MANCHESTER 1824

The University of Manchester

Research Newsletter

School of Computer Science

Issue 2 – Autumn 2014

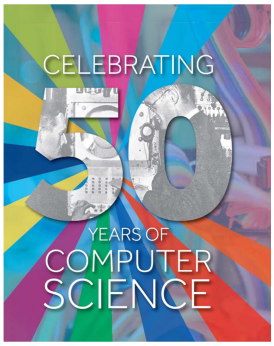
The School of Computer Science - Kilburn Building

In this issue

Contact us

School of Computer Science
The University of Manchester
Kilburn Building
Manchester
M13 9PL
UK

Email: researchsupportcsm@manchester.ac.uk
Web: www.cs.manchester.ac.uk



About us

At The University of Manchester, we have one of the longest established school of computer science in the UK and one of the largest. We are constantly building on our strong research history with research groups operating across the spectrum of computer science, from fundamental theory and innovative technology, through novel hardware and software systems design, to leading-edge applications.

The School is consistently ranked highly; 2nd in UK for 'research power' (RAE2008); 7th in the UK by ARWU 2014 and the expertise and achievements of our staff are well-recognised internationally.

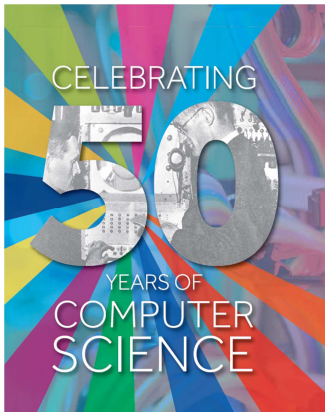
Editorial by the Head of School

Professor Jim Miles

We have a good cause to celebrate this autumn as we come to the School's 50th anniversary. The last five decades have seen some incredible innovations and achievements from the School of Computer Science, including five members of staff receiving honours from the Queen, alumni in 105 countries, eight nationwide computer Animation competitions and almost 10,000 degrees awarded. We look forward to the future; preparing and supporting computer scientists so that they can lead and influence exciting research in computer science.

Within this edition of the Research Newsletter you can see some of our recent research news and discoveries.

News



Happy Birthday to Us!

The School of Computer Science was founded on 1st October 1964, when Tom Kilburn became the first Professor of Computer Science and Head of School.
To commemorate our 50th anniversary we have produced a facts and figures booklet that captures the essence of our School. For example…

- 245,587: the total number of citations to research papers written by our academic staff
- In the last 10 years we have had 406 grant proposals funded to a value of £134M from 87 different funding agencies
- 8,000: approximate number of cups of coffee consumed during the Information Management Group weekly research meetings since its foundation in 1997

National Award for the School

The School of Computer Science have been awarded the Athena SWAN Bronze Award, to recognise our ongoing commitment to women's jobs and career development in STEMM (science, technology, engineering, mathematics and medicine) academia.

In July, **Dr Suzanne Embury** and Head of School Administration, **Karen Varty** attended the national awards ceremony at Durham University. Athena Swan highlighted the Computer Science 'buddying-up' scheme for promotion cases as a good practice example.

Dual honour for Professor Tsujii

Professor Jun'ichi Tsujii has been awarded the **2014 FUNAI Achievement Award** from the Information Processing Society of Japan for his pioneering work on Natural Language Processing, Machine Translation and Text Mining for Biology. Professor Tsujii is a principal researcher at Microsoft Research Asia in Beijing, a Visiting Professor at the School of Computer Science and

Scientific Director at the National Centre for Text Mining at Manchester www.nactem.ac.uk
In August, Professor Tsujii was appointed as **chairman of the International Committee of Computational Linguistics**. ICCL organises the International Conference on Computational Linguistics www.coling-2014.org

First International Workshop on FPGAs for Software Programmers

Dr Dirk Koch co-organised the First International Workshop on FPGAs for Software Programmers (FSP), which was held in conjunction with the FPL conference in Munich. The full-day workshop attracted 65 attendees from all over the world and was a great success with several requests for another event next year. More details and the program can be found on the FSP website: www12.informatik.uni-erlangen.de/ws/fsp201

Congratulations to Professor Carole Goble CBE!

The School of Computer Science is delighted and extremely proud to be able to congratulate Professor Carole Goble, who has been awarded a CBE (Commander of the Order of the British Empire) for services to science.

After being named in the 2014 New Year's Honours List, Carole attended the ceremony at Buckingham Palace in April and, alongside colleague Professor Doug Kell from Chemistry, was awarded her CBE by Prince Charles, the Prince of Wales.

Carole Goble is a Full Professor in the School of Computer Science, at the University of Manchester in the UK. She leads a large team of researchers and developers working in e-Science. She applies technical advances in knowledge technologies, distributed computing, workflows and social computing to solve information management problems for Life Scientists, especially Systems Biology, and other scientific disciplines, including Biodiversity, Chemistry, Health informatics and Astronomy. Her current research interests are in reproducible research, asset curation and preservation, semantic interoperability, knowledge exchange between scientists and new models of scholarly communication. She has been advocating the releasing of research as Research Objects (www.researchobject.org).

Prof. Goble CBE, FREng, FBCS, CITP has also recently:

- been nominated for the Technology category of the **2014 Inspiring Women Awards**. The awards ceremony was held in May at the Midland Hotel, Manchester www.inspiringawards.co.uk
- attended a reception to **celebrate the British technology industry at Buckingham Palace** in June. Carole was invited as a Co-Investigator of the Software Sustainability Institute (SSI), which is based at the Universities of Manchester, Edinburgh, Oxford and Southampton. The SSI represents the needs of software users and developers in the research community www.software.ac.uk
- wrote the opening piece in IEEE Internet Computing, entitled ***Better Software, Better Research*** DOI: 10.1109/MIC.2014.88
- spoke at the annual Royal Academy of Engineering Research Forum www.raeng.org.uk/events/list-of-events/2014/september/engineering-research-forum

For more information contact Prof. Goble http://www.cs.manchester.ac.uk/about-us/staff/profile/?ea=carole.goble&pg=1

Manchester Computer Scientists talk to New Scientist about automated discovery

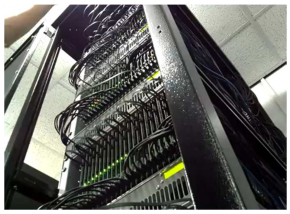
Professors Sophia Ananiadou and Ross King appeared in New Scientist (30 Aug 2014).

No researcher could read all the papers in their field – but machines are making discoveries in their own right by mining the scientific literature and analysing the data within them using text mining services such as Facta+ (**Professor Sophia Ananiadou**).

Professor Ross King from the School of Computer Science has developed a different kind of automated system, Eve, which has discovered the repositioning of a drug against malaria.

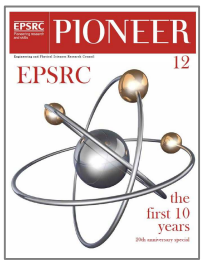
Rather than extracting new knowledge from the literature, Eve robotically runs lab experiments focused on finding new drugs to treat neglected diseases.
Read more in the New Scientist www.newscientist.com/article/mg22329844.000-supercomputers-make-discoveries-that-scientists-cant.html%23.U_83vRBsGU4

Wiring up the 103,680 core SpiNNaker105 Machine



SpiNNaker105 contains 103,680 mobile-phone grade (ARM) processor cores and a specialised high-speed network to simulate up to 100,000,000 neurons, or about the equivalent of one mouse brain.
Over the summer, PhD student **Jonathan Heathcote**, in the Advanced Processor Technologies group, made a time-lapse video of himself wiring up the machine. Read more and see Jonathan in action through www.cs.manchester.ac.uk/study/news/full-article/?articleid=1201
The group is working on the design and construction of a machine that will be 10 times larger – a million cores simulating a billion neurons as part of the European Flagship Human Brain Project.

Computer Science research features in 10-year edition of EPSRC magazine



Professors Andy Brass and Carole Goble's work has been highlighted in the EPSRC's Pioneers magazine (summer 2014).

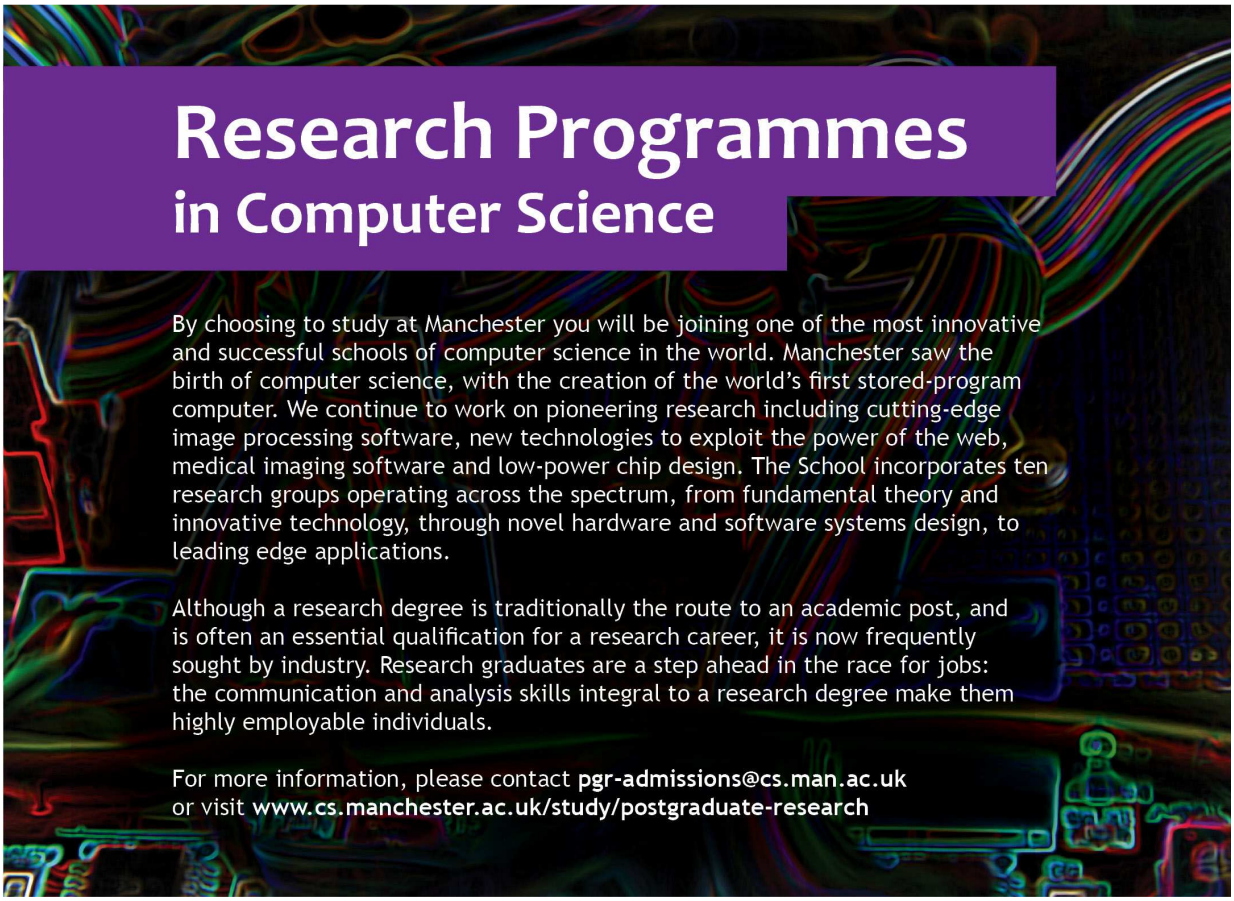
Fighting the scourge of sleeping sickness - with software: An international research team, including **Professor Andy Brass** and scientists at The University of Manchester, using a new combination of approaches, has found two genes that may prove of vital importance to the lives and livelihoods of millions of farmers in a tsetse fly-plagued swathe of Africa.
The team screened a multitude of genes to identify variants that give resistance to the deadly parasitic disease, that causes both African sleeping sickness in people and a wasting disease in cattle. They managed to capture, integrate and analyse the highly complex set of biological data by using Taverna software, developed by Professor Goble and her myGrid team.

'The Taverna workflows we developed are capable of analysing huge amounts of biological data quickly and accurately…Without Taverna, we would have been looking where others had already looked. But because we had the tools to look more widely, we spotted things that had been missed. That's pretty exciting.'

Linking Thinking: The myGrid initiative "underpins most bioinformatics research in the UK, and also illustrates the value of the physical and engineering sciences to all of the health and life sciences." The myGrid consortium is led by **Professor Carole Goble**. The myGrid interface supports a suite of bioinformatic programmes which use computer science, mathematics and information theory to model and analyse biological systems. It has enabled researchers to perform virtual experiments, collaborate on and share workflows, and access a wide range of databases. Director of the EPSRC, Lesley Thompson says:

'It is inconceivable now to think of doing social science research without access to big databases, and the comparative studies that birth cohorts and so on give you; and it's also inconceivable that you would do medical research without looking at the relationship between genomic data and population data.'

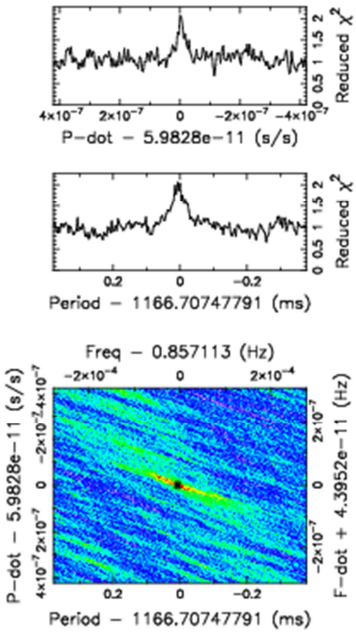
http://www.cs.manchester.ac.uk/our-research/news/full-article/?articleid=1116



Feature: Pulsars Discovered in Radio Data

The search for pulsars is something of a competitive sport in astronomy circles, and the School of Computer Science has become the latest worthy contender in these races, thanks to Rob Lyon, a PhD student in the Machine Learning and Optimization (MLO) Group. A pulsar is a rapidly rotating neutron star, a type of super-dense stellar remnant formed during the collapse of a massive star. The enormous mass of these objects make them exceptional natural laboratories for studying theories of gravitation and equations of state, if they can be directly observed. Sadly 'normal' neutron stars are difficult to find since they are dim compared to other stars, but pulsars emit an intense beam of electromagnetic radiation from their magnetic poles, which is potentially detectable on Earth. As the pulsar spins, this radiation beam passes across our line of sight, producing a periodic spike in broadband radio emission. Using radio telescopes we can 'listen' for these spikes, allowing us to find and study pulsars through their radio emission. Unfortunately since space and nearby radio sources make for a noisy place, these radio signals are often difficult to discern from background noise in practice. Indeed, since their existence was first posited in 1934, only 2328 pulsars have been found despite many continual searches of the skies (known as surveys) since 1967. That is why we are proud to announce that since August this year, Rob's work has increased the total number of known pulsars by an amazing 0.21%, with the discovery and confirmation of five new pulsars a direct result of his research!

Rob's work is an example of machine learning in action. Collaborating closely with astronomers at Jodrell Bank, he was able to identify a number of problems within existing search procedures, and provide better alternatives. The first major improvement arose from replacing the 'features' being used (until recently) to describe, in compact form, each signal detected by a radio telescope. These features, the product of much thought, had a firm foundation in the underlying astrophysics and made intuitive sense to radio astronomers, however Rob showed they are actually relatively poor separators of legitimate signals vs noise. Replacing them by fewer, much simpler statistics that captured the underlying patterns within the data greatly improved separation of pulsars from noise. These new improved features, however, are still insufficient to accurately isolate pulsar signals on their own. A key reason is that pulsar data is incredibly imbalanced; in fact for every legitimate signal detected, there are 10,000 arising from noise. To address this, Rob devised a novel tree classification algorithm using the Hellinger distance measure, and to make it suitable for next-generation telescopes with high data capture rates, he also devised a streaming variant based on the Very Fast Decision Tree (VFDT). This work was presented at the International Conference on Pattern Recognition, this year. Overall, these improvements **raised "recall" rates from 30% to 86%** on observational data, whilst the corresponding false positive rate rose from 1% to an acceptable 1.7%.



So far Rob's new stream classifier has helped to find 5 pulsars in LOTAAS data, including pulsar J0305+11, which wouldn't have been found with previous approaches.

These new developments are currently being applied to a number of pulsar surveys, among them LOTAAS, an ongoing all-Northern-sky survey for radio pulsars and fast radio transients, being undertaken using the Low-Frequency Array (LOFAR) in the Netherlands. This instrument possesses twice the sensitivity and a significantly larger field-of-view than earlier telescopes, but this means an incredible 16 TB per (survey) hour of raw data is produced, which has to be processed into usable products by the Dutch national super computer, Cartesius. Nevertheless, this is a mere stepping stone on the path to the monumental shifts in data rate that will be brought about by the Square Kilometre Array (SKA) telescope, which is expected to produce data at a rate of 1-10Tbps.

In the coming months it is hoped the new classifier will help make even more discoveries through application during the SUPERB and GMRT surveys. Looking further ahead, we expect the classifier's real usefulness lies in its applicability to future SKA data processing scenarios. It may help to make the scale of these challenges seem a little less daunting.

Notes:- **Rob Lyon** is undertaking his PhD in the School of Computer Science Centre for Doctoral Training, working with **Dr John Brooke** and **Dr Joshua Knowles**. Rob works with Professor of Astrophysics, Ben Stappers, and Sally Cooper, a PhD student at Jodrell Bank, who also take a lot of the credit for these finds. Details of the pulsars, catchily named J0317, J0305, J2057, J2336 and J1814 can all be found at www.astron.nl/lotaas.

Recent promotions

Dr Simon Harper is a Reader in HCI and an experiment Computer Scientist working in Human Computer Interaction and Information Systems. His particular interest is in Assistive Technologies (AT) in the domain of Web Accessibility with specific regard to profound blindness and visual disability. Simon's work is centred around understanding, predicting and influencing a user's interactions and flow through interfaces and information, while taking into account neurophysiological, cognitive, behavioural, perceptual and technological factors. His contributions lie in the development of adaptive user models of extreme users and/or extreme environments. http://www.manchester.ac.uk/research/simon.harper/

Dr David Lester is a Senior Lecturer in the APT group. After short stint working in the local aerospace industry doing control engineering, Dave went on to study Maths as an undergraduate, then took an MSc conversion course for Computer Science, finally writing a DPhil thesis at Oxford's Programming Research Group providing the first proof of compiler correctness for a functional language implementation. He then went on to work at GEC-Marconi's Hirst Research Centre becoming the project leader of one of the first EU research projects: ESPRIT 415B. This involved producing a parallel distributed compiler for the Transputer. When this project was competed he took up a lectureship at Manchester.
Things have now come full circle, and he is now writing, and managing, code production for the SpiNNaker system, which has many remarkable similarities to the Transputer systems of the 1980s. He is also a PI on the HBP project.
http://www.manchester.ac.uk/research/david.r.lester/

Dr Kieran Smallbone obtained his D.Phil. in 2006 from the University of Oxford, using mathematical modelling to understand the interplay between tumour growth and metabolism. He then moved to the Manchester Centre for Integrative Systems Biology, using mathematical and computation tools to attack a variety of biological problems, and teaching and supervising students at the associated Doctoral Training Centre. His recent research focuses on the creation of large-scale dynamic models of cellular metabolism. Kieran was promoted to Research Fellow in 2014. He is currently on six months' paternity leave.
http://u003f.wordpress.com

Dr Konstantin Korovin is a Senior Research Fellow in the Formal Methods research group in the School of Computer Science. His research interests include automated reasoning and verification of hardware and software. He has developed iProver, an instantiation-based theorem prover for first-order logic. Over the last few years, iProver has been winning major divisions at The World Championship for Automated Theorem Proving (CASC).
http://www.cs.man.ac.uk/~korovink/

Dr Bijan Parsia is a Reader in Computer Science and has been a member of the Information Management Group since May 2006. His research interests include the Semantic Web, Knowledge Representation and Reasoning, Programming languages, Software and Ontology Engineering and human-computer-interaction. Bijan had a key role in the development of Web Ontology Language (OWL), which is endorsed by the World Wide Web Consortium (W3C). Recently Bijan has been on sabbatical in the US with Siemens Healthcare. http://www.cs.man.ac.uk/~bparsia/

Recent appointments

Dr Daniel Dresner has been teaching popular security modules for the ACS MSc since 2004 and supervising related MSc projects. He worked at The National Computing Centre for 22 years particularly in the fields of software quality and information security management. Working with the University of Worcester, Daniel co-created the small business security assurance scheme IASME and is a founder member of the Institute of Information Security Professionals. Daniel is particularly interested in putting the 'netics' back into 'cyber', balancing technical security controls with human factors (a type of human penetration testing), a universal 'self-protecting' security architecture, and security metrics. He provides informed comment on UK cyber policy to the intelligence services and is a guest lecturer at the UK Defence Academy. A paper that he has co-authored with Neira Jones (former Head of Payment Security at Barclaycard) is due for publication in November.
http://studentnet.cs.manchester.ac.uk/pgt/COMP60721/syllabus

Professor John Goodacre has over 25 years of experience across both the software and hardware engineering disciplines. As well as a part time Professorship in Computer Science John currently holds the position of Director of Technology and Systems within ARM. For the past 5 years he has held a key semiconductor and software industry-wide role regarding the introduction of integrated embedded multi-core processor developments and design as exemplified by the ARMCortex A9 MPCore processor. By leveraging both multiple years of multi-processor experience from his software background and key architectural and methodological experiences during the development of ARM's multi-core strategy, products and road map, he brings with him the latest state of the art multi-core technology, tools and methodology, and the vision and experiences required to look ahead to the next generation of low-power architectures, advanced nanotechnology processes and associated software platforms.

John recently provided an introduction to his research interests through a **Research School Seminar**. Our seminars are free and available for anyone to attend. For more information see www.cs.manchester.ac.uk/our-research/seminars/

Grants and awards

The School of Computer Science has been awarded over £13 million external funding for research over the last two years. Much of the research involves working in collaboration with others across the University and all over the world.
Here are just some examples of recent research funding awarded in the School.

Prestigious Royal Academy of Engineering Fellowship for Dr Antoniu Pop

Dr Antoniu Pop
Funding body: RAEng
Award amount: £457k

Dr Pop from the Advanced Processor Technologies research group is **one of only seven Royal Academy of Engineering Research Fellowships to be awarded in 2014**. The aim of the five-year fellowships is to provide outstanding researchers with financial support and mentoring to enable them to establish independent careers in research and to bring radical innovation to their fields.
Computer processor technology has reached fundamental physical limits, in terms of power density and heat dissipation that preclude significant increases in single core performance. To meet the constantly growing demand for processing power, and enable more complex and demanding applications, the number of cores per chip is following an exponential growth path that leads to "many-core" processors.
However, using current programming languages to program many-core systems represents a tremendous challenge for software engineers. There are also theoretical constraints, aka Amdahl's law, on the maximum performance gained by running in parallel on multiple cores.
The five-year fellowship will address the programmability, performance and energy issues, from a software engineering perspective, for future many-core systems. He is investigating a new programming language based on a novel formal computation model, associated with a compiler and a runtime system, specifically designed to fully exploit the power of many-core processors. A key aspect is to express data dependences in the programming language.

For more information read the RAEng press release: www.raeng.org.uk/news/news-releases/2014/july/technologies-that-shape-the-future-academy-awards

HeRC funding helps household pets join the big data revolution

Advancing veterinary and public health using real-time healthcare data

involving **Dr Goran Nenadic**
Funding body: Health e-Research Centre (HeRC)

A new HeRC-funded Manchester-Liverpool collaboration between researchers is harnessing healthcare data about the nation's pets, with the main aim to facilitate advancements in both veterinary and human public health.
From cats and dogs to gerbils and rabbits, healthcare data is collected in real-time from over 100 veterinary surgeries allowing the Small Animal Veterinary Surveillance Network (SAVSNET) team to develop a better understanding of the factors

associated with diseases affecting pets. Real-time information also creates the potential for identification of abnormal trends in animal health and creates an opportunity for professionals to respond quickly and effectively.
More information is available through www.herc.ac.uk/2014/07/31/herc-funding-helps-household-pets-join-big-data-revolution/

Interested in finding out more about the impact that our computer science research has on the world? Visit http://www.cs.manchester.ac.uk/our-research/research-impact/ for a wide variety of case studies.

Runtime Adaptation as the Key to Power-Efficient Many-core System

Dr Mikel Lujan's Royal Society University Research Fellowship on many-core architectures and managed virtual execution environments has been extended for a further 3 years.

Dr Mikel Lujan
Funding body: Royal Society
Award amount: £305k

Current and future scientific advances require experiments that produce peta-bytes of data, a "data deluge", from bioinformatics, particle physics, astronomy, medicine and health, to environmental science. Similarly, in our home computers and iPods the collections of photos, videos, music and entertainment keep growing. Storing the high-quality video and audio for everything that one person experiences over a 70-year life-span is estimated to require around 27.5 tera-bytes. Making sense of this "deluge" will continue to push the demand for ever-higher computing capacity.
In contrast, computer systems have experienced a major change in how they are built as these have become fundamentally limited by thermal and power consumption issues. Moving forward, thermal constraints will force future architectures to be massively parallel, while power delivery limitations will prevent a system from running all its components simultaneously (aka dark silicon). These new design constraints push the urgency of rethinking the boundaries between hardware and software as to combat how stacked layers impede optimisations and can waste energy. Traditional computer systems are organised (stacks of layers: application/compiler/OS/virtual machine/micro-architecture) without changing the high-productivity software practices for application developers. When using such a rigid organisation, useful information (static and dynamic) gathered in one layer of the stack or known by a developer cannot be transferred nor exploited by others. The key insight we aim to exploit is how static, dynamic and statistical information about the computation as well as gathering the computer state to enable better optimized data management, scheduling decisions for performance and/or energy minimisation. In particular, the Fellowship **investigates Virtualization and Just-in-Time code generation to allow parallel applications to adapt seamlessly to the evolving roadmap of computer systems** (i.e. heterogeneous many-cores).Contact Dr Mikel Lujan for more information http://apt.cs.manchester.ac.uk/people/mlujan/

Developing real-time management for water distribution networks

Working with the water industry to create smart water networks.
Funding body: Innovate UK (formerly TSB) and WRc plc
Award amount: £172k

Dr John Brooke and WRc plc. have been awarded a Knowledge Transfer Partnership, funded by the Technology Strategy Board and the industrial partner. The post-doctoral Knowledge Transfer Associate will work hand-in-hand with the company to create a real-time management package that can be adapted to each of the many different Water Distribution Systems.

WRc is an innovative, research-based consultancy working in the water, waste and environment sectors. WRc assists governments and regulatory bodies in creating soundly based regulation and helps organisations impacted by regulation to optimise operational efficiency and minimise risk. http://www.cs.man.ac.uk/~jbrooke/

Identifying fractures in medical images

Funding body: Department of Health and the Wellcome Trust through the Health Innovation Challenge Fund
Award amount: £660k

Professor Tim Cootes is working with other Manchester colleagues on a new tool that automatically searches medical images for early signs of osteoporosis in the spine by identifying fractures there and could help reduce the number of future potentially fatal hip fractures.

Working with Optasia Medical and Central Manchester University Hospitals NHS Foundation Trust, Manchester scientists are looking to develop specialist computer software that can be easily incorporated into radiology departments in hospitals.

For more information see: www.manchester.ac.uk/discover/news/article/?id=12619