Department of Computer Science and Technology



PhD in Computer Science

Course Information for Applicants

UNIVERSITY OF CAMBRIDGE

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Welcome!

This guide should give you the essential information about this course. If it you have further questions you are welcome to ask us, the Postgraduate Education Team, by email graduate-admissions@cst.cam.ac.uk.

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Postgraduate Education Team

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Department of Computer Science and Technology

The Department of Computer Science and Technology was founded in 1937 as the Mathematical Laboratory, located on the part of the New Museums Site now occupied by the Arup Building. Its name changed to the Computer Laboratory in 1969, and the Computing Service was established as part of the same department in 1970. In 2001, the Department moved to purpose-built facilities in West Cambridge. In 2017, it was renamed the Department of Computer Science and Technology.

The Department of Computer Science and Technology and is part of the School of Technology along with Engineering, Chemical Engineering and Biotechnology and the Judge Business School.

Research students are typically allocated a desk in a room with two or more other research students or post-doctoral staff, near their supervisors. Rooms are allocated for a period of around three-and-a-half years after which time a student may be moved to the writing-up area if the student has not submitted a PhD dissertation.



Other facilities include a café on the ground floor, and small kitchens around the department. There are also cafés in the West Hub, the Ray Dolby building, and at the end of JJ Thomson. A Sainsbury's supermarket is a ten-minute bike ride away at Eddington, and there is a state-of-the-art Sports Centre on the West Cambridge site.

Applying for the PhD

Applications

Formal application for admission for the PhD degree must be made via the applicant portal https://www.postgraduate.study.cam.ac.uk/apply. You will find the application deadlines there. If you are applying for funding support, please see the Funding Competitions section below. Those who are applying for one of the Department's PhD studentships should use the deadline published on the individual job listing.

After starting an application, the supporting documentation and research proposal must be uploaded within 7 days. Your application can only be considered by the Department once it is complete.

Prerequisites

Applicants are expected to have met the following prerequisites:

- a very good degree (in the UK, a first-class Honours degree) in Computer Science or a related subject
- a masters-level degree (or other post-graduate work) is increasingly desirable
    - some PhD applicants may find prior study of our MPhil in Advanced Computer Science useful
- a research proposal
- a good IELTS or TOEFL score, where an English Language qualification is necessary.

Research Project Proposal

Students are not assigned to pre-specified projects. They are expected to propose an area or topic, and will be accepted only if an appropriate and willing supervisor is available.

The proposal should be drafted in collaboration with the intended supervisor. Candidates are asked to make informal contact with potential supervisors, before submitting a formal application. Staff members may be contacted by email in the first instance.

The statement of proposed research should be of no more than 3000 words (in addition to the usual personal statement) indicating the intended topic and research strategy. This should:

- show an understanding of existing work in the field
- identify an area for new work
- have concrete goals and deliverables for the first year
- indicate that you know how to achieve them.

Funding Competitions

Applicants wishing to be considered for funding competitions should check their eligibility on the University-wide Sources of Funding web page. The deadlines for the Postgraduate Funding competitions can be found on webpage https://www.graduate.study.cam.ac.uk/finance/funding.

Full funding must be secured before starting a course at Cambridge. You will need sufficient funding to cover the University Tuition Fee, and at least the minimum maintenance for three years.

Course Format

The Basics

The PhD in Computer Science is a three-year programme of individual research on a topic agreed by the student and the Laboratory, under the guidance of a staff member as the student's supervisor.

Students are expected to complete the substance of their research by the end of their third year, submitting their thesis then or within a few months.

The CPGS

All research students are admitted to read for the PhD Degree on a probationary basis; most will be registered for the Certificate of Postgraduate Study (CPGS) in the first instance. During this year, students may do some additional coursework and will write a research report that is likely to form the foundation of the eventual PhD dissertation.

- Research Skills training
- practical work
- research report of no more than 10,000 words
- attendance at research workshops and research seminars.

The CPGS is used as an end of first year assessment. At the end of the third full term of the first academic year, a formal assessment of progress is conducted by two independent assessors who make a recommendation about whether a student may be registered, retrospectively, for the PhD Degree. The assessment is based on consideration of the first-year report and thesis proposal, in the form of a single document, and an interview with the assessors. The document is principally a **PhD Proposal** that demonstrates a clear path from the candidate's current position to a complete PhD dissertation at the end of the third year. The document has two purposes:

- to help the candidate to reflect on and plan their research project and
- to allow the Computer Laboratory to assess the student's progress and planned research.

A student who is not recommended to be registered for the PhD will, normally, be awarded the CPGS alone and will leave the University before submitting a PhD dissertation.



Research Skills Programme

The Research Skills Programme is designed to provide advice on and training in a variety of practical skills required for research. The skills learnt will be useful in your individual project, other research-led modules, and in your future career. All students in their first year of research are required to take 12 units in total which includes the core units and a number of optional units. Other modules in the undergraduate Tripos and MPhil in ACS may also be recommended by the supervisor.

Core Units

There are 5-6 mandatory core units, covering topics such as ‘Academic English’, ‘Academic Writing’, and ‘How to prepare a research presentation’. Students who previously took the MPhil in Advanced Computer Science are not required to complete the Core Units.

Optional Units

You should choose units that are most relevant to your research plans, and supplementary to your previous experience. Optional units will not generally require coursework to be completed or submitted beyond participation in the session itself. Some options will involve practical work, which will be carried out during the session. This will provide an opportunity for students to practice specific skills but will not be formally assessed.

The PhD examination

The examination for the PhD degree normally consists of two parts:

- scrutiny of a **thesis** by two Examiners appointed by the Degree Committee, normally one Internal to the University (but not the Supervisor) and one External
- an **oral examination** involving both examiners and the candidate.

Doctoral degrees are awarded to those who have demonstrated all of the criteria below:

- a significant contribution to the field of study through the creation and interpretation of new knowledge, connection of previously unrelated facts or the development of new theory or revision of older views
- submission of work of a quality in whole or in part of a standard to merit publication (whether or not it is subsequently published)
- provides evidence of the acquisition of knowledge and a detailed understanding of applicable techniques for research and advanced academic enquiry
- is of a quality and quantity to reflect three years of full-time postgraduate study.



Research Groups

Students are integrated into the research culture of the Department by joining one of the research groups. Students are expected to attend the Department's and research group's programme of seminars. An element of the research training will be in the context of a research group and will be overseen by their project supervisor.

Algorithms & Complexity

This research theme focuses on the mathematical modelling and analysis of algorithmic processes. A particular interest is the study of the complexity of such processes. Research spans logic and algorithms, computational complexity, quantum computing, and the analysis of classical and quantum algorithms. Current work explores topics including logical definability, learning theory, coding theory, cryptography, graph theory, random walks on graphs, graph isomorphism, and the development of algorithms for complex and graph-structured data.

Computer Architecture

Computer Architecture has been at the heart of the Department's research since its foundation. Early work on mechanical calculators and analogue computers led to the development of EDSAC, the world's first practical stored-program computer in 1949.

Today, research considers traditional general-purpose CPUs, GPUs, and accelerators for areas like machine learning, artificial intelligence, scientific computing and data processing. Strong connections exist with security research through the CHERI project, machine learning and artificial intelligence, and programming language research via compilers and binary modification tools. The group collaborates widely with industry in both hardware and software.

Graphics, Vision & Imaging Science

Computer graphics, computer vision and imaging science address creating, capturing, rendering, and analysing visual information in the forms of 2D/3D images, geometry, appearance, deformation, and motion models.

The tasks of computer graphics and vision are profoundly related. Machine learning is utilised to exploit this relationship and develop effective systems for digitizing and interacting with the visual world.

Research combines novel software and hardware to tackle some of the fundamental problems of computer graphics, vision, and imaging. This often involves working with capture and display technologies, such as motion capture sensors, cameras, prototype displays, augmented and virtual reality headsets, or humanoid robots.

Human Centred Computing

The goal of human-centred computing is to create technologies that better meet human needs, through studying the needs of humans. Research addresses grand challenges using diverse research methods a vast range of disciplines. The group contributes to core fields of computer science such as human-computer interaction, computer graphics, visualisation, and display technologies. This work supports business, engineering, creative practice, and collaborative processes to address global challenges. Members of the group are also leaders in emerging specialist fields including affective computing, computer music, human-robot interaction, diagrammatic reasoning, computational photography, end-user programming and ubiquitous computing.

Machine Learning & Artificial Intelligence

The goal of the research in artificial intelligence and machine learning is to understand, represent, model, learn and reason about problems in the real world. AI technologies are created to benefit society and increase social awareness. The theoretical methods span all varieties of deep learning, classical statistical learning, computational biology, knowledge representation, Bayesian inference, causal modelling, logical reasoning, probabilistic reasoning, visual reasoning, stochastic processes, human-like computing, and natural language processing. These methods and approaches are applied in numerous settings such as personalised medicine and education, automated theorem proving, policy work and data, systems applications, sensor networks, and end-to-end solutions in the African context.

Mobile Systems, Robotics & Automation

This research theme encompasses the fundamental challenges introduced by systems that either move autonomously or are made mobile by human movement. The research spans issues related to how to make these systems more efficient, how to design algorithms that control and coordinate autonomous mobility and communication, and how to devise suitable machine learning models to analyse the data produced by them. This thrust also involves the investigation of security and privacy aspects and the interfaces between devices/robots and users.

Natural Language and Information Processing (NLIP)

The aim of Natural Language Processing is to develop computational models for analysing and generating human language. Research in the Department encompasses many areas of NLP, ranging from fundamental theory to real-world applications.

The models developed are mainly based on modern machine learning techniques. On the theoretical side, research seeks to understand the structure needed to represent language, how language is learned and processed by people, and how language varies between people and over time. On the application side, the ALTA institute develops

technology to support second language teaching and assessment. Other researchers work on automated fact checking, dialogue systems, document summarisation and scientific text processing, as well as interdisciplinary work in domains such as healthcare and cybercrime. Collaborations with other departments are supported by Cambridge Language Sciences.

Programming Languages, Semantics and Verification

Research in this group is centred around the study of programming languages, logic, and mathematical models, addressing hardware, software, and networks. It spans a wide range of applied and theoretical work: programming language design, compilers, and program analysis; the development of interactive theorem provers and automatic proof procedures; the formal verification of computational systems; and semantic models using techniques such as structural operational semantics, type systems, domain theory, category theory, finite model theory and linear logic. Work is in progress on the underlying mathematical structures of these, and on their application to the study of higher-order typed programming languages; object-based languages; low-level machine languages; foundational languages for concurrent, distributed and mobile computation; hardware description languages; security and networking problems; database theory; and computational complexity.

Security

Computer security spans topics such as privacy, safety and maintainability. Areas of focus include access controls, protocols, cryptology, formal methods, hardware design, biometrics and usability, as well as the dependability of whole systems, which involves the economics of information security and spills over into policy.

Groups collect data on cybercrime and abuse for use by researchers worldwide (the Cambridge Cybercrime Centre); develop novel vulnerability-mitigation mechanisms that are now starting to appear in commercial CPU designs (the CHERI project); and study tamper-resistance and emission security (the Tamper Lab).

Inspiration is drawn from tackling real problems, and work is support by funding from collaborations with commerce and industry in the UK and overseas.

Systems & Networking

One of the largest groups in the Department and at its heart since its foundation, this group undertakes research and teaching in all aspects of computer systems, including computing and communications hardware and software, operating systems, distributed and mobile systems, and legal and policy implications. The group has a strong tradition of design, implementation, and deployment of working platforms. Recent work includes the Xen hypervisor (2003), NetFPGA (2008), and the MirageOS unikernel system (2013). The group has a track record of commercialising research through successful startups.

Student Representation

PhD students are active members of the Faculty community and have a range of opportunities to contribute feedback, shape the student experience, and engage with faculty life. Student representatives serve on key committees and forums, including the Staff-Student Consultative Forum and Postgraduate Students' Forum, ensuring that postgraduate perspectives are heard in discussions about teaching, facilities, and the wider student experience. MPhil students are represented on the Faculty Board of Computer Science and Technology by a Junior Member. Elections for members are held in the November of each academic year. Postgraduate students also have a representative on the **Postgraduate School of Technology Committee.**

Alongside formal representation, students can take advantage of a vibrant and inclusive community. Initiatives such as **Women@CL** provide mentoring, networking, career development opportunities, and events that support women and non-binary people in computing research. Local activities include our **Speaker Lunches** where invited female speakers talk about their work, research, career issues and other relevant topics. This provides positive female role models to our students and early career researchers. The Department also run a local career development workshop.

Additionally, the annual Oxbridge Women in Computer Science Conference is organised in collaboration with the University of Oxford, with participants from other UK universities also invited. These activities help foster a welcoming environment, encourage leadership and professional development, and connect students with researchers, academics, and industry professionals. For more information, see http://www.cst.cam.ac.uk/women or email women-at-CL-admin@cst.cam.ac.uk.



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