

# DEPARTMENT OF COMPUTER SCIENCE

UNDERGRADUATE PROGRAMMES 2019/20

WARWICK

THE UNIVERSITY OF WARWICK

Our Department of Computer Science offers a thriving community of excellence across the breadth of Computer Science. From the teaching you will receive on your first day, to our cutting-edge research affecting the lives of people across the globe.

**3<sup>RD</sup>** **IN THE UK FOR COMPUTER SCIENCE**  
(THE TIMES AND SUNDAY TIMES GOOD UNIVERSITY GUIDE 2019)

**97%** **OF RESEARCH RATED WORLD LEADING OR INTERNATIONALLY EXCELLENT**  
(2014 RESEARCH EXCELLENCE FRAMEWORK, THE MOST RECENT GOVERNMENT RESEARCH ASSESSMENT)

**94%** **OVERALL SATISFACTION**  
(NATIONAL STUDENT SURVEY 2018)

**AVERAGE SALARY**  
**£34,500** **WITHIN 6 MONTHS OF GRADUATING**  
(DESTINATION OF LEAVERS FROM HIGHER EDUCATION 16/17)



## WHY COMPUTER SCIENCE AT WARWICK?

### FROM THE FIRST GENERATION TO THE FUTURE

Founded in 1967, we are one of the oldest and most established Computer Science departments in the UK. We are incredibly proud of our heritage in educating generations of computer scientists who have gone on to advance a science that now permeates every aspect of our society.

### TEACHING FROM THE CUTTING-EDGE

We are currently ranked second in the UK for computing research\*, which means that you will be taught by staff who are leaders in their field through innovative teaching which draws on their research expertise. And to ensure we remain as industrially relevant as we are academically recognised, our courses are also increasingly taught with industrial partners, cementing our already close links with employers.

### EQUIPPED FOR TECHNOLOGY PRESENT AND FUTURE

Our focus is on the principles and underpinnings of computer science, an understanding of which will give you the ability to adapt to change and new developments throughout your career. In short, while we teach using many of the latest technologies, our emphasis on fundamentals will prepare you to engage with new technologies emerging in the future. We believe this is crucial for our constantly evolving industry.

### ACCESS THE TOOLS YOU NEED, WHENEVER YOU NEED THEM

The Department is housed in a state-of-the-art building where you will have 24-hour access to dedicated computing laboratories. Each of these is equipped with high specification workstations and comfortable spaces for group work and collaboration. This is in addition to specialised hardware and software for student projects.

### GREAT MINDS THINK ALIKE

Our department attracts the brightest computing minds which means that you will have the chance to work alongside and collaborate with like-minded students and academics in a relaxed and friendly environment. Support is always at hand and we make every effort to ensure each of our students receives outstanding tuition and the opportunity to develop according to their own interests.

### READY FOR THE THE WIDER WORLD

We pride ourselves on equipping students with the knowledge, skills and confidence required to make the best possible start in their careers and to have an impact in the wider world. This is precisely why our students are sought after by premier graduate employers, including those in technology, engineering, financial services and government.

\*Research Excellence Framework 2014

## OUR COURSES

Our degree courses attract highly qualified students and provide them with a theoretical foundation in established areas of their discipline, as well as the opportunity to apply what they learn to industrially relevant problems throughout their degree.

This combination enables students to pursue careers in a diversity of sectors, regardless of which of our courses they decide to study.

### We offer the following undergraduate courses:

- Computer Science BSc/MEng
- Computer Systems Engineering BEng/MEng (joint with the School of Engineering)
- Discrete Mathematics BSc/MEng (joint with the Warwick Mathematics Institute)
- Computer Science with Business Studies BSc (joint with the Warwick Business School)
- Data Science BSc (joint with the Department of Statistics)

## COURSE STRUCTURE

The structure of our degrees is intended to allow students to tailor their studies to their own interests.

On all of our courses you will study a mix of core and optional modules in each year of your degree. Typically you will have fewer core modules and increasing freedom to choose from a broad range of optional modules as you progress through your studies.

As well as choosing options from the subjects you have chosen to study, for example Computer Science and Engineering or Maths, you will also have the opportunity to choose some options from other disciplines. This includes, for example, modules taught by Warwick Business School and the Departments of Philosophy, Economics and Modern Languages.

We find this degree structure ensures students get maximum enjoyment from their time at Warwick, and graduate with a unique knowledge and skill set which helps distinguish them as they enter the world of work or further study.



## STUDY ABROAD, INTERNSHIPS AND PLACEMENTS

We offer a variety of opportunities to students on all our courses to enhance their degree with industrial experience or study abroad\*.

Each of our degree courses has an 'intercalated year' option. This allows you to spend a sandwich year (between two years of your degree) studying abroad or working in industry, which will be reflected in your degree title. An alternative to a year spent in industry is to apply for a year spent on the department's established exchange programme with the Hong Kong University of Science and Technology. If successful, students following a four year degree can choose whether to take the year as intercalated or as a replacement for one of their degree years.

### STUDY ABROAD

Our established exchange programme with the Hong Kong University of Science and Technology provides students with the opportunity to experience teaching and learning at another world-leading institution. The university also has excellent relationships with a range of institutions around the world, and offers a variety of study abroad opportunities which students may apply to if they wish. In addition to benefitting from a rich cultural experience, students returning from studying overseas exhibit an international profile that is attractive to potential employers..

\*subject to visa regulations

### INDUSTRIAL PLACEMENTS

Students choosing to do a year in industry typically take it between the second and third year of their degree. We provide support for students wishing to spend a year in industry by promoting opportunities, hosting careers fairs and offering one-to-one sessions with our departmental careers advisor.

During your year in industry you will be supported by your personal tutor and our Industrial Liaison Team, and students working in the UK are visited by academic representatives to review their development during the year. Students who take a year-long industrial placement return with a deeper appreciation of the application of their discipline and often develop final-year project ideas based on their experience. Additionally, it is common for students to obtain an offer of a graduate role in their host company on completion of their degree.

Our students have spent successful internships at companies including Accenture, ARM, Bank of America, British Telecom, Cisco, Google, GSK, IBM, Intel, Microsoft, Reuters and Unilever.

Regardless of whether you decide to take an intercalated year, there are ample opportunities to gain real-world experience through internships which the department promotes and offers support with. These programmes usually take place during the summer vacation, allowing you to apply your knowledge and skills in an industrial setting.

# COMPUTER SCIENCE

## BSc Computer Science

3 years | UCAS code: G400

## MEng Computer Science

4 years | UCAS code: G403

Computer Science is an exciting and challenging discipline which covers a broad and continually growing range of fields, and is now seen in nearly every aspect of our everyday lives.

Whatever your knowledge of computing or programming, our course begins with the fundamental mathematical and scientific foundations of computer science, equipping you with the knowledge and understanding required to face any technological challenge.

Our course enables you to develop technical skills in areas such as software engineering, algorithm analysis and system design, as well as giving you experience of project management, research and scientific methods. Working closely with industry leaders, you will have opportunities to develop industrially relevant subject knowledge and transferable skills, such as communication, teamwork and planning, which are highly valued by employers.

Many of these skills are further developed through the third year individual project, which students often find to be a highlight of their degree. You'll bring together everything you have learned and apply it to a challenge of your choice under the supervision of world-leading academics.

## Entry Requirements:

**A Level:** A\*AA to include A in Mathematics

**IB:** 39 with 6,6,6 in three Higher Level subjects Including 6 in Higher Level Mathematics

If you follow the MEng course you will have the opportunity to broaden and deepen your understanding through the study of more advanced modules and through the application of this learning in a significant group project. The group project is also an opportunity to develop your research and teamwork skills in an environment similar to what you may experience as you progress to work or further study.

**Accreditation:** This course is accredited by the British Computer Society, fully meeting the educational requirement for Chartered Information Technology Practitioner (CITP) registration and, in the case of the MEng degree, for Chartered Engineer (CEng) registration.

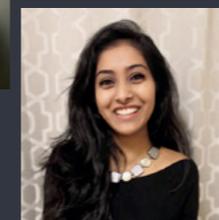
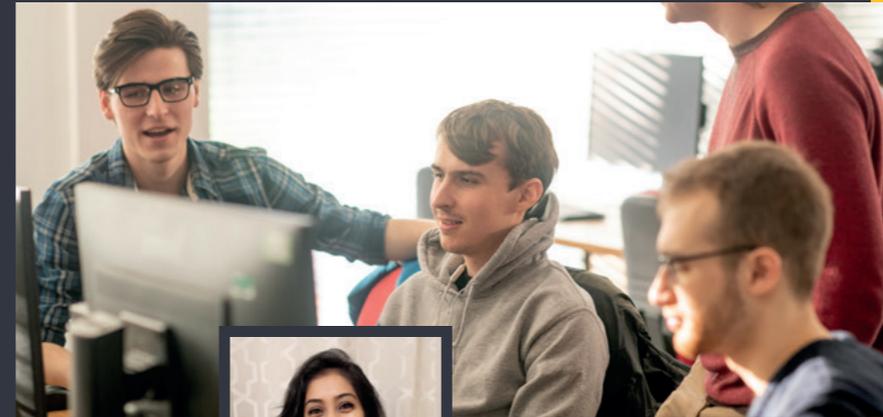
## 3 or 4 years?

Students are offered the flexibility to transfer between the BSc and MEng courses until the end of their second year, subject to academic performance. Therefore if you are unsure which degree path is right for you, pick either and you can change your mind later.

## CORE COMPUTER SCIENCE

## OPTIONAL MODULES

## PROJECT WORK



"When I came to visit the campus I had the opportunity to meet the staff and other undergraduate students from the Department of Computer Science. Seeing their passion and enthusiasm for this degree convinced me this was the place to be and one and a half years in, I am feeling confident and loving my degree!"

**Gowri**

2nd Year Computer Science student

## CORE MODULES

### YEAR 1

Programming for Computer Scientists  
Design of Information Structures  
Mathematics for Computer Scientists I  
Mathematics for Computer Scientists II  
Computer Organisation and Architecture  
Professional Skills

### YEAR 2

Operating Systems and Computer Networks  
Database Systems  
Formal Languages  
Algorithms  
Software Engineering  
Logic and Verification

### YEAR 3

Individual Project  
Project Management (MEng only)

### YEAR 4 (MEng only)

Group Project

## EXAMPLES OF OPTIONAL MODULES

Machine Learning; Digital Forensics;  
Computer Graphics; Functional  
Programming; Visualisation; Computer  
Security; Artificial Intelligence; Data Mining  
(MEng only); High Performance Computing  
(MEng only); A Foreign Language

## Further information

 [warwick.ac.uk/dcs/teaching/courses](http://warwick.ac.uk/dcs/teaching/courses)

# COMPUTER SYSTEMS ENGINEERING

## BEng Computer Systems Engineering

3 years | UCAS code: **G406**

## MEng Computer Systems Engineering

4 years | UCAS code: **G408**

Computer Systems Engineering is a fully integrated degree taught jointly by the Department of Computer Science and the School of Engineering.

This degree focuses on the design of computer systems and their real-time applications, with an emphasis on pervasive technologies including wireless networks, mobile devices and sensors, robotics and wearable technology.

You will receive a firm grounding in the principles of Computer Science, which is complemented by the knowledge and skills you will gain as an electronic engineer, with specific emphasis on digital electronics, low-power systems, communications, control and real-time operation.

This combined knowledge will give you the ability to apply state-of-the-art computer science methods in areas such as the validation and verification of software, fault-tolerant design and code optimisation, and to use high-performance computing techniques to design efficient and robust embedded systems.

In your third year you will undertake an individual project, where you will have the opportunity to apply your knowledge to a subject of your choice under the supervision of world-leading academics from Computer Science and Engineering.

## Entry Requirements:

**A Level:** AAA (BEng) or A\*AA (MEng) to include A in Mathematics

**IB:** 38 including 6 in Higher Level Mathematics (BEng) **or** 38 with 6,6,6 in three Higher Level subjects including 6 in Higher Level Mathematics (MEng)

If you follow the MEng course you will stay on for a fourth year to study more advanced material and participate in an interdisciplinary Engineering group project, which will help advance your research and development skills in a team environment closer to what you may experience as you progress to work or further study.

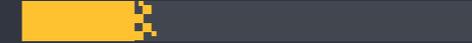
If you study the 3-year variant of this course you may choose to have your degree awarded as a BEng or a BSc.

**Accreditation:** This course is accredited by the British Computer Society, fully meeting the educational requirement for Chartered Information Technology Practitioner (CITP) registration and, in the case of the MEng degree, for Chartered Engineer (CEng) registration.

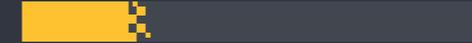
## 3 or 4 years?

Students are offered the flexibility to transfer between the BEng and MEng courses until the end of their second year, subject to academic performance. Therefore if you are unsure which degree path is right for you, pick either and you can change your mind later.

## CORE COMPUTER SCIENCE



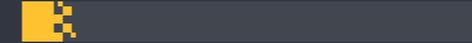
## CORE ENGINEERING



## OPTIONAL MODULES



## PROJECT WORK



## CORE MODULES

### YEAR 1

Programming for Computer Scientists  
Design of Information Structures  
Computer Organisation and Architecture  
Professional Skills  
Electrical and Electronic Circuits  
Engineering Mathematics  
Systems Modelling, Simulation and Computation

### YEAR 2

Operating Systems and Computer Networks  
Advanced Computer Architecture  
Software Engineering  
Engineering Mathematics and Technical Computing  
Analogue Electronic Design  
Digital Systems Design

### YEAR 3

Individual Project  
High Performance Embedded Systems Design  
Project Management for Computer Science (MEng only)

### YEAR 4 (MEng only)

Group Project

## EXAMPLES OF OPTIONAL MODULES

Functional Programming; Visualisation; Computer Security; Digital Communications and Signal Processing; Artificial Intelligence; Fundamentals of Modern VLSI Design; Starting a Business; Mobile Robotics; Computing Graphics; Machine Learning; Digital Forensics; Data Mining; Biomechanics; High Performance Computer (MEng only); Biomedical Signal Processing (MEng only); A Foreign Language

## Further information

 [warwick.ac.uk/dcs/teaching/courses](http://warwick.ac.uk/dcs/teaching/courses)

# DISCRETE MATHEMATICS

## BSc Discrete Mathematics

3 years | UCAS code: G190

## MEng Discrete Mathematics

4 years | UCAS code: G4G3

Our Discrete Mathematics course combines the study of computer science and mathematics. It focusses on studying the mathematical structures which form the foundations of computing and its modern applications.

The course is taught jointly by the Department of Computer Science and the Warwick Mathematics Institute, both world-leading in their fields, making it the ideal choice for talented mathematicians with an interest in technology.

Our course is designed to allow you to develop your skills in both mathematics and computer science, covering areas such as software engineering, combinatorial analysis, formal proof and algorithmic analysis. However it is the combination of these skills that enables its students to both analyse and solve problems in an abstract sense and realise solutions through computer software, which makes graduates from this course so highly employable.

Warwick is also home to the Centre for Discrete Mathematics and its Applications (DIMAP), a multidisciplinary research centre for discrete modelling, algorithmic analysis and combinatorial optimisation. This means you will be working alongside internationally renowned academics at the centre of the latest research breakthroughs.

## Entry Requirements:

**A Level:** A\*AA to include A\* in Mathematics or Further Mathematics

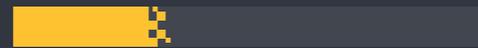
**IB:** 39 with 6,6,6 in three Higher Level subjects Including 6 in Higher Level Mathematics

In your third year you will work alongside academics on an individual project, where you will apply your skills to an area of your choice under the supervision of our world-leading academics. In your third and, if following the MEng, fourth years you will be exposed to cutting-edge research and focus on more advanced and exciting areas at the interface of computer science and mathematics.

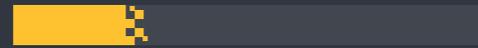
### 3 or 4 years?

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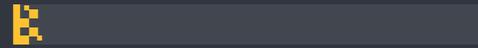
#### CORE COMPUTER SCIENCE



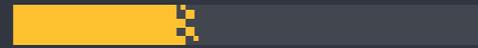
#### CORE MATHEMATICS



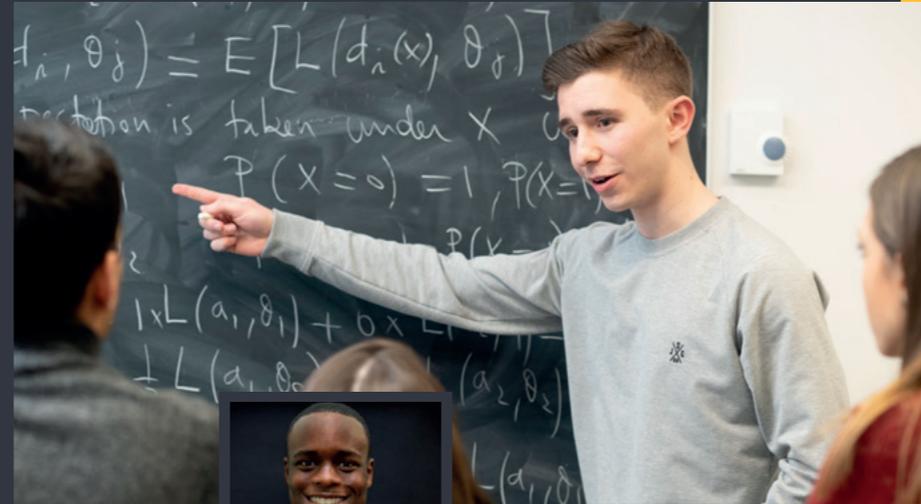
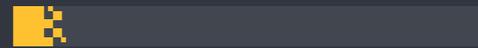
#### CORE STATISTICS



#### OPTIONAL MODULES



#### PROJECT WORK



"The most exciting module I took at Warwick was most certainly the Machine Learning module. This area of technology is growing quickly and I love how it's applicable to areas which mean a lot to me, such as healthcare and education. I now work as a Software Engineer at a fintech startup in London - an interest that was shaped by my whole experience of being a student in the Computer Science department at Warwick. The modules, the staff and my peers all contributed to my seeing the value of building useful products using code and subsequently pursuing this as a career."

#### Caleb

Discrete Mathematics with Intercalated Year BSc student 2014-2018

## CORE MODULES

### YEAR 1

Programming for Computer Scientists  
Design of Information Structures  
Discrete Mathematics and its Applications I  
Discrete Mathematics and its Applications II  
Linear Algebra  
Mathematical Analysis  
Sets and Numbers  
Probability A

### YEAR 2

Combinatorics  
Algorithmic Graph Theory  
Formal Languages  
Algorithms  
Norms, Metrics and Topologies (MEng only)  
Mathematical Analysis III (MEng only)

### YEAR 3

Individual Project  
Complexity of Algorithms  
Approximation and Randomised Algorithms  
Measure Theory (MEng only)  
Probability Theory (MEng only)

### YEAR 4 (MEng only)

There are no core modules

### EXAMPLES OF OPTIONAL MODULES

Experimental Mathematics; Computer Security; Advanced Linear Algebra; Stochastic Processes; Machine Learning; Geometry of Curves and Surfaces; Fluid Dynamics; Topics in Data Science; Bayesian Forecasting and Intervention; Games, Decisions and Behaviour

### Further information

 [warwick.ac.uk/dcs/teaching/courses](http://warwick.ac.uk/dcs/teaching/courses)

# DATA SCIENCE

## BSc Data Science

3 years | UCAS code: 7G73

### Entry Requirements:

**A Level:** A\*AA to include A\* in Mathematics or Further Mathematics *or* A\*A\*A + AS Level A to include A\* in Mathematics and A in AS Level Further Mathematics *or* A\*A\*A\* to include Mathematics *or* AAA to include Mathematics + 2 in STEP or Merit in AEA

**IB:** 38 to include 7 in Higher Level Mathematics

Data Science is concerned with how we gain knowledge from the vast volumes of data generated daily in modern life, from social networks to scientific research and finance, and the sophisticated computing techniques required to do this.

Our Data Science degree, the first undergraduate degree of its kind in the UK, is delivered jointly by the Departments of Computer Science and Statistics, with some modules being taught by specialists from the Warwick Mathematics Institute.

This flexible course gives you opportunities to develop your computing, statistical and mathematical skills while solving real-world problems as you study the theory and processes behind large-scale data analysis and its applications.

You'll develop expertise in specialist areas of machine learning, data mining and algorithmic complexity, and acquire skills in analytical thinking, cross-disciplinary communication, and mathematical and statistical modelling. The unique skill-set you'll develop is hugely in-demand in both industry and research, and you'll find yourself thoroughly prepared for the vast range of career opportunities that are consequently available to you.

## CORE MODULES

### YEAR 1

Programming for Computer Scientists  
Design of Information Structures  
Mathematical Programming I  
Linear Algebra  
Mathematical Analysis  
Sets and Numbers  
Statistical Laboratory  
Introduction to Probability  
Mathematical Techniques

### YEAR 2

Database Systems  
Algorithms  
Software Engineering  
Stochastic Processes  
Mathematical Methods  
Mathematical Statistics Part A  
Mathematical Statistics Part B

### YEAR 3

Data Science Project

### EXAMPLES OF OPTIONAL MODULES

Artificial Intelligence; Games, Decisions and Behaviour; Neural Computing; Machine Learning; Approximation and Randomised Algorithms; Mobile Robotics; Computer Graphics; Social Informatics; Programming for Data Science; Mathematics of Random Events

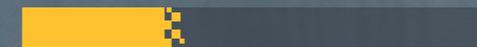
### Further information

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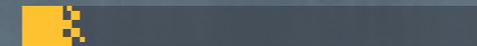
### CORE COMPUTER SCIENCE



### CORE STATISTICS



### CORE MATHEMATICS



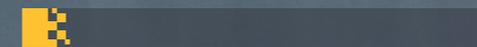
### CORE BUSINESS



### OPTIONAL MODULES



### PROJECT WORK



# COMPUTER SCIENCE WITH BUSINESS STUDIES

## BSc Computer Science with Business Studies

3 years | UCAS code: GN42

### Entry Requirements:

**A Level:** A\*AA to include A in Mathematics or Further Mathematics  
**IB:** 39 with 6,6,6 in three Higher Level subjects Including 6 in Higher Level Mathematics

Our Computer Science with Business Studies course is run jointly with the Warwick Business School, one of the leading business schools in Europe.

You will spend the first two years of your degree studying Computer Science, followed by a year studying in the Business School, where world-leading academics and industry professionals will teach you about business and management practices. As with our Computer Science course, no prior knowledge of computer science or programming is required.

Through studying the role of technology in the modern business environment, you will gain rigorous computer science and business expertise which can be applied to utilising technology to meet real-world business goals.

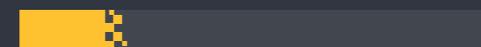
You will gain technical skills in software engineering and system design, as well as an understanding of how these impact organisations. Software engineering projects conducted throughout your degree are taught in conjunction with industry professionals and give you the opportunity to test your skills against real-world problems. Alongside a range of technical skills, you will have opportunities to develop business and industrial knowledge with relevant real-world skills, including those in communication, planning and management.



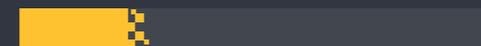
### CORE COMPUTER SCIENCE



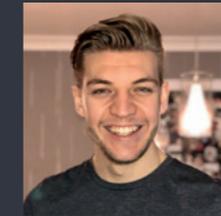
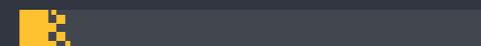
### CORE BUSINESS



### OPTIONAL MODULES



### PROJECT WORK



The courses on offer at Warwick helped highlight the areas of computer science I found most interesting. The opportunity to take more modules at the start of a term to establish which courses were best suited and then retain the most interesting ones to me was very helpful."

### Will

Computer Science  
 BSc student, 2014-17,  
 Now Software Engineer  
 at The Hut Group



## CORE MODULES

### YEAR 1

Programming for Computer Scientists  
 Design of Information Structures  
 Mathematics for Computer Scientists I  
 Mathematics for Computer Scientists II  
 Computer Organisation and Architecture  
 Professional Skills

### YEAR 2

Operating Systems and Computer Networks  
 Database Systems  
 Formal Languages  
 Algorithms  
 Software Engineering  
 Logic and Verification

### YEAR 3

In third year you will select from an extensive list of WBS modules. Some may be linked to prerequisite modules. For example, if you would like to study International Marketing, generally you will need to have also chosen the Marketing module in a previous year.

### EXAMPLES OF OPTIONAL MODULES

Business Data Analytics; Computer Security; Artificial Intelligence; Simulation; Marketing; Design in Business; Company Law; Accounting in Context; Corporate Strategy; Behavioural Economics; Organisational Analysis; Starting a Business; Enterprise Information Systems; Consumer Behaviour; Supply Chain Management; Global Sourcing and Innovation

### Further information

 [warwick.ac.uk/dcs/teaching/courses](http://warwick.ac.uk/dcs/teaching/courses)

## APPROACHES TO TEACHING

All our degree programmes offer a level of flexibility so that you can tailor your degree to the subjects that interest you most, meaning our students' can have different experiences of teaching and learning during their time at Warwick.

However, although each student's experience may differ, there are some elements of teaching and learning that all students are likely to experience at some point during their time in our department.

This page gives an overview of some of the opportunities and experiences, as well as the huge levels of support available to students on our courses.

If you are considering the Data Science degree we advise visiting the Department of Statistics webpages for more information about teaching, learning and assessment on this degree programme.



"I've found that the staff in the department are friendly and willing to help with any problems you have, and it's great that every student has a personal tutor they can go to for advice. The facilities are also excellent and you almost always have access to a workstation no matter how late or early you are working!"

**Cameron**  
2nd Year,  
Computer Science

### SUPPORT

As a department we are committed to offering each student a personalised experience and extensive support throughout their time at university.

On arrival at Warwick you will be allocated a dedicated Personal Tutor, an academic from within the department who you will be encouraged to meet with on a regular basis. Your personal tutor can offer support and guidance for all matters relating to your academic progress or personal wellbeing. Additional academic support is also offered by our teaching staff who have dedicated open Office Hours in which you can go to them should you have questions relating to any of the course content.

Our students often find their peers also provide a great source of support, encouragement and, of course, friendship throughout their degree, and we encourage students to work together on revising study materials. Our student Computing Society also offers academic and professional skills support through regular programming workshops, academic talks with industry professionals as well as hosting gaming and other social events. In addition the university's Wellbeing Support Services provide



a range of support to help students develop useful skills and resources for navigating student life.

### TEACHING

Our courses offer a balance of core material delivered through lectures, small-group seminars and hands-on laboratory sessions. Lectures are large group lessons in which an academic will speak for usually around an hour on a particular subject. Seminars offer an often complimentary smaller group session where you will have a chance to build on topics introduced in lectures, while laboratory sessions provide opportunities to apply your learning and develop your practical skills under the support of supervision staff.

Approximately a quarter of your time is spent in timetabled classes, with the remainder being used for private study, completing

assignments or projects, and practical work in the dedicated computing laboratories which are open 24/7.

### ASSESSMENT

Your performance on most modules will be assessed by a combination of coursework and written examination. The coursework may be individual or group work involving programming, research, writing and presentation. Typically in the third and fourth years of some of our courses, depending on which degree path you follow, project work is fully assessed by a presentation and project reports.

Each year contributes to the final degree classification, typically in the ratio of 10:30:60 for a BSc degree and 10:20:35:35 for an integrated Master's degree.

## RESEARCH SPOTLIGHTS

Take a look at some of the exciting research our academics are working on to get an idea of the challenges and progress being made in the sector right now.



### GUESS WHO?

Professor Graham Cormode

How can you collect personal data from a population without revealing the true information about any one individual? That's the paradox at the heart of the area of private data collection.

There's a neat solution using probability. Suppose we want to ask a group of people a yes/no question. Every person independently tosses two fair coins: if your coin comes up heads, you answer truthfully, otherwise you use the second coin to give your answer - heads for yes, tails for no. We can work out that the probability of collecting a true answer is  $3/4$ , and a lie with probability  $1/4$ . Then we can estimate what fraction of people would truly answer yes, even though we are unsure for any individual whether they are really a 'yes' or a 'no'.

So far this sounds like a question in a probability exam. But this same idea is at the heart of algorithms used by Google, Apple, Microsoft and Snap to collect data privately from hundreds of millions of users every day. Google use this to spot malware attacks on browsers, while Snap build machine learning models to better predict spam messages.

The algorithms become more complex: Apple's approach involves sampling coefficients from a Fourier transform of user data, and using a randomized algorithm called a "sketch". They make use of a data structure designed by one of our Professors Graham Cormode, the Count-Min Sketch, which has been widely adopted in a variety of applications, from tracking popular tweets to warning about common password choices.

Professor Cormode's current research continues to develop new approaches for private data collection, looking at problems such as how to measure more advanced statistical properties of the distribution of users' data, and how to build accurate prediction models.

### THE FUTURE OF E-VOTING

Professor Feng Hao

E-voting systems are increasingly being used in elections around the world. However the systems used in countries such as India, Brazil and the US are currently unverifiable; they rely on "trusted authorities" such as government-appointed election officers to tally votes.

It is this reliance on "trusted authorities", who in the advent of e-voting are also required to have expertise in computer science and cryptography, that one of our department's research teams, led by Professor Feng Hao, challenge. Professor Hao is looking into how cryptography can be used to make an e-voting system verifiable with the aim "to provide a means whereby voters can independently verify that their votes are accurately captured and tallied by the system", hence ensuring that the integrity of an election result is maintained. In the process, the researchers eliminate reliance on trusted authorities who tally the cast votes, so the election is "self-tallying."

Such a secure and publicly verifiable system could be used in all manners of elections, from local to national, and would be more secure, usable and dependable. The system Professor Hao is researching would also detect and provide evidence of electoral fraud, thereby acting as a strong deterrent to vote-tampering, furthering trust in the integrity of the outcome.

Professor Hao's team currently conduct trial elections and evaluations here in the UK but they are also in contact with election think-tanks in the US and Europe and, more recently, have started an international



collaboration with Professor Bimal Kumar Roy of the Indian Statistical Institute under the support of a Royal Society International Collaboration award. Their research looks at using this kind of system to strengthen e-voting in India, where electronic voting machines have replaced paper ballots in all national and general elections in the country.

In the longer term, Professor Hao aims to create freely available open-source software tools for voting and auditing, and is in the process of commercialising such e-voting research under the Innovate UK academic start-up programme.

## RESEARCH SPOTLIGHT

### TURNING FREE-TEXT TO KNOWLEDGE

Professor Yulan He

90% of the world's data is stored in the unstructured text format making it difficult for machines to understand and analyse. But what if computers were able to understand the semantic meanings conveyed in human's spoken language and written text?

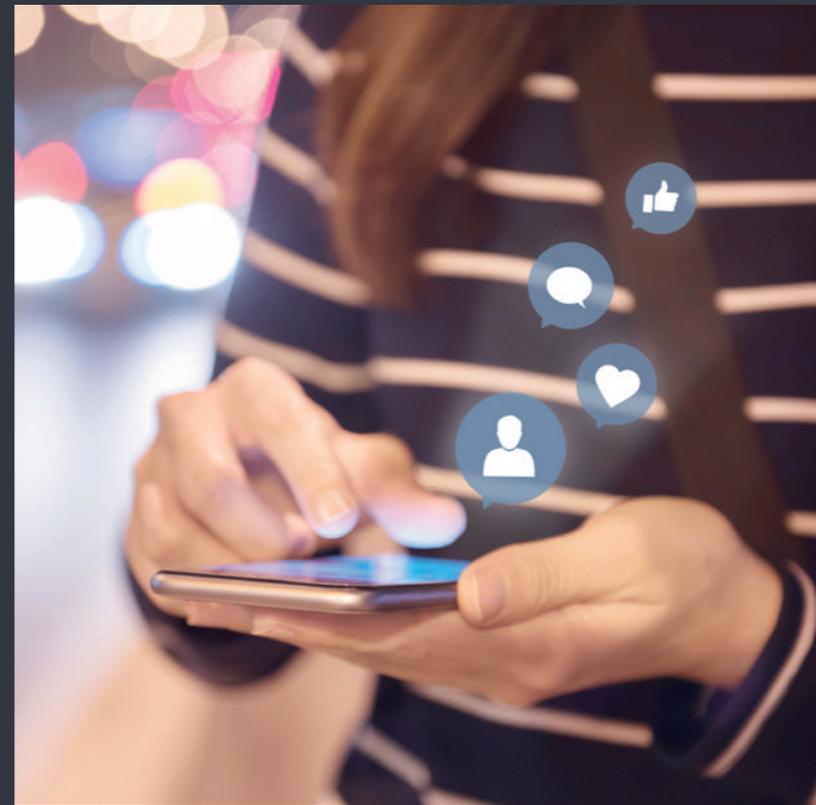
This is the ultimate goal of Professor Yulan He whose current research in our department uses a combination of machine learning and language processing techniques to analyse social media content, online user behaviour and opinions expressed on the web.

Professor He explains, "Together with my students and collaborators, we have proposed a series of unsupervised Bayesian models for automatic extraction of newsworthy events discussed on Twitter. We have also developed models which can discover hierarchical viewpoints and opinions expressed in social media during the US general election and Brexit."

Undergraduate students have the opportunity to draw on examples from Professor He's research which she shares in her teaching to show how data mining approaches can be used to analyse social media data.

However Professor He's interests and the implications of her research also reach far beyond just social media as she explores the use of statistical methods for acquiring knowledge from clinical documents, biomedical literature and the investigation of artificial intelligence techniques in finance, legal and insurance documents.

Speaking of her current work, Professor He added "I am currently an academic lead of the cR&D project, funded by Innovate UK, which aims to develop statistical models in order to uncover the hidden meaning within unstructured data to provide output that is human readable, comprehensible and succinct. Examples of such data include case notes in Adult & Child Care, Medical/Patient Records, Clinical & Pharmaceutical Trials, Insurance Claims and Legal Margin Notes."



## CAREERS

Our graduates are highly sought after by premier graduate employers, who appreciate the rigour and industrial relevance of our degree courses.

This means that our students have a great deal of freedom in deciding on their career path, with the majority having a host of exciting options open to them on graduation. Sectors popular with our students include software engineering, technical consultancy and financial services.

We work closely with the University's Student Careers and Skills Centre to offer guidance and support on graduate employment, including application reviews, interview preparation and one-to-one advice. We also have a dedicated departmental careers advisor. In addition to the University's careers fairs, our students benefit from departmental careers events including our annual flagship "Computing Your Career", where we host multi-national organisations with whom we have long-standing partnerships.

97%

**GRADUATES IN EMPLOYMENT WITHIN 6 MONTHS OF GRADUATION (DLHE 16/17)**

3<sup>RD</sup>

**IN THE UK WITH AN AVERAGE SALARY OF £46,800 FOR GRADUATE EARNINGS FIVE YEARS AFTER GRADUATION**

(2018 LONGITUDINAL EDUCATION OUTCOMES DATASET)

Turn over to see where a degree from our department has taken some of our recent alumni...



## RUTH

Computer Science MEng student 2010-2014.  
Now Senior Site Reliability Engineer (SRE) at Google

My job is to run really large distributed systems that are fast and reliable. Emergency response and mitigation is a critical part, but most of the time we work on “projects”. Projects include things like writing automation, for example for releases or capacity management, writing monitoring systems, consulting with developers on launches or designs, or changing some part of the system itself, for example the load balancing algorithm. I currently work in London on Google Cloud Compute Engine and have previously worked on Google Calendar and security and privacy infrastructure.

Whilst at Warwick I interned at Google twice, the first as a developer in London and the second time as an SRE in Zurich. I really enjoyed the second internship so decided to come back full time as an SRE. I find distributed systems very interesting and have a lot of fun thinking of ways in which something could break, but I also enjoy the diverse kinds of work we do.

The official goal of my job is “to automate myself out of the job”. I really like this goal and also hold it personally as something I would like to accomplish - it’s about never having to do repetitious work anymore, and getting the system to run and fix itself.

My favourite module at Warwick was Neural Computing. At a first glance it doesn’t seem directly relevant to my job, but I think it is - Neural Computing was about studying how brains function and ways of artificially mimicking this. Distributed systems can go wrong in so many ways, and often have such unexpected side effects that diagnosing a problem requires similar skills. Neural Computing inspired me to investigate problems logically and with an open mind.



## CHARLIE

Computer Science BSc student 2012-2015.  
Now Deployment Strategist at Palantir Technologies

By focusing on the principles and underpinnings of computer science, my time at Warwick helped to equip me with the ability to continuously adapt to new developments throughout my career. The emphasis on fundamentals prepared me to engage with any technology, and not just what was relevant during my studies. Most notably, the group software engineering project undertaken with an international industrial partner was particularly good at giving an insight into how theoretical concepts taught throughout the course can be applied in a real-world software engineering environment.

I now work as a Deployment Strategist, working directly with customers to deliver value from their data, and ensure they’re using our products as effectively as possible to solve problems. I’m focused on helping to create the best user experience for our customers to work with data, enabling them to answer complex questions without requiring them to master querying languages, statistical modelling, or the command line.

I always knew that I wanted to work closely with customers, in a role where I can see the direct output of my work. Through undertaking summer internships and having a strong focus on technical fundamentals in my degree, I was able to find the right role for me.

My advice to anybody starting out at Warwick would be to, alongside expanding your technical abilities, make sure you take all of the opportunities that are thrown at you to help develop industrially relevant subject knowledge and transferable skills, such as teamwork, communication, and planning.



## DANIELLE

Data Science BSc student 2014-2017.  
Now Software Engineer at Accenture

I develop software for Accenture and their clients depending on which project I’m on. Currently, I’m specialising in writing Python code for a Cloud Platform solution taking advantage of AWS technologies.

My degree definitely helped me get offers for interviews and assessment centres because it offers a unique experience. I can also proudly say that I’m the first ever female in the UK to have an undergraduate degree in Data Science! The feeling I had when I found out I had passed my degree and got a job offer, it was incomparable, it’s one of the proudest moments of my life.

I am now motivated by many different things, I work with some incredible people and they have taught me so much since university and I think it’s the fact that I can work with these people that motivates me from day to day. I’ve also discovered I have an eye for the creative side, and as such I have created several bespoke websites for my friends and family because I have a growing passion for front-end development. Personal goals I have in my job are to be able to curate a portfolio of my creative achievements, I’ve found I’m really empowered through UI/UX (User-Interface/User-Experience) design, because not only should it make sense (there’s a whole science behind it), it should be beautiful too.

In fact, it was the Social Informatics module that I took at Warwick, which looks at the science behind HCI (Human Computer Interaction) and includes a project task to design a working online shop-front, that was probably one of the biggest influences that piqued my interest in front-end design.



## HAMISH

Computer Science BSc student 2014-2017, Computer Science MSc student 2017-18.  
Now Big Data Developer at Barclays

I am mostly doing platform engineering of the data science and surrounding platforms my team have created and own within Barclays. There is a bit of data analytics and science mixed in where feasible to allow for me to understand the structure of the bank’s data, where and how it is stored.

I gained several skills from my time studying Computer Science at Warwick including how to network, how to be more social, improved organisation and time management and most of my coding ability and knowledge that I utilise now. All of this, alongside my own motivation, self-taught skills and work with start-ups and as a web development contractor have helped me get to where I am today.

There were some really interesting modules that I got to choose from during my time at Warwick, and the content is updated according to the current technology, so it feels like you are ready to help advance fields of research by the time you get to your dissertation. I particularly liked the first year Web Development module as it allowed me to start working towards becoming a web development contractor whilst continuing to study my degree in later years. I did much of this work for The Boar, the student newspaper, and was actually able to open a company with a few friends doing web development which allowed us to earn some money while still at university.

Looking forward I am hoping that my own start-up business will become a success. In my job I would like to understand more about distributed systems and how our current internal platforms fully work so that in future I can help others gain a similar knowledge and feel empowered to take on any job and any role regardless of their background.

## HOW TO APPLY

Applications are made through UCAS [ucas.com](https://ucas.com). If you are made and accept an offer, and get the required grades in your exams we will confirm your place and look forward to warmly welcoming you at the start of your life here at Warwick.

 [warwick.ac.uk/study/undergraduate/apply](https://warwick.ac.uk/study/undergraduate/apply)

## OVERSEAS APPLICANTS

We welcome applications from international students. Local advice about the application procedure is available from all British Council offices and Warwick representatives.

 [warwick.ac.uk/study/international](https://warwick.ac.uk/study/international)

## STUDENT FEES AND FUNDING

We want to ensure that, wherever possible, financial circumstances do not become a barrier to studying at Warwick and therefore we provide extra financial support for qualifying students from lower income families.

For more information about fees and funding for both home/EU and Overseas students see

 [warwick.ac.uk/study/undergraduate/studentfunding](https://warwick.ac.uk/study/undergraduate/studentfunding)

## ACCOMMODATION

Warwick Accommodation has over 6000 rooms across a range of well-managed, self-catering residences. We also have an excellent network of support staff in the Residential Life Team.

 [warwick.ac.uk/accommodation](https://warwick.ac.uk/accommodation)

## VISIT US

The university organise four open days in early summer and in autumn for students wishing to visit the university, including opportunities to visit the academic departments of your choice.

 [warwick.ac.uk/opendays](https://warwick.ac.uk/opendays)

If you receive an offer from us, you will also be invited to one of our Computer Science Offer Holder Days giving you a chance to learn more about the course and student life in our department.

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 [warwick.ac.uk/dcs](https://warwick.ac.uk/dcs)

The information in this brochure was correct at the time of printing. Our course and module content is continually renewed and updated to reflect the latest research expertise at Warwick. It is therefore very important that you check the website for the latest information before you apply and when you accept an offer.

The bar-chart infographics used throughout this brochure are designed to give an indication of typical course content only. Exact amounts will vary depending on which variant of the course you take, module choice and availability and are subject to change in line with course updates.