how smartphone apps track people

The 1.9 billion people around the world who currently use smartphones have the luxury of choosing from over 4.4 million apps offering particular kinds of digital functionality. Among these apps are those that have re-defined how people work, learn, socialise, and live. Yet, most of these apps have a second purpose that remains largely hidden: to feed vast digital marketing ecosystems. Such ecosystems use apps as sensors

for skimming fragments of information about users, which are channelled to vast networks that reassemble them into descriptive and predictive models of people's interests and activities.

Whilst such practices have given rise to a multi-billion dollar digital marketing industry, they also pose a significant threat to users' long-term interests, and, consequently, to their own long-term sustainability. The rapid, unbridled establishment of user surveillance as the de facto business model of the app ecosystem means that people have little choice but to submit to being constantly monitored as they interact with digital apps, devices, and services. Moreover, the hidden nature of such practices means that people have little understanding of the scope and nature of this surveillance, and how their data is being used. As a result, end-users cannot practically assess whether or how such practices are violating their privacy preferences.



The effects of this ever-widening gap between the reach of digital surveillance and users' ability to ensure such practices stay aligned with their privacy preferences has already had visible consequences. Privacy and security fears over data collection are driving record numbers of people to withdraw from digital ecosystems entirely, by ceasing to use apps or smartphones altogether.



Previous research into the privacy and security of apps has focused primarily on apps in isolation. However, the fast evolving ecosystem of third-party tracking companies poses a challenge to this app-centric approach, and suggests privacy decisions may need to be informed by an understanding of the complex data-sharing networks behind these apps and services, as well as of the broader, social and economic consequences of a personal-data driven industry.

*continued on next page* ►



The EPSRC-funded SOCIAM (Theory and Practice of Social Machines) project, is being undertaken by Oxford Computer Science Department's Max Van Kleek, Reuben Binns, Jun Zhao, and Professor Sir Nigel Shadbolt. It is an interdisciplinary effort examining such human-digital ecosystems, including understanding how various entities use social and technical mechanisms to accomplish their goals. Informed by this 'social machines' perspective, we are examining the following aspects of smartphone app privacy:

**Digital surveillance ecologies** – A primary goal is to map app surveillance ecosystems as collective ecologies, to understand the entities, relationships and methods involved, as well as the technical, social and economic forces that influence their function. As a first step, we have developed methods to collect and analyse large collections of apps. An initial analysis of 5000 popular apps from the Google Play Store (UK) revealed over 60% of apps transmitted information to two or

more advertising networks, whilst 18% used obfuscation techniques to deter others from such an analysis.

**Impact on privacy** – The second is to understand how such practices affect people's privacy. Whilst prior work has looked at overall perceptions of privacy, this work focuses on the relationships between tracking behaviours and people's perceptions of control, autonomy, security, and privacy.

**Re-establishing user control** – Another area of research pertains to empowering people with better control over their information. In an initial experiment, we designed personalised visualisations to illustrate how data was collected about them, finding that they enabled people to make significantly more robust, consistent and confident judgements. As a next step, we are looking at mechanisms to enable people to control how their data is used even after they are disclosed, through distributed accountability and policy mechanisms.

Read more about SOCIAM: [sociam.org](http://sociam.org)

## Internships

*A year in industry doesn't form part of undergraduate Computer Science degrees at Oxford. However, many of our students use the long summer break to gain real-world experience. From start-ups to multi-nationals, at home and abroad. Here's what two of our students have been up to this summer.*

### Emma Espinosa

Computer Science,  
Worcester College

Internship at ARM, Cambridge, UK.  
July – September 2016



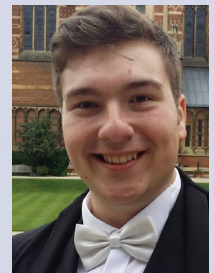
In the summer after my second year I headed off to Cambridge (!) to work in the Development Solutions Group at ARM. I was in the Advanced Product Development team, doing some investigation on compiler feedback driven optimization. This involved running lots of benchmarks and delving into the LLVM codebase, written in C++. The Compilers course I took in my 2nd year proved very useful, and I found it really interesting to learn about the more advanced optimizations a compiler performs, a topic which wasn't covered in the course. In addition to my project, the company put on several intern events, and I visited the Manchester office as well. I also got to experience an acquisition which made international news – a pretty eventful summer!

I stayed at Peterhouse, a Cambridge college, throughout the summer which meant I was right in the city centre.

### Gabriel-Robert Inelus

Computer Science,  
Keble College

Internship at Bloomberg LP, London.  
June – September 2016



This summer I was delighted to accept the challenges of applying in industry, both the knowledge gained in my university courses, and C++ experience that I previously got throughout different programming competitions. During the vacation between my first and second year, I worked as a Software Infrastructure Developer at Bloomberg LP, and while there I won the 'Bloomberg Summer Intern 2016 – Stand Out Project Award'.

My task was to optimise the performance of the software infrastructure using algorithms and data structures. Therefore, I had the opportunity to use my algorithmic skills in order to come up with efficient solutions to the company's challenges on a global-scale system. During my internship I enjoyed working at full time employee standards and also took part in many events and lectures, which broadened my horizons even further. Overall, I had an excellent experience at Bloomberg LP, which I would definitely recommend.

Interested in advertising your vacancies or internship opportunities to current students?

Please visit: [cs.ox.ac.uk/recruiters/](http://cs.ox.ac.uk/recruiters/)

# A web portal for cardiac safety in pharmacology

Members of the Computational Biology team have developed a web portal 'Action Potential-predict online', or APportal, which makes it easier for pharmaceutical companies to model how likely it is that particular drugs will have a negative effect on the electrical activity of heart cells.

Pharmaceutical drugs can have unwanted interactions with heart cells, which in some cases can lead to fatal disturbances to the heart's normal rhythm. Over the past 20 years the membrane proteins that drugs bind with to cause these disturbances have been identified, and the degree to which drugs influence the ionic currents flowing through an individual type of protein can be measured in early drug development routinely and cheaply. However, it isn't clear what the collection of results for a handful of different proteins means for the whole cell or whole heart. This is where simulation of the electrical activity of heart cells comes in useful.

The Oxford team, Professor David Gavaghan, Geoff Williams and Gary Mirams, have developed and released a public version of a web portal user interface to open-source cardiac safety simulation software at [goo.gl/1pg3iS](http://goo.gl/1pg3iS). In this portal, users

can manually enter data on drug effects on the currents flowing through individual ion channel proteins, and get predictions of the effects on the whole cell, which has been shown are also a good prediction for heart tissue.

The portal has three principal components: the user-facing component which stores simulation results and generates HTML for rendering the portal web page in a web browser; the simulation manager component which invokes the 'AP predict' simulation software and monitors simulation progress; and finally the 'AP predict' cardiac electrophysiology simulation software itself, based on the Computational Biology Group's Chaste C++ library. The portal takes care of gathering input data, running the simulation, storing the results, and presenting them to the user as graphs in the portal, or for download as a spreadsheet. It has already

been used to perform thousands of compound safety simulations and is being used internationally by some of the largest global pharmaceutical companies.

The project has been awarded new funding through an EPSRC Impact Acceleration award that will enable further development of the portal. The aim is to make testing via the portal easier for pharmaceutical companies and regulatory bodies, by generating generic programming interface components, as well as training materials and technical documentation, to enable their own IT departments to install and couple the software to their own databases.

The requirement to perform such testing, and the need to make this testing easier continues to be of importance. Screening for cardiac safety has to be done for all drug candidates, and costs billions of pounds a year worldwide. By providing more accurate predictions of risk, earlier in drug discovery, we can reduce the risk to patients, minimise animal testing and save time and money in pharmaceutical research and development.

The US Food & Drug Administration (FDA) has announced that mathematical model simulations should form part of a new Comprehensive In-Vitro Pro-arrhythmia Assay (CiPA). This ongoing project is a rare opportunity for mathematical modelling in biology to have a direct impact on international policy, and the provision of open and easy-to-use tools such as this web portal are going to be instrumental in simulations being accepted and successful.

