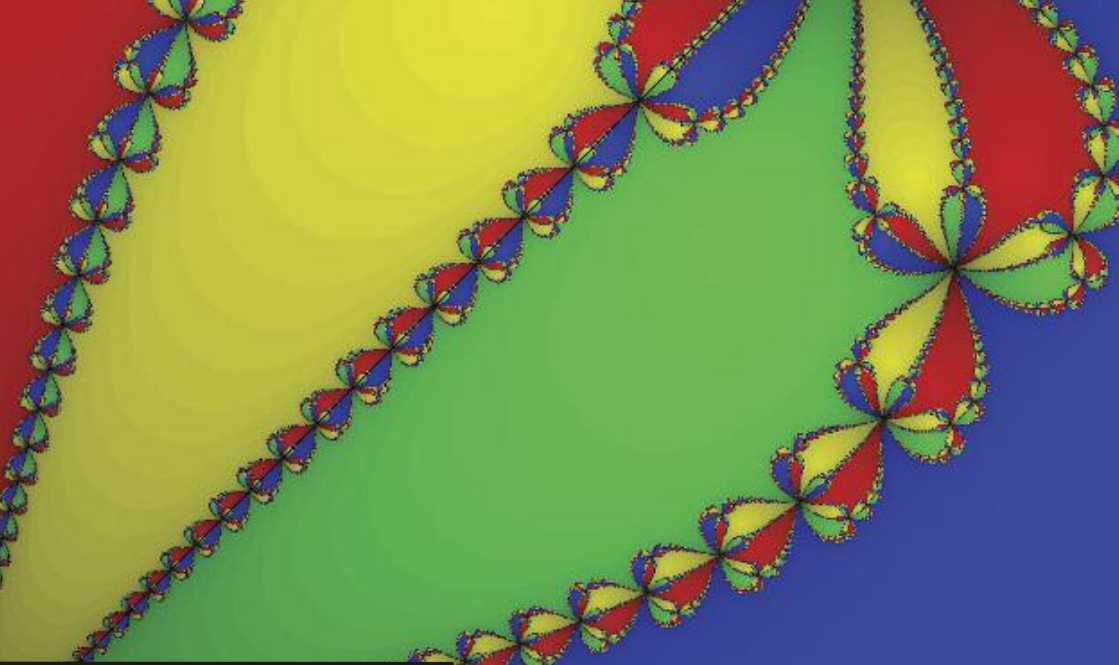
MANCHESTER 1824

The University of Manchester

Computer Science

UNDERGRADUATE BROCHURE 2014

www.manchester.ac.uk/cs



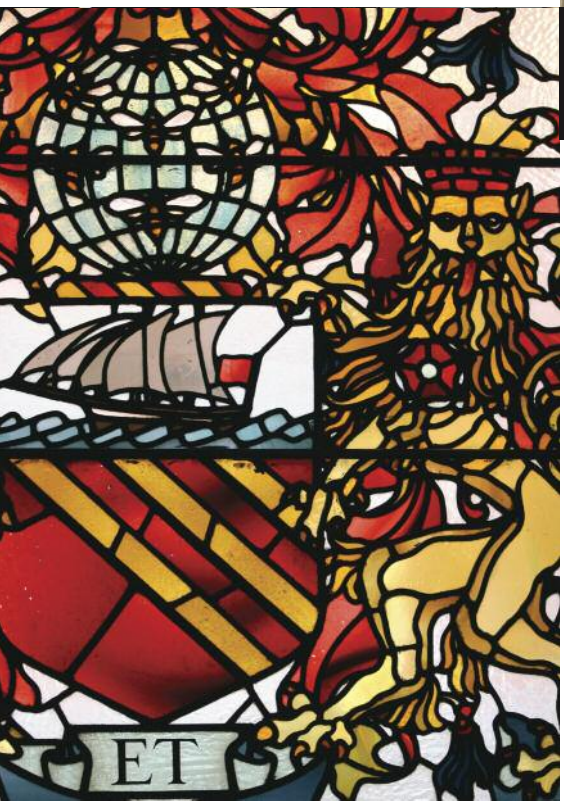
The facts

The birthplace of computer science: the world's first stored-program computer was created at Manchester

Ranked first in the country for research power in computer science

Strong industry contacts ensure cutting-edge course content

> The benefit of a degree in Computer Science from Manchester is that you become so employable
>
> **Sarah King**
> **Computer Science and Mathematics with Industrial Experience [BSc]**



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Our University
Making things happen

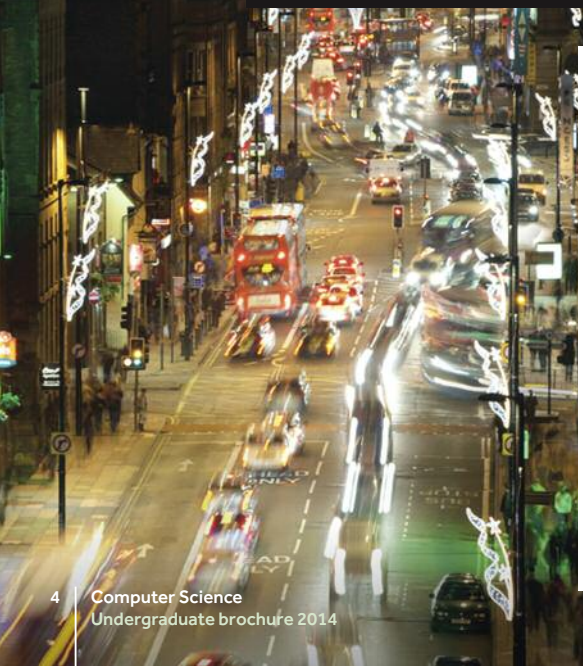
Influential, forward-thinking and down-to-earth, we'll give you an amazing university experience rooted in a rich academic heritage. We turn enthusiasm into achievement and groundbreaking theory into practice.

We accomplish feats of global significance, from splitting the atom to giving the world graphene – the two-dimensional wonder material that is one atom thick but 200 times stronger than steel. With more Nobel laureates on our staff than any other UK university, and strong links to industry and public services, we vitalise our undergraduate courses with pioneering research.

Join us at the heart of Britain's most popular student city.

Learn more about us:
www.manchester.ac.uk

Introducing Manchester



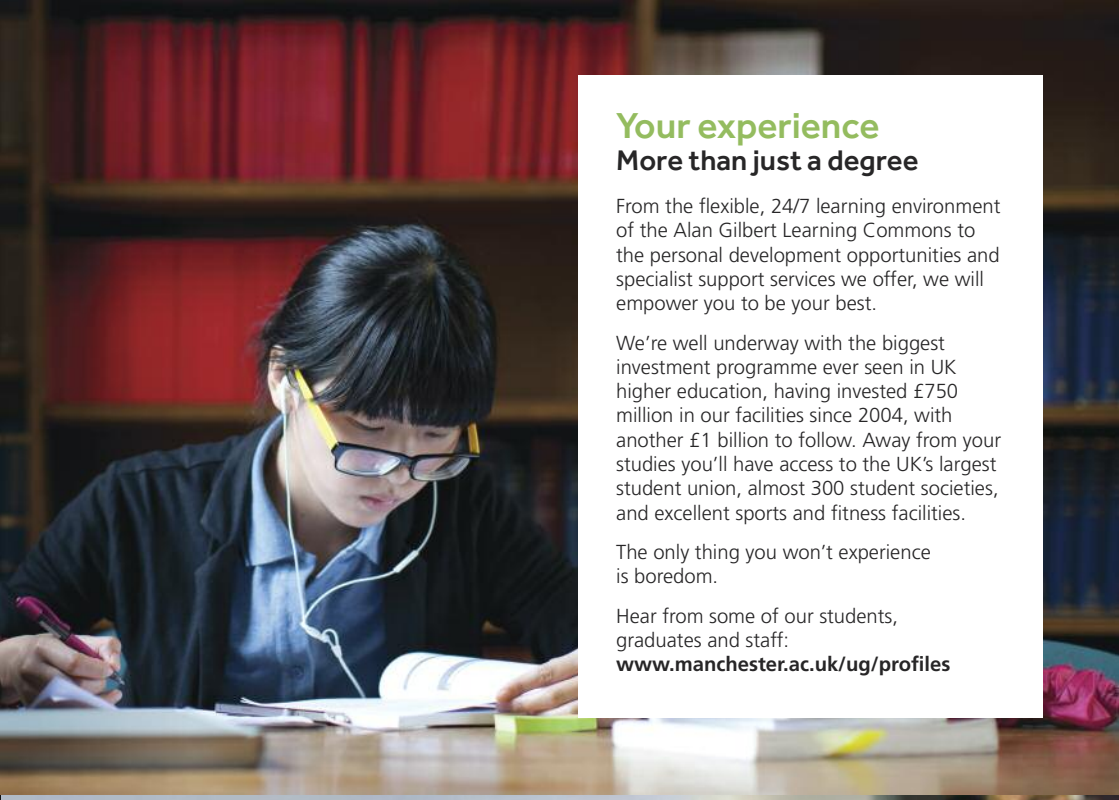
Our city
Always moving forward

Manchester lives on the edge of tomorrow, ever a step ahead in science, industry, media, sport and the arts. The Mancunian character, exemplified by the city's central role in the industrial revolution, strives for excellence in all walks of life.

This is a city of many accents, having become a cosmopolitan magnet for students and professionals eager to experience its can-do attitude, independent spirit and cultural wealth.

Never content to live on past glories, Manchester has a passion for progress.

Discover what makes Manchester unique:
www.manchester.ac.uk/cityofmanchester



Your experience
More than just a degree

From the flexible, 24/7 learning environment of the Alan Gilbert Learning Commons to the personal development opportunities and specialist support services we offer, we will empower you to be your best.

We're well underway with the biggest investment programme ever seen in UK higher education, having invested £750 million in our facilities since 2004, with another £1 billion to follow. Away from your studies you'll have access to the UK's largest student union, almost 300 student societies, and excellent sports and fitness facilities.

The only thing you won't experience is boredom.

Hear from some of our students, graduates and staff:
www.manchester.ac.uk/ug/profiles

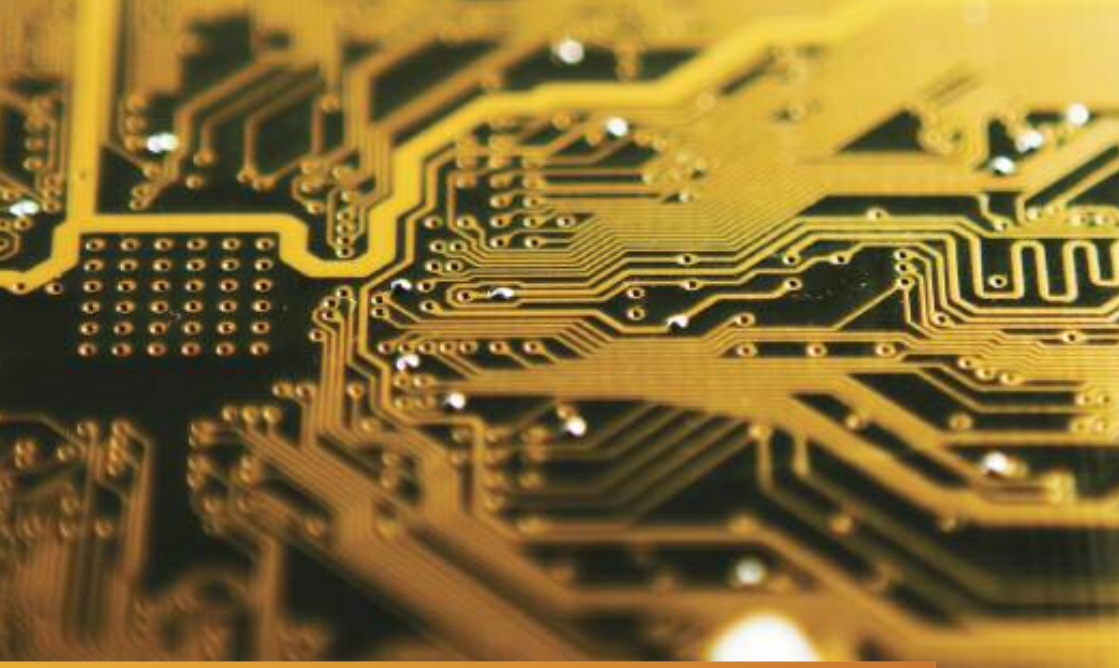
Your career
On a course to success

We are one of the UK's most targeted universities by employers – 92% of our graduates go straight into employment or further study.

We design our courses with your employability in mind. Our problem-based approach to learning inspires you to think critically, creatively, and independently. You'll also be able to learn new skills through volunteering, personal development programmes and study abroad pathways.

We have the UK's best careers service, providing advice and mentoring services, and connecting you with employers who'll put you on a path to career success.

Take control of your career:
www.manchester.ac.uk/careers



Computer Science at Manchester

"It is with great pleasure that I welcome you to the 2014 edition of our undergraduate brochure. Inside, you will find full details of the courses and teaching that make Computer Science at Manchester one of the top Schools in the country.

"Studying Computer Science at Manchester is interesting and fun. Our School provides a friendly, lively and supportive environment for students from all kinds of backgrounds and cultures.

"We offer a range of exciting undergraduate courses delivered by our world-class teaching and research staff. Our learning environment supports students with no previous computing experience, but also challenges those already familiar with the subject.

"Our courses provide a firm grounding in the concepts, knowledge and skills that today's graduates need, and are constantly revised and updated to keep track of a rapidly changing field and to equip you with the knowledge and skills you need for a career shaping the future.

"The computing revolution is changing our world, and Manchester was the birthplace of computer science, creating the world's first stored-program computer in 1948. From that time, our School has been a world-leading pioneer in software and hardware research.

"Today, we are rated amongst the top UK schools of computer science for the quality of our research. The widely used 'research power' measure, which takes into account both quality and size of research contributions, places us second in the UK and first in England. Our research excellence informs our curriculum and teaching, and we spotlight two examples of current research projects in this brochure.

"Students graduate from our School with a degree recognised and valued throughout the world. Employers like Google, Microsoft, IBM and EA Games actively seek out our students for projects, placements and graduate jobs but the career options open to our graduates are by no means limited to traditional IT companies.

"Computing is at the heart of revolutions in business, science, and society, transforming areas like medicine, biology, chemistry and social science. New career opportunities are appearing all the time.

"Of course, studying for a degree is not all work! We have a thriving student social committee and students are active in many aspects of university life. But don't take my word for it – in this brochure you can read what some of our current and recent students have to say, in their own words.

"I do hope you'll find this brochure interesting and stimulating, and I look forward very much to welcoming you to the School of Computer Science."

Best wishes,

Professor Jim Miles
Head of the School of Computer Science

RESEARCH SPOTLIGHT

Using virtual reality to treat phantom limb pain

Many people who have had limbs amputated because of accidents or illnesses find that they still feel as though the limb is attached. What's more, for many of these people, their 'phantom limb' can be a cause of serious pain, and because there is actually no arm or leg there to do anything with, many of our modern pain-relief techniques such as painkillers or physiotherapy don't work.

Computer scientists at The University of Manchester, working together with psychologists and pain specialists from local hospitals, have been investigating a radical new approach to treating phantom limb pain, in the hope of providing a cheap, side-effect-free therapy that will improve the lives of phantom pain sufferers.

The system immerses the patient in a 3D virtual world where they see themselves and their missing limb recreated using computer graphics. Controlling their 'virtual phantom' using their remaining anatomical limb, which is tracked using a Kinect sensor, they are given a series of simple games to play in the virtual world with the hope that by re-engaging with their missing limb, their brain can reconfigure itself to avoid the painful phantom limb sensations.

Peter King, one of the participants in the experiments, says: "My phantom pain is very strong. I get burning pains, and terrible pins and needles. Over the years I've been prescribed so many different forms of medication, but nothing ever works for me. The virtual reality therapy has given me hope that at some point I'll be able to live a pain-free life."

The University has given me experiences that have changed my life for the better. It prepared me for the 'real world' after graduation.

Ben Cope
MEng Computer Science (2012 graduate)
Now working for Credit Suisse

Why Manchester?

- A distinguished history in computer science, dating from the birth of the world's first stored-program computer at the University
- An entrepreneurial culture, enhanced by close relationships with industry and a commitment to producing highly employable students.
- The knowledge, principles and transferable skills necessary for a career at the forefront of innovation, in virtually any area of business or society

Study resources and facilities

- More than 300 computers in our School of Computer Science available exclusively for the use of our students
- Wi-Fi access throughout the entire School
- Java and C++ development environments (IDEs) for software development
- Oracle and MySQL systems to support database teaching
- Commercial electronic system design tools and development boards in our specialist computer engineering laboratories
- Specialised group-working areas complete with computing and audio-visual equipment to support effective group working
- Access to computing clusters around the campus and in student accommodation, including network connections in many of the University's study bedrooms
- Fully integrated web-based learning support environment available to all students

UK Schools Computer Animation Competition

If you're into animation, you might be interested in entering our School's annual animation competition, open to all UK school students aged between 7 and 19. The challenge is to create an animated film, of a minute or less, using packages like Flash, Scratch or Blender.

Since its inception, our annual competition has received over 5,000 entries from more than 900 schools and colleges nationwide. The competition was launched in 2008 to celebrate the 60th anniversary of the world's first stored-program computer, 'The Baby', which was designed and built here at the School in 1948.

Our undergraduate students help run the competition and organise the Animation Awards Festival and inspirational Computer Science Day in July each year. Sponsored by industry leaders and partners including Electronic Arts, Google, BBC 21CC, NESTA and cs4fn, the competition offers great prizes, including laptops, tablet computers and digital cameras.

To find out more, visit:
animation13.cs.manchester.ac.uk

Animation13

Computer Science at Manchester

Career opportunities

Companies who have recruited our graduates and industrial placement students in the last few years include:

- Accenture
- Amazon
- Apple
- AppSense
- Arm
- AstraZeneca
- BAE Systems
- Bank of America Merrill Lynch
- Barclays Capital
- BBC
- Bloomberg LP
- CERN
- ChannelGrabber
- Civica
- Credit Suisse
- Deloitte LLP
- Digital Applications International
- E.ON
- Ernst and Young
- Facebook
- Fujitsu Services
- GCHQ
- GE Aviation
- GlaxoSmithKline
- Goldman Sachs
- Google
- Hewlett-Packard
- IBM
- Imagination Technologies
- Isatec
- KMP Digitata
- LCH Clearnet
- Logica
- London Organising Committee of the Olympic and Paralympic Games
- Mercedes GP Petronas
- Microsoft
- Morgan Stanley
- NCC Services
- Nomura
- Oracle Corporation
- Plymouth Marine Laboratory
- PricewaterhouseCoopers
- Royal Bank of Scotland
- SAP
- Schlumberger
- Sophos
- Team Netsol
- Twitter
- UBS
- Universal Music Group
- Web Applications UK

Studying for any undergraduate course involves a significant investment of both time and money. We are committed to ensuring each and every student sees a return on this investment, and we consult widely with industrial partners so that our undergraduate courses are industrially relevant.

There are significant employment opportunities in the traditional IT industry, but our Computer Science graduates are in demand from a very broad range of employers, as they come to depend increasingly on computer-based products, services and ways of working. Opportunities exist in fields as diverse as finance, films and games, pharmaceuticals, healthcare, consumer products and public services – virtually all areas of business and society. Increasingly, employers are seeking graduates with a high level of computing skills and the ability to apply these in innovative ways to solve the problems facing their organisations.

Employers – from large multinational firms, to small local organisations – actively target our students, recognising that Manchester Computer Science graduates are equipped with the skills they need. Organisations across the spectrum recognise that the grounding our students receive in analytical thinking, problem solving and team working enables them to excel in a whole host of positions, including many that are not traditionally associated with computing graduates.

Whatever path you choose on graduation, a Manchester Computer Science degree will equip you with the technical, team-working, independent learning and communication skills to help you stand out from the crowd.

Industrial placements

Participation in higher education has risen dramatically over the last ten years and students are increasingly looking for ways to differentiate themselves in the graduate jobs market. An excellent way of doing this is by opting for an industrial placement as part of your degree. This involves undertaking a one-year work placement in industry between the second and third years of your study at Manchester.

Besides the money that you earn during this year, you also gain practical experience that can be invaluable both in your final-year project and when competing for graduate jobs. Students with industrial experience tend to not only improve their final degree performance, but also develop clearer ideas about their future career path. A placement is also a place to build your network of contacts.

We appreciate that a year in industry can be a step into the unknown for many students and we therefore provide help in both finding and vetting placements. Even when out on industrial placements, you remain very much part of our School and will have regular contact with members of our academic and support staff.

Life in our school

Teaching, learning and assessment

At Manchester, we aim to provide a unique experience that gives you the chance to follow your academic curiosity and explore a fascinating subject.

We want you to develop a strong combination of understanding the underlying principles of computer science, developing practical computing skills and acquiring the appropriate learning, communication and team-working skills that are essential for success in any future career.

The emphasis throughout is on independent learning, supported by regular meetings in small groups with personal tutors, together with lectures and labs. You receive practical help and support from experienced staff and postgraduates, with leading experts guiding your learning and stimulating your interest.

A significant amount of your work will be project-based teamwork, tackling real problems. This starts right at the beginning of your studies with the first-year team project.

Using Linux

Your practical work is spread across Windows and Linux, a popular open source version of the Unix operating system, which is increasingly being employed throughout the IT industry. Being comfortable using both operating systems means our graduates are well equipped to contribute immediately in a wide range of working environments and towards the future development of the industry.

First-year team project

All our students undertake a team project in their first year. This project is designed to help you develop the independent and team-working skills that are essential for any successful student.

The final project deliverable is a database-driven website for an application entirely chosen by the group. Previous examples have included: sites to support people building their own computers; 'Grub on A Grant'; a site to support an existing artist's business; and a site on which you can plan your own wedding.

Computer Science at Manchester

Assessment

Unseen examinations account for about 60% of your assessment. These assess your abilities in the selection and application of knowledge, problem solving, and design and evaluation of software or hardware.

Other assessment is mainly through laboratory-based coursework, through which you demonstrate your understanding of computer science by tackling specific problems on a more realistic scale, both individually and in groups. The remaining assessment is through presentations and essays where, in particular, you demonstrate the transferable skills that you have developed.

Third-year projects

A major activity in the third year of all our courses is the project. Unlike the team projects in Years 1 and 2, the third-year project is an individual piece of work, often involving the construction of a significant piece of software or hardware. Each student has a member of the academic staff as their personal supervisor, and you will have weekly project meetings together.

In the descriptions of courses that follow, we give an example of a project that might be appropriate for students on each course. You can also get a better idea of what is involved in a third-year project by watching the student project video on our website.

I studied Mathematics and Computing at A-level and really enjoyed the problem-solving and programming aspects of the subjects. Manchester has a great reputation for Computer Science. The open day had some interesting demos and presentations, and everybody I spoke to was really friendly, which is why I chose Manchester. I studied a wide range of topics, from software engineering to machine learning, but the course unit I found most interesting, and difficult, was Understanding Programming Languages, where we looked at the formal semantics of programming languages.

"Having done a lot of programming by the third year, it was interesting to see some theoretical computer science behind it. The course units I think were most useful to my career were Software Engineering and Software Design Using Patterns. After I graduated I went into a software development role and the content covered in those modules were things I now use everyday.

"I decided to do an industrial placement because I had heard that it helps students perform better in their final year, as well as possibly setting them up for a job after their degree. My placement was based in London working for Goldman Sachs where I worked as part of a global software development team working to strict deadlines. The thing I enjoyed most about my placement was being able to put all the things I had been taught at University into practice, as well as learning a load of new technologies and skills, which helped me so much in my final year.

"At the end of my placement, Goldman Sachs offered me a job on their graduate scheme, which meant I didn't need to spend my final year applying for jobs. One of the most important things I gained from my experience as a student was finding the way that I best learn. During my course I tried various revision/learning techniques and I now use the ones that best suit me for learning new skills in my job too.

Luke Torjussen
BSc Computer Science with industrial experience student (2012 graduate)
Now working for Goldman Sachs

PROJECT PROFILE:

Daniel Drake, BSc Computer Science

Biometric authentication and fingerprint recognition technologies were once the stuff of Bond movies and spy fiction. However, such technologies are now increasingly prevalent in the mobile computing market and became the focus of an undergraduate project by Computer Science graduate Daniel Drake.

Daniel's project, 'fprint', enables fingerprint scanners to be used simply and efficiently on the open-source operating system Linux.

Where previously individual scanners were supported by their own drivers and API (Application Programming Interface), Daniel created 'libfprint', a standardised API that works with a whole host of different fingerprint readers. In doing so, he has made previously unusable hardware available to Linux users, generating a sizable user base and significant media interest in the process.

Daniel's work plugs a gap in the open source desktop and is now available via SourceForge.

Study and personal support

You will meet your personal tutor within days of your arrival, and then on a weekly basis throughout the year to support the team project, in which members of the team also provide help and encouragement to one another.

We also have a very active scheme in which second and third-year students support students in their first and second years. In this Peer Assisted Study Sessions (PASS) scheme, older students meet weekly with groups of first-year students to assist them with any course problems and help them adjust to university life. This is a great opportunity for you to learn from those who have had a very recent experience of the sort of problems that you might face. Evaluations have shown this scheme to make a real difference to the performance and confidence of first-year students.

PASS leaders also found that they too had improved confidence and transferable skills to enhance their CV.

Computer Science Society

Our Computer Science Society (CSSoc) is a student-run group set up to encourage socialising within the School and interaction with other Schools within the University.

We are especially busy during induction week, helping first-year students get to know each other and welcoming them to Manchester.

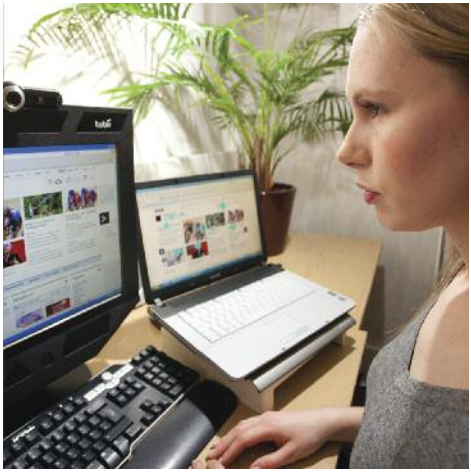
With the help of our sponsors from the School's Industry Club, we have organised a great variety of events over the past year, starting with the Freshers' Week Pub Crawl. Other highlights include a brewery tour, a treasure hunt, curry nights, the pub quiz, Laser Quest, pub golf, Halloween fancy dress and the annual summer ball.

Student blogging

To find out what life is really like at the School of Computer Science, why not lift the lid and visit our online students' blog page? Here you'll be able to read about:

- Laura's return to the University after her placement year and the challenge of her third-year project
- why Zac chose to take Computer Science and Mathematics
- the thoughts of young aspiring entrepreneur Edoardo
- German student Sam's top 10 things about living in the UK.

See for yourself: **http://studentblog.cs.man.ac.uk**



CASE STUDIES:

Student success

Every year, numerous Manchester students enter competitions and internships offered by some of the world's largest computing and IT services companies.

Our students have achieved considerable success. Second-year student Robert Clarke won the Bank of America Merrill Lynch Optimisation Competition, picking up an iPad for his efforts. The task was to present optimised pseudo-code to process share-price data.

The organisers said: "We were impressed by the consideration that Robert gave to the required precision of the variable used to store the averages, and his use of queues and threads, in dealing with the bottleneck within the problem." Well done, Robert!

Furthermore, our students 'Team Loading...' who participated in last year's Microsoft Imagine Cup were placed third in the UK. The competition judges were very impressed with the entry. The Microsoft Imagine Cup competition is extremely demanding, so this was a superb result for our students.

You could be part of our next winning team.

Course details

Computer Science MEng 4yrs
UCAS Code G401

Computer Science BSc 3yrs
UCAS Code G400

Computer Science with Industrial Experience MEng 5yrs
UCAS Code I100

Computer Science with Industrial Experience BSc 4yrs
UCAS Code G405

Software Engineering MEng 4yrs
UCAS Code GG64

Software Engineering BSc 3yrs
UCAS Code GG6K

Software Engineering with Industrial Experience MEng 5yrs
UCAS Code I300

Software Engineering with Industrial Experience BSc 4yrs
UCAS Code G603

Artificial Intelligence MEng 4yrs
UCAS Code G702

Artificial Intelligence BSc 3yrs
UCAS Code G700

Artificial Intelligence with Industrial Experience MEng 5yrs
UCAS Code G703

Artificial Intelligence with Industrial Experience BSc 4yrs
UCAS Code G701

Computer Systems Engineering MEng 4yrs
UCAS Code GH4P

Computer Systems Engineering BEng 3yrs
UCAS Code HH66

Computer Systems Engineering with Industrial Experience MEng 5yrs
UCAS Code H650

Computer Systems Engineering with Industrial Experience BEng 4yrs
UCAS Code HHQ6

Computing for Business Applications BSc 3yrs
UCAS Code G510

Computing for Business Applications with Industrial Experience BSc 4yrs
UCAS Code G511

Internet Computing BSc 3yrs
UCAS Code G450

Internet Computing with Industrial Experience BSc 4yrs
UCAS Code G451

Computer Science with Business and Management BSc 3yrs
UCAS Code G4N2

Computer Science with Business and Management with Industrial Experience BSc 4yrs
UCAS Code GNK1

Computer Science and Mathematics BSc 3yrs
UCAS Code GG14

Computer Science and Mathematics with Industrial Experience BSc 4yrs
UCAS Code GG41

Computer science is an exciting and fast-changing subject that continually presents new challenges to both industry and academia. To keep up with new developments, it is essential to have a firm grasp of the underlying principles of the subject on which to build.

All of our School's courses combine the study of core computer science principles with the development of a high level of practical skills. The principles and practical skills vary from one course to another, but are based around a common core, so that changing between courses is often possible.

To enable you to function effectively in a wide variety of workplaces, you will also develop a range of non-technical skills. Among these is the ability to analyse problems and propose and evaluate solutions. They also include other life skills, such as working as part of a team, planning a significant-sized project, presenting your work effectively using a variety of media, and managing conflicting demands on your time.

Typical offer

A-level **A*AA-AAB**
(Please note that all courses except for Internet Computing and Computing for Business Applications require A-level Mathematics or equivalent)

IB **38-35**

For full details of our entry requirements, visit: **www.manchester.ac.uk/ugcourses**

Choosing your course

Computer Science courses

Our Computer Science courses provide broad coverage of computational principles, techniques and applications – and, from the second year onwards, offer considerable choice, enabling you to specialise in areas of particular interest. We offer the following courses:

- Computer Science
- Computer Systems Engineering
- Software Engineering
- Artificial Intelligence

Interdisciplinary courses

These combine coverage of relevant computational techniques with complementary material on important application areas. We offer:

- Internet Computing
- Computing for Business Applications

These courses are taught jointly with business information system and interactive systems specialists from Manchester Business School.

Joint courses

Our joint courses combine core material from different disciplines, equipping graduates for jobs that require rich skill sets and cross traditional topic boundaries. We offer:

- Computer Science and Mathematics (joint with our School of Mathematics)
- Computer Science with Business and Management (joint with Manchester Business School)

Types of course

You can study our courses in any of the following variants:

- Three-year BSc – the fastest route to graduation
- Four-year BSc with Industrial Experience – provides an industrial placement within your course
- Four-year MEng – designed to fulfil the highest professional requirements and challenge the ablest of students
- Five-year MEng with Industrial Experience, combines the four-year MEng with an additional industrial placement year in the third year

Many of our best students often choose the four-year variants that offer the valuable opportunity to spend time in industry as part of your studies.

Our MEng courses fulfil the educational entrance requirements needed to become chartered engineers by giving exemption from professional examinations.

Most of our courses are accredited by the major professional bodies – the British Computer Society (BCS) and the Institution of Engineering and Technology (IET). You can find the precise accreditation status for each course on our School website:
www.manchester.ac.uk/cs/undergraduate/programmes

Flexible options for changing courses

Undergraduate teaching is modular, with core course units shared by the different courses. This means that, with some exceptions, it is often possible to change between courses up to the end of your first year – and, in exceptional circumstances, at the end of your second year.

For example, it is always possible to swap between Computer Science, Artificial Intelligence, Computer Systems Engineering and Software Engineering at the end of Year 1, and it is always possible to swap between Computing for Business Applications and Internet Computing at the end of Year 1.

COMPUTER SCIENCE

By developing new applications in science, engineering and business, computer science is changing people's lives. Our Computer Science course combines the study of software and hardware, and information and communication technologies, to provide you with the skills needed for a challenging and evolving career. The course is the most flexible that we offer and allows you to adapt your studies to reflect your developing, possibly changing, interests.

Core topics covered include object-oriented (Java) and imperative (C) programming paradigms, software development techniques, databases and computer architecture. You can mix these with general computing subjects such as graphics, networking and computer vision. You can also combine them with the themes that support one or more of the specialised courses in software engineering, artificial intelligence, distributed computing and computer systems engineering.

Additionally, you have the opportunity to take subjects taught by another School in the University.

Available course variants:

- BSc (Hons) Computer Science
- BSc (Hons) Computer Science with Industrial Experience
- MEng (Hons) Computer Science
- MEng (Hons) Computer Science with Industrial Experience

On the Computer Science course, you take at least two complete themes (see pages 31 to 34).

Final-year project example

Real-time tracking of multiple skin-coloured objects

This project involves designing and implementing a system that robustly detects and tracks the hands and face of a human operator, using one or possible more cameras. The system will exploit skin colour information to track the objects.

For my industrial year, I worked at Apple. My tutor recommended me to a former Manchester student who now works for Apple in Cupertino, California. I sent my CV and then took part in two phone interviews with senior Apple engineers. A few weeks later, I was told I had the job! While I was there I worked in the Core Platform Team on embedded software for mobile devices, such as the iPhone.

"Working in Silicon Valley was a great experience, and made full use of the technical skills I gained on my course. Interacting with a team of professional software engineers really brought home to me what life working in the technology industry could be like.

"I'm now in the final year of my course, and have just accepted a job offer to work at ARM, a company that designs microprocessors.

Steven Slatter
BEng (Hons) Computer Systems Engineering with Industrial Experience

SOFTWARE ENGINEERING

Software systems are at the heart of all successful modern businesses. These systems are complex and long-lived, and must be robust and adaptable. By studying software design and production techniques on our courses, you will be equipped with the skills needed to follow a career specifying and developing such systems.

Software engineering techniques consider the whole lifecycle of an application, from its specification and design, through its implementation and testing, to its maintenance and adaptation. Central to these techniques is the use of specifications and models, which support analysis of solutions for correctness and the generation of skeleton implementation code.

In addition, many different methodologies have been developed for software engineering, a range of which are used in project work, enabling you to understand their properties and the contexts in which they are most appropriate from direct experience.

Available course variants:

- BSc (Hons) Software Engineering
- BSc (Hons) Software Engineering with Industrial Experience
- MEng (Hons) Software Engineering
- MEng (Hons) Software Engineering with Industrial Experience

Students on the Software Engineering course must take at least two of the following themes:

- Agile Methods
- Software Engineering
- Rigorous Development

See pages 31 to 34 to find out more.

ARTIFICIAL INTELLIGENCE (AI)

One of the challenges in computing is to make computers think, or be intelligent, so that they can solve new problems, or cope with the unknown. Current achievements include image and voice recognition, and NASA's Mars Rovers.

By combining the study of AI and traditional computing techniques with an understanding from psychology of how humans learn, these courses prepare you for a career applying computing in challenging applications. AI-specific topics covered include the key techniques of machine learning, which are built upon knowledge representation and reasoning. These are used in both simple learning, where solutions are remembered and reused, and in the generation of a solution from several related cases.

Our courses give you the opportunity to study these techniques in the context of general computing, and their application in areas such as computer vision, natural language processing and robotics.

Available course variants:

- BSc (Hons) Artificial Intelligence
- BSc (Hons) Artificial Intelligence with Industrial Experience
- MEng (Hons) Artificial Intelligence
- MEng (Hons) Artificial Intelligence with Industrial Experience

Students on the Artificial Intelligence course must take at least two of the following themes:

- Learning and Search in Artificial Intelligence
- Natural Language, Representation and Reasoning
- Visual Computing

See pages 31 to 34 to find out more.

COMPUTER SYSTEMS ENGINEERING

Sophisticated electronic systems permeate all aspects of life. Typical examples include MP3 players, games consoles, mobile phones, vehicle control systems and radar. All of these are embedded systems, which typically contain one or more microprocessors, memory, a communications capability, and application-specific hardware and software.

Consequently, we need a wide range of knowledge and skills to support their development, including digital electronics, software engineering, computer architecture and digital signal processing.

The first two years of this course involve the study of subjects crucial to the design and implementation of embedded systems. The later parts provide the opportunity for specialisation, and for involvement in leading-edge research and development projects, often sponsored by industry.

All graduates will have skills in both software and hardware development. You will be capable of contributing effectively to the development of embedded systems, and also of pursuing careers in related areas of computing, hardware system design, or electronics.

Available course variants:

- BEng (Hons) Computer Systems Engineering
- BEng (Hons) Computer Systems Engineering with Industrial Experience
- MEng (Hons) Computer Systems Engineering
- MEng (Hons) Computer Systems Engineering with Industrial Experience

Students on the Computer Systems Engineering course must take at least the following themes:

- Computer Architecture
- System-on-Chip

See pages 31 to 34 to find out more.

Final-year project example

Predicting facial beauty on mobile devices

With the increasing sophistication of mobile devices there are new exciting applications for image processing techniques. One of these tasks is being able to intelligently recognise aesthetically pleasing images. This project aimed to implement facial beauty prediction on mobile devices. It presented a system which was able to learn a predictive model offline, transfer this model to the phone and then use it to predict facial beauty in a mobile application using images taken by the device's camera.

The Computer Science and Mathematics degree has given me the chance to explore both subjects in both an applied and theoretical manner. My most enjoyable topics were within the Artificial Intelligence theme, in which I particularly enjoyed the second-year course unit, Machine Learning. Course units such as this, as well as Algorithms, AI and Games, appeal due to their overlap with areas of Mathematics.

"I decided to do an industrial placement year to gain more insight into how I can apply the knowledge I have gained from my degree in the real world and as a step in the door for further career prospects. My placement was based in London – I worked as a business analyst for Credit Suisse in the Prime Services Indexing Team. The placement was a valuable experience and greatly helped me to develop skills applicable to my third year and for my future career.

"I feel the department, staff and students are friendly, willing to help and passionate about their thirst for knowledge in various subject areas, which gives me further determination to pass on my own passion and thirst for knowledge to younger generations. I am currently on a gap year working for Randstad Education as a cover supervisor, also known as an unqualified supply teacher. This has been a fantastic opportunity for me to gain further experience and knowledge before starting Teach First in Secondary Maths in June 2013. The role is rewarding, challenging, lots of fun and never boring! ARM, a company that designs microprocessors.

Shahnavaz Mehta
BSc Computer Science and Mathematics with Industrial Experience

Final-year project example

Real-time tracking of multiple skin coloured objects

This project looked into the implementation and analysis of a system for detecting and tracking skin coloured objects in a temporal image sequence. The system uses a non-parametric Bayes classifier to detect skin coloured pixels in an image. The classifier is trained offline using a large dataset of images and continues to learn online to adapt to illumination changes. Each object is modelled by an ellipse using parameters that are derived from the orientation and size of each skin coloured region detected. Tracking over time is then achieved by using Euclidean distance to assign skin coloured pixels to object hypotheses and a linear prediction mechanism to adjust object positions for each frame. The result is a system which is capable of efficiently detecting and tracking a varying number of objects in real-time.

Neural networks as a character recognition system

This project took the principles of connectionism and applied it to the problem of pattern recognition; engineering a software based solution. The system was developed around the work-flow of a generic pattern recognitions system, utilising an application of Artificial Neral Networks (ANN) to classify character inputs successfully.

INTERNET COMPUTING

This course, taught jointly by our School of Computer Science and Manchester Business School, will equip you with a mixture of methodological and technical skills required for the design, deployment and evaluation of internet applications.

The internet has become central to a wide range of commercial, educational and leisure activities. As a result, it is used directly by a diverse collection of individuals and organisations, with different requirements and priorities. Our Internet Computing course provides you with knowledge and understanding of the architecture and design of web-based systems and web development tools. It also provides you with skills that underpin the development and evaluation of collaborative and interactive websites in commercial settings.

Available course variants :

- BSc (Hons) Internet Computing
- BSc (Hons) Internet Computing with Industrial Experience

Students on the Internet Computing course must take the following themes:

- Web and Distributed Systems
- one other theme

See pages 31 to 34 to find out more.

COMPUTING FOR BUSINESS APPLICATIONS

Modern organisations are heavily dependent on IT systems, which can range from applications such as financial management packages, to sophisticated decision support and knowledge management tools. As the 'knowledge economy' becomes ever more important, the need for software to manage the information that an organisation depends on is also becoming more important.

This course therefore develops in you the sought-after abilities to develop software systems using an understanding of the consequences of introducing or changing IT systems as part of a wider collection of activities within an organisation. Taught jointly by our School of Computer Science and Manchester Business School, the course equips you with a mixture of technical and contextual skills. We prepare you for careers developing and exploiting software systems in commercial or public organisations.

Available course variants:

- BSc (Hons) Computing for Business Applications
- BSc (Hons) Computing for Business Applications with Industrial Experience

Students on the Computing for Business Applications course must take:

- Information Systems in Business

And at least one of the following themes:

- Agile Methods
- Enterprise Information Systems
- Software Engineering

See pages 31 to 34 to find out more.

Final-year project example

Knowledge representation
By Alice Farquharson

With the continual growth of the UK e-retail sector, the need for a flexible and personalised consumer-browsing experience has risen in turn. Most online product catalogues are currently implemented using relational database models, whose rigid design often inhibits significant changes to the data structure. Continually evolving consumer demands has created the need for a more versatile and expressive information structure.

"Knowledge Representation (KR) is a concept fundamental to computer science that strives to capture some aspect of the real world in a computational form. The ability to determine consequences to actions through reasoning of these models has enabled the development of a range of systems designed to automate intelligent deduction, such as medical diagnostic software and speech recognisers.

"One particular field of KR, ontologies, focuses on representing knowledge to be shared within a community. This project aims to explore the capabilities of using an OWL ontology to store products and their information for use in an online shop. The application design is built around three main components: development of the web application; defining the ontology; and the interaction of these using the OWL API. It examines the potential of utilising an ontology in a database-dominated domain, through the implementation of user-friendly features that offer flexible browsing and intelligent query functionality."

COMPUTER SCIENCE (67%) WITH BUSINESS AND MANAGEMENT (33%)

Delivered in collaboration with Manchester Business School, these courses take a different approach to the relationship between computing and business. Instead of addressing the issues of systems development within a business context, they complement the study of computer systems development with the study of the underlying principles and practices of business and management.

These business aspects will give you an appreciation of the whole business environment, from management and marketing, through the financial aspects and human resource management, to the development of technology for application to new products, processes and services. We combine these with core computer science topics in programming, software development and database management, and give you the opportunity to study topics from specialised areas, such as distributed computing and artificial intelligence.

Available course variants:

- BSc (Hons) Computer Science with Business and Management
- BSc (Hons) Computer Science with Business and Management with Industrial Experience

Students on the Computer Science with Business and Management course must take at least one complete theme in Computer Science. See pages 31 to 34 to find out more.

FINAL-YEAR PROJECT EXAMPLE:

Newton's method and the Newton fractal
By Anthony Chiu

"Newton's method is a numerical method for root finding. The behaviour of Newton's method is dependent on the initial guess of the root, or 'seed'. If the seed is well chosen, it converges quadratically; otherwise, its behaviour can be quite unusual and it could converge to a root further away than the nearest one. If we consider each point of the complex plane as an initial guess and colour the points according to the root it converges to, we can obtain beautiful 'Newton fractals', which illustrate the dynamical behaviour of Newton's method.

"For my project, I have created a system that allows a user to enter any mathematical function to apply Newton's method to. The system then draws the Newton fractal for this function. There are also a few tools that allow mathematicians to explore these fractals. These include viewing the orbits of points in the complex plane and changing the branch for multi-valued functions."

COMPUTER SCIENCE (50%) AND MATHEMATICS (50%)

Mathematics and Computer Science have always been closely related, each providing support and suggesting new problems to the other. These Joint Honours courses enable you to acquire a useful combination of mathematical and computer science knowledge and skills. They prepare you for a choice of careers within the computing field and beyond, such as financial modelling.

Topics studied develop your knowledge and understanding of important mathematical ideas, including the concepts of rigorous argument, formal proof and the power of abstract formulation of problems. These are combined with core computer science topics of programming and software engineering, together with a study of the mathematical principles underpinning the foundations of computing.

Available course variants:

- BSc (Hons) Computer Science and Mathematics
- BSc (Hons) Computer Science and Mathematics with Industrial Experience

FINAL-YEAR PROJECT EXAMPLE:

Conway's Game of Life
By Dan Garry

Conway's Game of Life, or simply Life, was invented by the mathematician John Conway in 1970 and is a celebrated example of a cellular automaton; a structure that consists of an n-dimensional grid containing a potentially infinite number of cells, with each cell being in one of a finite number of states. Life, as defined by Conway, is a two-dimensional cellular automaton with a grid of infinite size, which has only two states for the cells: 'dead' and 'alive'. Life's infinite grid presents a problem for modelling the automation using computers, as computer memory, although increasingly large, is only finite.

"This project focuses on the development of a program that can model Life on a personal computer. Once developed, this tool will be used as an aid to research a variation of Life where the playing field is modelled as a torus of finite size, and the final goal of this project is to derive and explain some properties of this variation"

Computer Science at Manchester

Undergraduate student Laura is keeping a record of her experiences across each year of her degree course...

Year 1

"The first year of my course has been hard work, but it's unbelievable how much I've learnt about the different aspects of computer science. The first-year course units give you a taste of the themes offered by the second and third years of the course. This has given me a good idea of the kind of career I want and which units I am going to choose in the second year. The first year is really all about the basics: for example, we have been taught Java to show us the fundamentals of programming languages, so when it came to the group website project I was easily able to pick up other languages such as JavaScript, HTML and PHP.

"The school itself is like a community. I have got to know my lecturers through labs and classes and I have found a great group of friends who share similar interests to me. The social committee has put on some amazing events too – pub crawls, laser quest, quiz nights and even a treasure hunt around the city. I've joined the staff-student committee, where I get to voice the opinions of fellow students and tell the staff about anything we want changing in the school. I've also helped out at open days, where you can even get paid."

Year 2

"The second year has certainly lived up to expectations in regards to 'knuckling down'! For me, compared to the first year the workload has been lighter, but the work has been more difficult. I worked hard last year, so the step up hasn't been too noticeable. Also, some second-year course units are optional, which means you can focus your attention on the areas you find most interesting.

"I chose a more software-driven approach and found Machine Learning especially fascinating; it taught me how computers learn from previous data to predict the outcome of an unseen input. For example, I used a program called MATLAB to perform handwriting recognition. As you'd imagine, Computer Graphics and Image Processing has been very fun; one laboratory task is to create an orrery and fly through your solar system in a spaceship. I'm really looking forward to AI and Games in the third year.

"Actually, next year will not be my final year of university, as I'm on the Industrial Experience course. Most of my first semester was spent researching jobs and companies, updating my CV and writing personal statements. There are many career events and visitors to the school during autumn/winter where you can listen to presentations, ask questions – and get free merchandise! I applied for four companies around early November, got interviews after Christmas and have accepted a job at IBM as a software engineer. I can't wait!

Year 3

"My industrial year as a software engineer at IBM has given me the opportunity to put the knowledge I gained at university into practice. It's one thing to follow a programming exercise and another to design, structure and develop your own code! This knowledge has been furthered through my assigned projects – for example, I now know how to implement threads in Java. I have learnt new technical skills from scratch, such as AJAX, Android Development and IBM specific software.

"Working with other professionals has allowed me to practise and improve my transferable skills. My daily team project meetings incorporate many key skills, such as presenting my work, listening to others and communicating my ideas and opinions – to name just a few.

"IBM encourages 'giveback' to fellow colleagues or members of the community. I have painted a playground at a local primary school and represented IBM at careers events as part of IBM's University of Manchester Campus Team. It is also a great chance to network and make connections that could affect your future.

"IBM Hursley is a beautiful location, based in and around an 18th century mansion. There are around 50 other industrial placement students, so there is no shortage of social events!

"I believe the Computer Science course prepared me extremely well for my industrial placement year and that this year has prepared me indisputably well for my future career.

Year 4

"The final year is dominated by the third-year project. I proposed my own project (instead of choosing from the supervisor's suggestions): gesture recognition using Microsoft's Kinect. I experimented with features of the Kinect SDK and machine learning algorithms, finally producing software to correctly identify gestures. In the eight-month period, I presented my research and achievements, demonstrated my implementation and wrote my thesis. I learnt a huge amount in a short period of time and although it was challenging, I really enjoyed programming for the Kinect.

"The modules that complete themes provide culminating details in the subject area ready for any postgraduate education. You can explore other interests or fill gaps in your knowledge in the remaining modules. My favourite subject has been AI and Games, where you learn about game theory and how it can be useful in real world applications. The first semester team project was to create a bot to play the game Kalah, which then competed against bots from other teams. It was a lot of fun, especially trying to beat our friends!

"I genuinely believe the School has prepared me for my future career. It's given me all the technical and soft skills I need, the support to find a graduate job or postgraduate education (holding fairs and activities) and the opportunities to fill in any blanks on my CV with clubs and events inside and outside the School."

Laura Howarth-Kirke
BSc Computer Science
with Industrial Experience
Final-year student

Research spotlight

Computing to emulate the human brain

Professor Steve Furber, ICL Professor of Computer Engineering

Most of the frontiers of science, from particle physics to radio astronomy, seem to be concerned with the incredibly small or the unimaginably large. But there is a lump of stuff inside each of our heads that we could easily hold in our hands and look at, yet we have no idea how it works.

The world's most sophisticated computer models can perform impressive feats of calculation, but fail when given some of the simplest tasks that humans undertake with ease and from a very early age. The human brain's neural networks are proof that there are alternative computational architectures that can outperform the fastest manmade systems in tasks such as face recognition, speech processing and the use of natural language.

Professor Steve Furber is leading a pioneering research project that delves deep into the possibilities of producing computer models that can simulate and carry out the detailed workings of the human brain. Highly parallel and complex systems, brains are built from a hundred billion small cells called neurons. Neurons have evolved to perform an essential information-processing function; everything that we see, smell, hear, think, dream and say – indeed, our very being – is a consequence of the billions of cells inside our heads going 'ping' from time to time. The pings, or 'spikes', are the electrical messages travelling from neuron to neuron along connecting axons.

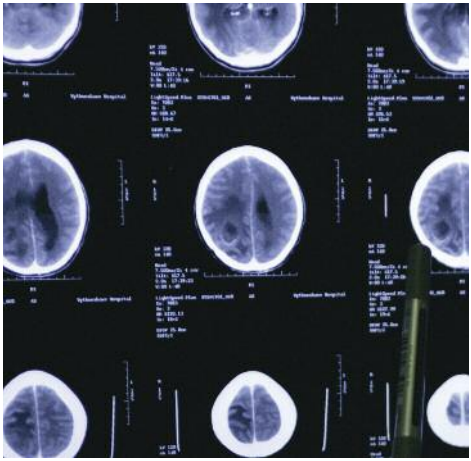
However, though exceedingly power efficient, neurons are imperfect, slow and often at risk of failure. The adult brain loses a neuron a second without obvious ill effect, hence why we have billions of them up there to function efficiently.

Professor Furber's 'SpiNNaker' project mimics the human brain's biological structure by recreating the spiking process in real time, while also studying the parameters of individual component failure – where the brain is able to lose neuron after neuron, but still manages to work reliably.

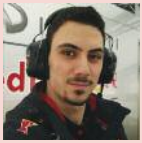
Steve and his team have modelled the neuron's spiking process with digital processors, and the axon connectivity is represented by messages, or information packets. They aim to build a machine that incorporates a million ARM processors linked together by a communications system that can achieve the very high levels of parallel connectivity observed in the brain. Such a machine would be capable of modelling a billion neurons in real time – which is still only around 1% of normal human brainpower!

His team has also begun collaborating with psychologists to build a computer model of normal human language, capable of learning to read, comprehend and speak basic English words. After training, the model will be selectively 'damaged' in ways that reproduce the patterns of behaviour observed in individuals who have suffered brain damage, strokes and mental illness. Our team hopes to gain an ever-deeper understanding of how the brain supports language, how it can fail, and the best ways to achieve recovery from those failures.

Find out more:
http://apt.cs.man.ac.uk/projects/SpiNNaker



Computer Science at Manchester



I was always fascinated by the world of Formula 1 (F1). The excitement, the passion and the commitment of the teams, who constantly push the limits while trying to build the fastest car on the track, make it such a unique sport. I would have never believed that I would now be working for the reigning F1 World Champion, the Red Bull Racing F1 team.

"It all began during my second year at the School of Computer Science, when I was given the choice for a year in industry as part of my course. I will never regret the moment I decided to take that opportunity. Later on, I received an email from the Careers and Placement Officer promoting a job in the Information Technology department of the Red Bull Racing F1 team. I immediately thought this was my chance to make my dreams come true!

"However, balancing the workload for my studies and the preparation for the job assessment was not an easy task. Thankfully the Career Services at the University helped me through the entire assessment phase. Nevertheless, after submitting my CV and a covering letter, I was called twice for face-to-face interviews and eventually I was informed that I got the job.

"My role as a High Performance Computing (HPC) systems engineer is challenging. As a team of three systems administrators we are responsible of maintaining 24/7 operation of the HPC systems, including a large datacentre. In addition, we provide full support to the company's Aerodynamics department, which is where the car is designed.

"During the first couple of months of my industrial experience I was training to adapt to the new working environment and to gain the basic knowledge required for the job. As soon as I felt confident enough to take on critical tasks, I was given administrator access to all key IT areas of the business and root access on the HPC systems.

"My daily tasks include researching for new technologies, performing administrative tasks like configuring and troubleshooting servers and client workstations, and writing and debugging scripts on Linux to automate various processes. Apart from my everyday tasks, I am involved in several high-importance projects such as web developing, designing new computation and backup systems, and installing, configuring and benchmarking state-of-the-art systems.

"As the time goes by, I keep on learning. I am constantly developing my skills and broadening my knowledge and my areas of expertise. The tasks I am assigned are always demanding and they have a high impact on our business and the rest of the employees, therefore the level of responsibility is quite high.

"As a motivated and hard-working student, I am making the most out this incredible placement year. My best experience so far was when I travelled to Barcelona for the pre-season testing and I had the chance to see what it is like to be a part of the race team. When the placement is over, I would like to recall the entire year and be glad that I enjoyed it because opportunities like these are given once in a lifetime.

Kyriacos Georgiou
BSc Computer Science with Industrial Experience
Currently working at Red Bull Technology

COMPUTER SCIENCE THEMES

As the largest School of Computer Science in the UK, we are able to offer course units on a wide range of technical areas, thereby enabling you to match the topics you study to your interests and career aspirations. Course units in second and subsequent years are grouped into themes.

We work closely with industry to ensure our themes introduce cutting-edge approaches and technologies; in fact, many of our themes are sponsored by industrial partners.

Agile Methods

Focuses on processes and techniques for managing software projects under challenging conditions. They are important because software often has to be developed under pressures of time and in uncertain settings, where more traditional software development techniques have proved to be too cumbersome.

The theme consists of the following course units:

- Year 2: Software Engineering Project
- Year 3: Agile Software Engineering Development
- Year 3: Software Evolution

Computer Architecture

Involves the selection and interconnection of hardware components to create computers that meet functional, performance and cost goals. As a result, the development of effective computer architectures is a central part of technology development, and an understanding of the capabilities of architectures is important for developers of higher-level systems.

The theme consists of the following course units:

- Year 2: System Architecture
- Year 3: High-Performance Microprocessor Architectures
- Year 3: Chip Multiprocessors

Computer Languages

Computer languages are central to the development of software systems. A good understanding of programming languages is important for software developers, and many sub-disciplines of computer science use specialised languages that suit their specific requirements.

The theme consists of the following course units:

- Year 2: Algorithms, Data Structures and Programming
- Year 3: Specifying and Implementing Programming Languages

Information Systems in Business

Addresses the role and impact of software systems within organisations. Many large-scale software development projects fail because business requirements, organisational structures, or inter-organisational relationships are less than fully reflected in the design or deployment of the new software.

The theme consists of the following course units:

- Year 2: Information Systems and Business Process Modelling
- Year 3: e-business
- Year 3: Information Technology and Organisation

Computer Science at Manchester

Learning and Search in Artificial Intelligence

Concerned with constructing intelligent systems that can adapt to a changing and uncertain environment. Applications in which learning and search are central include game playing, financial prediction and mobile robotics.

The theme consists of the following course units:

- Year 2: Machine Learning
- Year 3: Probabilistic Modelling and Games
- Year 3: Artificial Intelligence and Games

Mobile Computing and Networks

Concerned with the provision of an infrastructure whereby distributed computational devices can cooperate efficiently and securely. Both wired and wireless networks are increasingly ubiquitous, and the importance of networked computing increases with the number and diversity of networked devices and mobile applications.

The theme consists of the following course units:

- Year 2: Mobile Systems
- Year 2: Computer Networks
- Year 3: Digital Wireless Communications and Networks
- Year 3: Cryptography and Network Security

Natural Language, Representation and Reasoning

Concerned with techniques and tools for capturing and making use of knowledge in computer systems, and for using natural language to communicate with users about that knowledge. Knowledge representation is important in many applications, from the description of web pages in the semantic web, to the interpretation of natural language statements in grammar checkers and machine translators.

The theme consists of the following course units:

- Year 2: Symbolic Artificial Intelligence
- Year 3: Knowledge Representation and Reasoning
- Year 3: Natural Language Engineering

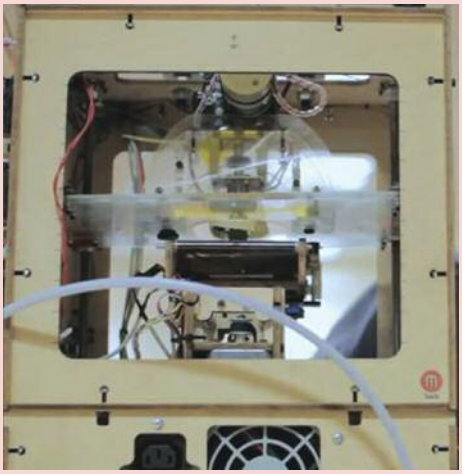
Programming and Algorithms

Algorithms capture the way in which a problem is to be solved. As a result, they are central to software development, and a wide range of techniques has been developed that underpin the design and analysis of algorithms. In this theme you explore a wide range of algorithms and data structures, investigates how their properties can be analysed systematically, and explores how they can be implemented efficiently.

The theme consists of the following course units:

- Year 2: Algorithms, Data Structures and Programming
- Year 3: Advanced Algorithms

Third year project example: 3D Printing



3D printing is a novel manufacturing technique where physical objects are made up of thin layers of material printed layer-by-layer. One of the key parts of any 3D printer is its control system which is required to exactly coordinate all of the printers components (to sub-millisecond accuracy) while also handling communications with the outside world.

As my '3rd year project' I designed and built a new 3D printer control system building on a range of topics from electronics to operating system design and information theory. Throughout the project I was given tremendous freedom to experiment (and play!) while also being able to meet with researchers to quickly get to grips with challenging topics. This is undoubtedly one of the department's greatest strengths: the lack of barriers between students and staff; such contact was invaluable when stuck on challenging topics and allowed me to explore areas of personal interest in more detail.

Rigorous Development

Concerned with techniques for specifying and analysing algorithms and systems, with a view to reaching a level of understanding that enables guarantees to be made about their behaviour. It is important as many applications of computer systems are both complex and safety critical, and thus stand to benefit from a systematic investigation of their properties.

The theme consists of the following course units:

- Year 2: Logic and Modelling
- Year 3: Verified Development
- Year 3: Concurrency and Process Algebr

Software Engineering

Concerned with all aspects of software production, from the early stages of requirements gathering, through system design and implementation, to maintenance and evolution. Software engineering is important because software projects may involve large teams of people, diverse or conflicting requirements, tight timescales and limited budgets.

The theme consists of the following course units:

- Year 2: Software Engineering Project
- Year 3: Software Design Using Patterns
- Year 3: Software Quality

Computer Science at Manchester

System-on-Chip

Involves the integration of the components in a computer or other electronic system into a single integrated circuit. System-on-Chip techniques are of increasing importance because they support the development of specialised embedded systems, such as MP3 players.

The theme builds on Fundamentals of Computer Engineering in your first year, and consists of the following course units:

- Year 2: VLSI System Design
- Year 3: System-on-Chip Modelling
- Year 3: Implementing System-on-Chip Designs

Visual Computing

Concerned with the acquisition, analysis and production of visual data. Visual computing is ubiquitous: its applications include computer games and virtual environments, scientific data visualisation, face recognition and medical imaging.

The theme consists of the following course units:

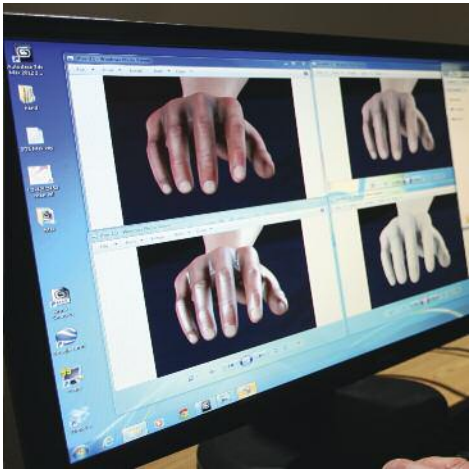
- Year 2: Computer Graphics and Image Processing
- Year 3: Advanced Computer Graphics
- Year 3: Computer Vision

Web and Distributed Systems

These systems are among the most widely used computing systems, and are increasingly central to commercial, educational and leisure activities. As a result, many organisations – and thus their customers – are heavily dependent on the robustness and scalability of their distributed systems.

The theme consists of the following course units:

- Year 2: Databases
- Year 2: Distributed Systems
- Year 3: Documents, Services and Data on the Web



Industrial Placement Experience

For my year in Industry I worked down in London for a small company working as a developer on php, python and web applications for radio stations across the UK. I think what is really important about doing a year in industry, is that it gives you more experiences to talk about in job interviews after you graduate. Rather than answering each question with examples of work you did at university, the placement year gives you that breadth of knowledge of what it's like to work in the real world, which is really attractive to potential employers once you start your professional career. I don't think I know of anyone that went on the Industrial experience year that had a problem securing a job once they finished their degree. I think it's a really valuable thing to do and I thoroughly recommend it to anyone considering it, as it makes your life so much easier!

Sam Starling
Internet Computing with Industrial Experience Graduate (2012)
Currently working as a Software Engineer, BBC Future Media

Find out more online

Accommodation
Discover your new home:
www.manchester.ac.uk/accommodation

Admissions and applications
Everything you need to apply:
www.manchester.ac.uk/ug/howtoapply

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Take a look around our 24/7, independent learning space:
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Balancing your studies with your caring responsibilities:
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Talk to us about any support you need:
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Funding and finance
Get to grips with fees, loans, scholarships and more:
www.manchester.ac.uk/studentfinance

International students
Let us help you prepare for your time here:
www.manchester.ac.uk/international

IT Services
Online learning, computer access, IT support and more:
www.manchester.ac.uk/itservices

Library
We have one of the UK's largest and best-resourced university libraries:
www.manchester.ac.uk/library

Maps
Find your way around our campus, city and accommodation:
www.manchester.ac.uk/aboutus/travel/maps

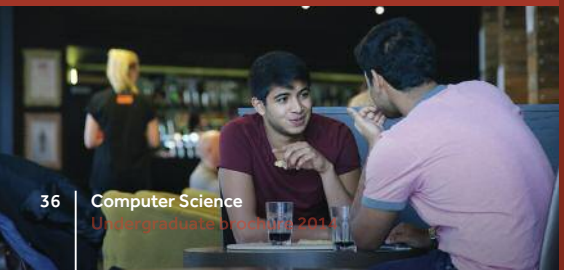
Prospectus
Download or order a copy of our prospectus:
www.manchester.ac.uk/ug/courses/prospectus

Sport
Get active with our clubs, leagues, classes and facilities:
www.manchester.ac.uk/sport

Support
Let us help with any academic, personal, financial and administrative issues:
my.manchester.ac.uk/guest

Students' Union
Immerse yourself in societies, events, campaigns and more:
manchesterstudentsunion.com

Videos
Learn more about us on our YouTube channel:
www.youtube.com/user/universitymanchester



Contact details

For further information about the courses, or about qualifications, please contact:

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For the most up-to-date course information, please visit our website: **www.manchester.ac.uk/cs**

Disclaimer

This brochure is prepared well in advance of the academic year to which it relates. Consequently, details of courses may vary with staff changes. The University therefore reserves the right to make such alterations to courses as are found to be necessary. If the University makes an offer of a place, it is essential that you are aware of the current terms on which the offer is based. If you are in any doubt, please feel free to ask for confirmation of the precise position for the year in question, before you accept the offer.

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