The Ring

The journal of the Cambridge Computer Lab Ring

Issue XXXVII — September 2014

Who's Who

Marko Balabanovic (CC BA90 PhD98) has recently joined Connected Digital Economy Catapult as Innovation Director. The Connected Digital Economy Catapult, part of the Technology Strategy Board's Catapult programme, builds platforms for use by a large number of SMEs.

David Bell (EM BA07) is working at adba.biz in Northern Ireland.

Youssef Bouguerra (PEM Dip98) is now working at Dell in Brazil where he is a LATAM Portfolio Manager.

Dolly Chen (SS BA12) is now working at SunGard.

Peter Cowley (F BA77) has won Angel Investor of the Year at the 2014 UK Business Angels Association (UKBAA) Angel Investment Awards. The award is aimed at individual angel investors that have been very active in investing small businesses during the past year.

William Denman (CL PhD14) is now at The University of Edinburgh where he is a postdoctoral research assistant.

Nicholas Edwards (BA03 MBA11) is now Head of Marketing Analytics and CRM at ArenaNet in Bellevue, WA.

Tony Gould (F BA91) has recently joined RMS as Senior Principal Software Engineer.

Jim Grundy (F PhD94) is now at Apple in Austin, Texas, where he is a working as a formal verification engineer.

Amir Hajizamani (JN BA11) is now a software engineer at Google.

Tim Harris (CHU BA97 PhD00) is leading a new Cambridge group for Oracle Labs. Their work focuses on software scalability, and on how systems software and language runtime systems can evolve to better support today's "rack scale" clusters — for instance, how to exploit reliable low–latency interconnects to improve the performance of distributed systems, and how to share large multi–core machines amongst multiple competing parallel workloads.

Daniel Kumar (MASt14) is working at Google in Pittsburgh, PA.

Tzu-Chiang Liou (MPhil10) is a manager in the Research Engineering team at Yahoo Taiwan.

Min Lin (CAI PhD09) is now a Senior Technical Director at China Unicom in Beijing City.

James Lingard (R BA01, W MPhil14) has joined Microsoft Research in Cambridge, UK, where he is a senior research software development engineer.

Chaoying Ma (PhD92) is a Senior Lecturer at the University of Greenwich.

Tomas Pfister (CAI BA10) is doing a PhD at the University of Oxford.

Omi Reza Chowdhury (PEM BA12) is Lead User Experience Designer at SCUID in New York.

Christian Richardt (CAI BA07 PhD12) is a postdoctoral researcher at the Intel Visual Computing Research Institute in Germany.

Sunil Shah (F MA09) has recently graduated from UC Berkeley with a MEng in Electrical engineering and Computer Science, and has now joined Mesosphere Inc as a distributed applications engineer.

Aneesh Shukla (CC BA14) has joined the Bank of America Graduate Scheme.

Murray Williams (MA98) is Senior Software Architect at i–nexus.

David Wolfram (T PhD90) has founded Ocelot Consulting, a specialist consulting service for Information Technology Management and Property Management in Melbourne, Australia.

Krzysztof Wos (JN BA10) is a senior software developer at SBI Japannext in Tokyo.

Assel Zhiyenbayeva (F BA10) is advisor to the Deputy Governor at the National Bank of Kazakhstan.

A big 'thank you' to Sunil Shah for oganising the first Bay Area Ringlet bar on September 9th 2014.

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DeepMind

Demis Hassabis's 20–year dream has come true.

TR: After a very successful career in the games industry you switched to a career in cognitive neuroscience. A PhD at UCL was followed by neuroscience and AI research (as a Wellcome Trust research fellow) at UCL's Gatsby Computational Neuroscience Unit. You were also a visiting researcher at MIT and Harvard. What then prompted you to leave academia and start DeepMind Technologies?

DH: My ultimate plan was always to try and fuse the best of academia with the best of startup industry environments. I've been lucky enough in my career to have experienced working at some of the top institutes and most exciting startup companies around, and with DeepMind I've tried to combine the best of both those worlds. Then around mid–2010 we felt we finally had all the technical ingredients in place from systems neuroscience and machine learning, and that it was the right time to launch DeepMind with the ambitious goal of solving intelligence.

> *If we can fundamentally understand and recreate intelligence artificially, then ultimately we could use that technology to help society to solve everything else.*

TR: What was your vision for DeepMind?

DH: DeepMind has been the culmination of a 20–year dream for me. If we can fundamentally understand and recreate intelligence artificially, then ultimately we could use that technology to help society to solve everything else. We work on general–purpose learning algorithms that can learn directly from perceptual experience and are capable of performing well on a wide range of tasks. I also wanted to assemble the most talented group of AI scientists anywhere in the world, as I felt only such a team would be able to make any significant progress on a problem as challenging as this.

TR: Did your first experience of starting a company (Elixir) impact the way you approached DeepMind?

DH: The experience of running Elixir was vital to the success of DeepMind. From building and coordinating large teams of very smart engineers, to working on really ambitious technical projects, and how to project manage it all. I have tried to utilise the useful lessons I've learnt from all the different experiences I've had from running companies, to playing games, to doing academic research to inform my approach to leading DeepMind.

TR: Did you do anything differently second time around?

DH: There was not really one big thing, more dozens of small things, but together they made a really huge difference. For example I decided this time around to always raise more money than we strictly needed in the short–term, to give us the runway to make the right strategic decisions for the long-term. For that I needed to find investors who would share our ambitious long–term goals as well as have deep enough pockets to back that up, which is why we went to some of the biggest names in Silicon Valley to secure funding.

TR: Will Google's acquisition [of DeepMind] change the focus of your research? Will your role change?

No it hasn't change anything, in fact it has just accelerated things on the research front. The reason we teamed up with Google was because we felt it would give us the opportunity to focus on our mission. With Google's scale behind us, their compute power, data, resources and engineers, it allows us to really turbo–charge the research. With this platform we have an incredible chance to achieve something amazing and have a big impact by embedding our technology into Google's products.

TR:Will you be staying in London or decamping to Silicon Valley?

We plan to stay here in London and make it a real centre for AI research. In the UK we have some of the best talent in the world, with renowned universities such as Cambridge and UCL producing first–rate scientists and engineers who want to work on world–changing technology. We want to show that world–class fundamental research into new technologies can be conducted right here in the UK.

TR: What challenges is DeepMind looking to tackle and meet over the coming years?

DH: On the research side the big challenges coming up include developing algorithms that can learn abstract concepts from perceptual inputs and that exhibit transfer learning capabilities, that is, using prior knowledge appropriately in a new situation to help with performance a novel task. From an applications point of view, I think over the next 5–10 years we will start seeing an intelligence layer being built into the core of nearly every technology that we use.

TR: Do you still have time to play computer games?

DH: It turns out that computer games are the perfect proving ground to test the performance of our artificial intelligence agents. So these days it's the algorithms that we are developing that are playing the games, rather than me!

Deepmind was the winner of the Hall of Fame Company of the Year Award 2014.

All Ring members are invited to submit nominations for the 2015 awards.

Full details of the award categories can be found at www.cl.cam.ac.uk/ring/nominations.html

Go to www.cl.cam.ac.uk/ring/halloffame.html for the list of Hall of Fame companies. If you know of a company that should be on the list but isn't please email cam-ring@cl.cam.ac.uk

Rormix

Mark Wheeler (SID BA10) had past experience of building a start–up before Rormix. Now he's putting unsigned artisits on the map.

TR: Can you tell me about your career prior to Rormix?

MW: Before Rormix I worked on my own startup (I learnt a lot about business the hard way). Whilst looking for a team I bumped into (CEO) Amman (Ahmed) who was looking for a CTO for this idea called Rormix.

TR: Despite the fact that Rormix was started less than a year ago, the app was named as one of the best apps released in 2013 by The Next Web. What is the Rormix app and where did the idea come from?

MW: The idea for Rormix came from the CEO's previous background with YouTube musicians. He was frustrated because there are lots of good emerging artists submitting music videos on YouTube, but they were really hard to find; to find them you have to know what you're looking for. There was no discovery element which means there is this amazing talent that is being missed.

With this in mind we founded Rormix, a platform for unsigned artists to promote their music. Unlike YouTube, we built in a discovery element from the beginning. Our aim is to make new music as easy to find as possible, and even push music we think users might like when it's released.

The Rormix App allows users to discover new music videos, and build up a collection of music they have found and liked. The more music they collect, the better the recommendations get.

TR: The Rormix founders have an eclectic background. What brought you together?

MW: Our diverse backgrounds are part of what makes our team work so well. We're based in Manchester where there is a very intimate start–up community. We met at the various events and our passion for the idea brought us together.

TR: The app was made using PhoneGap. Why did you use it in preference to developing a native iOS app?

MW: Like all startups, we made a MVP product as quickly as possible to get a better feel for the market. At the beginning I was the only developer and we needed as much data as possible, so using PhoneGap it meant I could write a codebase and reuse components from the web version in the PhoneGap App, minimising the time to market, whilst still retaining the basic features we needed.

We targeted the two major mobile platforms iOS and Android, and the codebase for both apps was nearly identical (with some minor interface tweeks). From the initial design to the submission in both App stores took just one month - a feat that (for one developer) would have been impossible if two native apps had to be made in the same time frame.

TR: How are artists selected?

MW: The artists are selected based on the quality of their music videos. They submit their video to us and we analyse it based on factors like audio and video quality.

There are some kinds of music we just can't accept, covers and remixes for example, as the artist does not hold the rights to the original music.

TR: What differentiates Rormix from other apps in the same space?

MW: All the music on Rormix is quality controlled to ensure that every video is of a certain calibre. Every video is tagged with commercial artists they sound similar to, enabling us to recommend music based on the music you already like, with no effort from the user.

With automatic music library scanning, a user can instantly start listening to curated lists of content based on music on their phone. With one click they can start discovering new artists.

It is this quality control and actionable meta data that makes us stand out in the market.

TR: You've secured investment from The NorthWest Fund for Digital & Creative (managed by AXM Venture Capital). What is your business model?

MW: Our business model is to revolutionise the way mobile advertising fits in with a product. We are not going to make the user watch a 30 second advert just to watch a 3 minute music video. Unfortunately I'm not allowed to say much more!

We are also going to share revenue generated with the artists involved to help the emerging music scene.

TR: What is the greatest challenge you've faced to date?

MW: Raising our first round of investment has been the hardest challenge to date. Building the technology is the easy part, selling the vision of the company is much harder.

TR: What are your plans for the next 12 months?

MW: Our roadmap for the next 12 months is packed full of new features. Faster media delivery, audio only options, and social playlists are just a few of the new features coming soon.

Stay tuned to http://rormix.com for the latest updates.

Can computer science rescue mathematics reform?

The new mathematics curriculum continues to rely first on counting, not algebra. **Ian Benson** argues that computer science in schools can deliver this essential entitlement.

Four years ago I reported on the progress of the Tizard project to help the then Secretary of State for Education to get better value from the government's investment in ICT in schools (Ring, XXIII, 2010). This article reports on the fate of the strategy we recommended since then, and updates it in the light of changes in technology in schools and the new statutory entitlements for education in mathematics and computer science.

Change in education is a complex process, involving pedagogy, subject knowledge, technological, financial and organisational innovation. In 2005 we recommended a threefold strategy. Firstly, that the Department for Education (DfE, then DfES) unlock the ICT infrastructure in schools so that it could be programmed by teachers or pupils. Secondly, that the curriculum moves away from the "conceptually impoverished unfolding of arithmetic concepts mandated by national strategy," or risk reducing teachers and children to machine minders. And, thirdly, that the Secretary of State should open a debate about the content of primary education — starting with mathematics. We recommended that this conversation be built around the work of Dr Caleb Gattegno, a pure mathematician and educationist who had been the founding secretary of the Association of Teachers of Mathematics (ATM, formerly the Association for Teaching Aids in Mathematics). Gattegno was one of the first influential mathematicians to argue that the post war school curriculum needed radical revision and that the mathematics that underpins modern computer science can help (note 1).

Gattegno argued in the 1960s that mathematics in schools should be based on teaching algebra first, before arithmetic. He promoted a curriculum whose goal was mastery of all four arithmetic operations and fractions as operators for small numbers in Year 1. His approach was developed in collaboration with George Cuisenaire, whose colour coded rods became for a while commonplace in Anglo-American and French schools. It was popular with teachers and their organisations, and was evaluated in controlled trials of 20,000 student years. These trials, over the first three years of primary school, showed that after four terms of study learners outperformed their peers in the traditional classroom by a decile or more.

We argued that these experiments were repeatable and could help achieve the target the government had set of a 15% step change from the 2006 Key Stage 2 mathematics results.

Under the current government progress has been made on all three fronts. A new generation of hardware and software means that computing can be integrated with the mathematics curriculum from the early years. Web based interactive development environments such as code.org and fpcomplete, Raspberry Pi and 1 to 1 iPad deployments are beginning to weaken the computer room bottleneck. They allow teachers to schedule more substantial programming tasks. Mobile computing apps are making software tools ubiquitous both for personal productivity, workflow automation and mathematical modelling.

At the same time as schools have been able to harness these trends in consumer electronics, the DfE has been able to exploit commodity web services to develop specialist portals for teacher professional development. They launched the National Centre for Excellence in the Teaching of Mathematics (NCETM) as a web portal for maths teachers and educationists in 2006. DfE part funds the work of a portal for computer science in schools, Computing At School (CAS). CAS has gained 3,000 registered teachers and 8,000 other members in the last 18 months. Over the same period NCETM registrations have grown from 90,000 to 130,000. The NCETM has inherited the role of the national strategies in promoting teacher training materials and resources, as well as certifying teachers and consultants who provide professional development. Computing At School operates a similar model. It certifies teachers who deliver professional development to colleagues.

These changes in school technology and internet collaboration are incremental. They build on the commodification of hardware, new layers of software that can be safely programmed in schools and new habits of social networking.

The changes in the mathematics and computer science statutory requirements are more profound, yet problematic. In the 2014 mathematics curriculum the DfE adopted Gattegno's goal for Year 1, but not his means — early algebra. Instead it maintains its former commitment to Piaget's "counting first" progression. As with the national strategies, algebra makes its first appearance in the statutory programmes of study in Year 5. Testing at Key Stage 1 permits the use of the number line. It precludes the use of colour coded Cuisenaire rods. Schools looking to the NCETM for guidance on teaching the new curriculum in Year 3 and 4 are directed to the Singapore Bar model — coloured rectangles which are not proportional in length. They are used to model systems of linear equations with a small number of unknowns. Schools in Singapore have found that rather than easing the transition to algebra at secondary school the bar model can make it more difficult. Nevertheless this is the only implementation approach that the DfE is exploring. They have invested £700,000 through the Education Endowment Foundation to fund the ARK academy chain to customise the Singapore approach. This will be compared with traditional teaching in English schools in Year 1 and Year 7. Publishers estimate that over 1000 primary schools are following ARK's lead.

In contrast the new statutory requirements for computer science require learners to write code at Key Stage 1 (Years 1 and 2). To do this learners need to be able to reason about objects and their relationships using symbolic systems — precisely the competences that the maths curriculum and its Singapore implementation rule out. The text books of Gattegno and his colleagues show how to do this. I published a text book in 2011 that summarises their work. It forms the basis for resources and software tools for early algebra. We are writing this code with Key Stage 3 secondary teachers and learners, and plan to use it for in service training for primary Key Stage 2 in the new academic year.

In my 2010 Ring article I hoped that the Improving Schools and Safeguarding Children Act would help open up a market for school clusters to buy support for curriculum implementation. A market of sorts has developed, but it is dominated by the educational publishers and independent contractors. Local authority maths consultants, previously on the national strategy payroll, have largely disappeared. Gattegno's own legacy is kept alive by a US charter school, a small family businesses, free web publication of his books, a teacher training co–operative and schools in France and in the activities of the ATM.

In 2011 I founded a social enterprise with a colleague, Sociality Mathematics CIC, to invest in developing a network of schools to embed Gattegno's work in implementations of the revised mathematics and computer science programmes of study. We call these resources algebraFirst™. The enterprise recruits new schools, develops web and mobile apps, curates lesson designs, operates a question and solution database, administers formative assessment tests for maths and computer science, and offers in service training in person and through the web. Sociality is asset–locked to Churchill College. We are exploring with non–resident mathematicians how a form of "Teach Last," modelled on "Teach First," might help scale our intervention to 30 schools. Mathematicians familiar with algebraFirst would offer consulting support to participating schools.

2016 will be the first year of testing for the new Key Stage 1 goals. I am confident that schools in our network will continue to deliver outstanding improvements in performance.

Notes

(1) Charles Wells, Communicating Mathematics: Useful Ideas from Computer Science, Mathematical Association of America, 1995, http://www.jstor.org/stable/2975030

Saunders Maclane, The Impact of Modern Mathematics on Secondary Schools, The Mathematics Teacher, 1956, http://www.jstor.org/stable/27955082

Ian Benson graduated with a PhD from King's College in 1992. If you know of people or schools that might be interested in learning more please contact sociality@me.com or visit www.sociality.com

Hall of fame news

ARM

ARM has acquired Duolog Technologies, a leader in design configuration and integration technology for the semiconductor industry.

Bango

Bango has announced a partnership with Etisalat, the Middle East's leading telecommunications operator. The partnership has seen not only Direct Operator Billing launched for users of Google Play and BlackBerry World, but also Bango's first integration with Samsung Galaxy Apps.

blinkx

blinkx has launched Skyrocket Player, a downloadable Windows application which allows seamless online video viewing directly on a user's desktop while working, browsing the Web or gaming. blinkx is currently developing a version of Skyrocket Player for mobile devices.

Health2Works

Health2Works, an innovative software company that has developed an online platform to help families and carers better support ill relatives, has secured funding from venture capitalist firm Midven and a number of angel investors.

Health2Works's 'Rally Round' app gives relatives and carers the ability to co–ordinate practical help for a frail or ill family member. Network members are able to add and manage jobs or tasks that need completing. The free 'Rally Round' app is now available for download on the App Store.

ObjectSecurity

ObjectSecurity, an information security leader, has started a 44–month research contract in the area of big data analytics. The project is titled 'Visual Analytics for Sense–making in Criminal Intelligence analysis'.

Object Security will receive around EUR932k from an overall EUR13mio project budget funded by the European Commission. ObjectSecurity will collaborate with an organisation consortium of 18.

Raspberry Pi

A new version of the Raspberry Pi has been released. Called the B+, the updated version uses less power than its predecessors and will cost around £20.

The B+ can also power more peripherals without the need for a dedicated power source and has more connectors to help link it to other devices.

Spektrix

Spektrix has opened its first US office in New York. Gavin Berger, the new President and CEO of the US division, will lead Spektrix through the next phase of American growth building on a customer base that includes The Julliard School and some of the most high profile names in global theatre.

Spektrix, which works with over 140 arts and cultural organisations around the UK, the US and Spain, is the leading arts–focused box office management solution built with cloud architecture.

SwiftKey

SwiftKey, one of the most popular paid Android apps of all time, used to cost US$3.99 but is now free of charge. Rather than charging customers up front to get the app, Swiftkey is taking the freemium route where you pay for add–ons and other extras.

1248.io

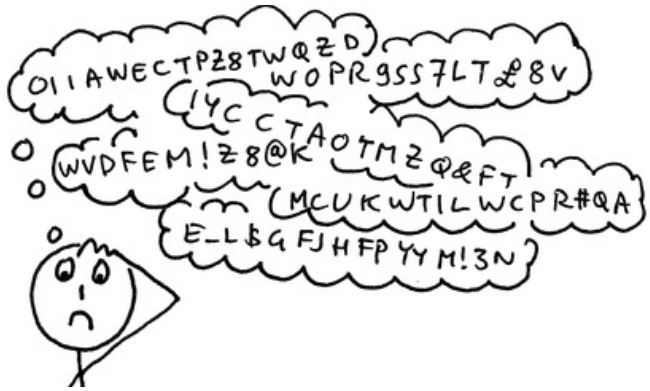
1248 is one of the 40 UK–based companies that make up the HyperCat development consortium.

HyperCat, backed by £64mio of Technology Strategy Board funding, is a new specification designed to spur on the development of the Internet of Things (IoT).

Pico: no more passwords

Frank Stajano and his team are developing a device that will store your electronic details and keep them secure.

Like every computer enthusiast, I have always been the IT help desk for friends and family. A few years ago I noticed that one of the most frequent questions had become 'how can I deal with all those passwords?'.



All the people who asked for my advice had their own personal coping strategy (from recording the passwords in a Word file to reusing the same passwords many times with systematic variations), but they felt uncomfortable and guilty because they knew they were violating the hard–to–follow official advice. They wanted me to tell them what they should really do.

Looking at their plea objectively I had to conclude that, after removing anything that was forbidden by the rules of the so–called security experts (never write passwords down; never reuse them on different accounts; never use names of family, friends, pets; never use dictionary words; include at least an uppercase, a lowercase, a digit and a symbol; use at least 8 characters; use the initials of a sentence; change passwords every 3 months), all that was still allowed was the empty set. As someone brilliantly summarized: Pick something you can't remember, then don't write it down! Essentially, the arrogant security geeks tell the rest of humanity to do something impossible, but then blame them if they don't; if you get hacked, it's your fault because you failed to follow the rules. I found that fundamentally wrong.

The Pico project was born out of a desire to redress this unfairness. As the architects endowed with the amazing superpower of designing and writing the code that makes the digital society tick, I believe we have a moral duty to make it secure, usable and, above all, *fair* to non–geeks. Hence, my primary design goal: to design and build a universal password–replacement system that would not require you to memorize *any* secrets.

The Pico is a small device that remembers all your login credentials. (Pico della Mirandola was a Renaissance philosopher with an incredible memory.) To login to a web site, or your computer, or anything else, you scan a QR code with your Pico and a cryptographic protocol is initiated that logs you in. To protect your privacy, Pico gives you a different set of credentials for every account, to prevent the linking across applications that could happen if you had to use a static identifier such as fingerprints or ID card.

> *In line with my primary directive of 'you shall not be required to memorise secrets', Pico takes a different approach.*

Because Pico holds your credentials in a physical object, you have a security problem if this object is stolen. Will the thief be able to use your credentials in your stead? That's what usually happens if they steal your home keys: burglars can get in and steal all your stuff. At other times, the security token is protected by a PIN; then you have to pick one that you'll remember but others won't be able to guess, and we're not very good at that. Joe Bonneau (PhD12, now at Princeton) once plotted a remarkable graph showing the distribution of PINs observed in a corpus of leaked credentials; many of them were just month–date or date–month — probably the owner's birthday. In line with my primary directive of 'you shall not be required to memorise secrets', Pico takes a different approach.

The Pico's storage is cryptographically locked, like that of a laptop with full disk encryption, and the key to decrypt it is generated by

the presence of small wearable gadgets that each contribute one share in a secret–sharing scheme. This means you can imagine having an 'aura of safety' around you that unlocks your Pico, a zone defined by your wearing those glasses; that belt; those shoes; those earrings; that hairpin; those cufflinks; that watch; or any k of them (say $k=2$, though we're still conducting user studies to figure out the correct value as a compromise between convenience and security). In theory you could still be mugged and lose both your Pico and all your 'Picosiblings', as we call them; but how many times has a thief not only mugged you but also taken away all your clothes?

Besides theft protection, we also offer loss protection: the Pico does

its own backups because we know you probably can't be bothered. If you lose it, just get yourself a new one and restore.

The European Research Council generously funded this research and allowed me to recruit a team that is now building all these ideas into prototypes. We have built a software prototype of the Pico as a smartphone app, and a prototype of the back–end as a plugin for Wordpress, the most widely deployed CMS on the web. I have supervised three undergraduate and three masters students on Pico–related projects and I have a PhD scholarship ready, sponsored by BT, for a bright and creative new candidate (know anyone?).

Funnily, we get a lot of questions about how secure Pico would be — even though passwords, which we use all the time, already have more severe security problems, even for those who are so diligent as to memorize a 'really secure' password like 'a6Gepn$3,XoyFslw'. Our prime research goal with Pico is not so much to make it more secure than passwords, which we are doing anyway, but to make it convenient, easy and desirable. That's why the Pico team also includes an applied psychology PhD and an HCI PhD. And it's not merely about usability, which of course is very important to us, but also about making people want to wear Picosiblings, rather than just tolerate them because they allow the Pico to work. So we have to consider the gadgets' attractiveness and their looks as part of the design, not merely their functionality. Thinking like a geek is insufficient if we want to improve the lives of regular human beings. We have conducted many interviews using low–fidelity plastic mock–ups to figure out what people would find annoying, acceptable or desirable.

The biggest challenge for Pico is that it is not backwards compatible, requiring changes at both the server and the client. Passwords are so strongly entrenched that nothing so far has been able to displace them. We face a 'vicious circle of adoption' where nobody will want a Pico if they can't use it to log into their favourite websites, and no website will support Pico if nobody has one. To break this vicious circle we created the Pico Lens, a browser plugin that examines and augments websites on the fly as you visit them, making them appear Pico–compatible. This means you can use your Pico to interact with the website, with most of the associated usability benefits, much as you would if the site actually supported Pico natively. Behind the scenes, the website still receives a password, so security hasn't improved very much, except for the fact that it's the Pico that remembers it, not you, so you can afford to have a really complicated password, and a different one for every website. This helps us build a critical mass of Pico owners even before major websites support Pico natively.

We've had quite a bit of press coverage recently, and potential investors are starting to contact us. Please visit our website, http://mypico.org, to meet the team, read our technical papers and, before any of that, watch our introductory video, featuring Max Spencer (T BA13) as The Burglar.

The Pico team

Principal investigator: Frank Stajano (JN PhD01), Reader in Security and Privacy; Head, Academic Centre of Excellence in Cyber–Secuirty Research.

Research Staff: Graeme Jenkinson, PhD; Jeunese Payne PhD; Max Spencer (T BA13); Quentin Stafford–Fraser (CAI PhD96); Chris Warrington (CL BA13).

Project students: Anders Bentzon (W MPhil13); Fabian Kraue (W MPhil14); Jonathan Millican (JE BA14); Oliver Stannard (CHU BA12); Bo Tian (T BA12); Cristian Toader (CHU MPhil14).

Research Skills course

Colin Rotherwell: Full–stack research from the CTSRD team

Computer architecture research is difficult. Much modern architecture research is performed using simulated models, but these may not be capable of running real applications, or work well in reality. Additionally, architecture research is often performed without input from the compiler writers and operating systems developers who have to make use of the new architectures. The CTSRD project at Cambridge has assembled a team of researchers with expertise including computer architecture, operating systems, and compilers to perform full–stack research on real–world systems.

If this cross–disciplinary approach is such a good idea, why isn't all research performed this way? A lot of the difficulty of collaborative hardware research comes from poor design tools. These lack features for iterative development, as they are focussed on the design of silicon chips, where no change can be made without a retooling costing millions of dollars. Whilst this might have been reasonable in the past, it does not take into account recent developments in field-programmabble gate arrays (FPGAs), reprogrammable hardware devices which can be configured to act as different circuits. Designs programmed onto FPGAs are approximately ten times slower than a dedicated chip, but can be modified quickly and easily, making traditional hardware description languages (HDLs) a poor fit. The CTSRD team takes a different approach, using 'Bluespec SystemVerilog', a modern HDL offering a higher level of abstraction than previous languages.

As a base for its research, the CTSRD team has developed the 'Bluespec Extensible RISC Implementation' (BERI), a processor implementing a 64–bit MIPS instruction set. The first project using this platform is 'Capability Hardware Enhanced RISC Instructions' (CHERI). This introduces capabilities into the processor. Capabilities are unforgeable tokens governing the permissions granted to a piece of code. They can be used to implement 'sandboxes', environments which prevent programs from damaging parts of the system that they do not need to access. Sandboxes are already used in some applications, including Google Chrome, which attempts to run each of its tabs in a separate sandbox. This approach is hampered by poor performance: when many tabs are opened, Chrome is forced to run multiple tabs in the same sandbox, reducing security. By introducing hardware capabilities we are able to provide sandboxes at an extremely low performance cost. This allows fine–grained protection, where not only each tab, but each rendered image may have its own sandbox. By building on currently existing software, this enhanced protection can be introduced gradually.

The BERI platform is not limited to security research. Versions of BERI which are multicore and multithreaded are being created, allowing cutting edge research to be performed and proven in an environment as close to the real world of fabricated processors as possible.

More information on the CTSRD project can be found on its website, http://www.cl.cam.ac.uk/research/security/ctsrd/

The MPhil in Advanced Computer Science has just one compulsory module: Research Skills. It is also taken by all first–year PhD students who have not already had training in the skills required for a successful research career: critical reading, summarisation, and review of research papers; presenting research findings in seminars and at conferences; and the design and analysis of experiments.

The best three essays from the academic year 2013–2014 are being published in 'The Ring'. This is the second of those three essays.

Computer Laboratory news

Sonic Pi

Sonic Pi, an open source programming environment designed to explore and teach programming concepts through the process of creating new sounds, and created by the Dr Sam Aaron, a Research Associate at the Computer Laboratory, has been much in the news this summer.

Sonic Pi's initial development started in the autumn of 2012 when, in collaboration with Carrie Anne Philbin (an award winning Computing & ICT teacher and now Education Pioneer at the Raspberry Pi Foundation), and under the guidance of Dr Rob Mullins (Senior Lecturer at the Computer Laboratory and co–founder of the Raspberry Pi Foundation) and Dr Alan Blackwell (Reader at the Computer Laboratory and co–director of Crucible network), Sam developed a prototype environment and associated Key Stage 2 scheme of work for the new Computing curriculum.

The following summer an arts–focused project, funded by the Arts Council and led by the University of Cambridge's Crucible Network in collaboration with Wysing Arts Centre (with guidance from freelance Creative Producer and Arts Consultant Rachel Drury), invited artists to learn how to program with Sonic Pi. The results were presented at the Cambridge Festival of Ideas in autumn 2013.

Since the back end of 2013, it's been full steam ahead with the Sonic Pi: Live & Coding project, one of only eight new digital research projects to be supported by a prestigious national award from Digital R&D Fund for the Arts (a partnership between Arts Council England, Arts and Humanities Research Council, and Nesta).

The project, which explores the computer's use in education, particularly the creative potential of live coding to provide new routes for young people into digital music, encompassed this summer's Sonic Pi: Live & Coding summer school which gave 60 children (aged 10-14) a unique opportunity to develop digital music. The summer school (by Cambridge Junction in partnership with Cambridge University Faculty of Education and the Raspberry Pi Foundation), taught the children how to do basic coding using Sonic Pi, develop digital music and — in some cases — perform it at the Friday finale.

Said Jon Pratty, Relationship Manager Creative Media, Arts Council England, 'This project highlights the immense value that digital technology, and specifically Raspberry Pi, has in supporting children and young people to engage with arts and culture. Sonic Pi: Live & Coding has demonstrated that there is strong potential for Raspberry Pi to be embedded more widely in music education across England …'

If you'd like to hear Sonic Pi, why not go to the Algorave at the third Network Music Festival on Friday September 26th 2014, where Sam Aaron and Alan Blackwell will be performing.

There will also be a chance to see live coding in action, view ten specially commissioned Pop–Pi videos and hear the results of the project's research at a Sonic Pi: Live & Coding summit on November 4th 2014. Tickets will be on sale from September 1st 2014 at www.junction.co.uk

lowRISC

low RISC is a new project producing fully open hardware systems.

The team (Dr Robert Mullins, Senior Lecturer at the Computer Laboratory, PhD student Alex Bradbury and Gavin Ferris formally of Dreamworks, co–founder of Radioscape and former CIO of Aspect Capital) hopes that the existence of a quality open SoC implementation will serve as a benchmark design for academia, will help lower the bar for semiconductor start-ups, form the part of better teaching/training materials and help transition ideas from academia into industry.

More information can be found at: www.lowrisc.org

The Cambridge Coding Academy

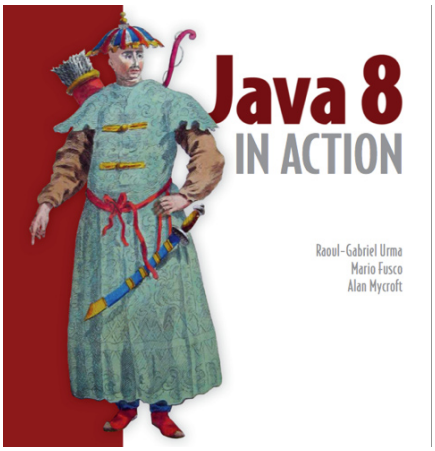
The Cambridge Coding Academy (CCA) has recently been co–founded by Lab PhD students Andrius Aucinas and Raoul–Gabriel Urma, along with Chih–Chun Chen, a Research Associate at the University of Cambridge Engineering Design Centre.

The CCA seeks to empower school children, and University students from the Arts and Humanities, to turn their creative ideas into reality through coding. This is done through hands–on one–day coding workshops where attendees learn how to create a web game using industry relevant technologies and practices. The workshops are taught by Cambridge students and graduates.

If you are interested in finding out more about the work of the Cambridge Coding Academy, please contact Raoul-Gabriel Urma at rgu20@cam.ac.uk

Java 8 in Action released

Java 8 in Action, co-authored by the Computer Laboratory's Professor Alan Mycroft and PhD student Raoul-Gabriel Urma, along with Mario Fusco, has been released.



The book is a clearly written guide to the new features of Java 8. The book covers lambdas, streams, and functional-style programming.

Appointments

Dr Anil Madhavapeddy and Dr Richard Mortier have been appointed to Lectureships.

Anil completed his PhD in 2006 at the Computer Laboratory and is a Horizon Research Fellow at the Lab.

Richard, who completed his PhD in 2001 at the Computer Laboratory, has been based at the Unversity of Nottingham School of Computer Science where he has been one of the Horizon Transitional Fellows in Computer Science at the Horizon Institute.

Research Facilitator

Dr Andrea Kells joined the Computer Lab in November 2013 as Research Facilitator. This is a new post that involves supporting the development of research proposals, identifying appropriate funding sources, and acting as a point of contact for companies and individuals interested in potential collaborations, or in finding out more about the work that goes on.

Andrea Kells

If you are interested in finding out more about current research in the Lab in a particular area, or would like to visit and see things for yourself, then please feel free to contact Andrea who will give you a warm welcome. Similarly, if you or the company that you work for would be interested in potential collaborations, please contact (andrea.kells@cl.cam.ac.uk) to discuss further.