



Programme Specification

A statement of the knowledge, understanding and skills that underpin
a taught programme of study leading to an award from
The University of Sheffield

1	Programme Title	Computer Science (Artificial Intelligence) with an Industrial Placement Year
2	Programme Code	COMU39
3	JACS Code	I400
4	Level of Study	Undergraduate
5a	Final Qualification	Bachelor of Science with Honours (BSc)
5b	QAA FHEQ Level	Bachelors (BSc)
6	Intermediate Qualification	Not applicable
7	Teaching Institution (if not Sheffield)	Not applicable
8	Faculty	Engineering
9	Department	Computer Science
10	Other Departments involved in teaching the programme	None
11	Mode of Attendance	Full-time
12	Duration of the Programme	4 years
13	Accrediting Professional or Statutory Body	British Computer Society
14	Date of production/revision	September 2023

15. Background to the programme and subject area

Artificial Intelligence (AI) is the branch of Computer Science that is concerned with the modelling and automation of intelligent behaviour. Intelligence involves complex abilities such as perception, reasoning, learning and planning. Modern AI focuses on the development of biologically-inspired computer algorithms, their exploitation in intelligent systems engineering and their relationship to living biological intelligence.

A degree in Computer Science (Artificial Intelligence) with an Industrial Placement Year covers a wide spectrum of knowledge, ranging from algorithms and data structures, logic and mathematics, hardware and networks to professional issues and software engineering. It also develops a wide range of technical and interpersonal skills, including computer programming, analysis and design, team management, report writing, presentation skills and enterprise. Our degree combines the study of Artificial Intelligence with core topics in Computer Science, and a Year in Industry. Key features include symbolic AI programming, robots that use neural and evolutionary algorithms and a project dissertation. At the higher levels, students may pursue advanced topics in computer speech and language processing, adaptive intelligence, the intelligent web, 3D computer graphics, distributed systems and computer security and forensics.

Students on the Computer Science (Artificial Intelligence) with an Industrial Placement Year degree spend the penultimate year of their degree working in a degree-relevant company of their choice. This provides them with wide-ranging experiences and opportunities to put their academic studies into context, and to improve their technical and professional skills. It also enhances their employment prospects, enabling them to gain direct experience of industry culture, make contacts and strengthen their CV. Students are responsible for finding their own industrial placements, but are assisted by staff in the department and the Careers Service.

In addition to the year in industry, our curriculum reflects the latest research developments and professional standards in Software Engineering. Teaching is informed by the research activity of staff, which has an international reputation for the quality of its research. In the 2021 Research Excellence Framework (REF), 99% of our research was rated in the top two categories, meaning it is classed as world-leading or internationally excellent. The Department is rated 8th nationally for the quality of our research environment. Close links are maintained with industry-leading companies through the department's Industrial Advisory Board. Our degrees are accredited by the British Computer Society (BCS), thus providing a route to the professional status of Chartered Information Technology Professional (CITP), Chartered Engineer (CEng) and Chartered Scientist (CSci).

See the Department of Computer Science website: <http://www.shef.ac.uk/dcs> for more information.

16. Programme aims

The aims of the programme are:

1. To provide a thorough academic grounding in the core subject matter of Artificial Intelligence and Computer Science, with advanced study paths informed by the Department's wide-ranging research interests;
2. To develop technical, professional and managerial skills through exposure to practical group projects, emphasising teamwork and communication as well as software design and development skills;
3. To expose students to leading-edge world-class research in Artificial Intelligence;
4. To provide students with direct experience of working in industry, applying and developing their technical and professional skills;
5. To produce immediately employable graduates with an industrially relevant mix of knowledge, practical skills and self-motivation;
6. To provide an international dimension with opportunities for study in universities in other countries.

17. Programme learning outcomes

Knowledge and understanding - On successful completion of the programme, students will have obtained:

K1	A full understanding of programming languages and styles, algorithms and data structures.
K2	A full understanding of discrete and continuous mathematical foundations for computing.
K3	An appreciation of software engineering, analysis and design methods and process management.
K4	A full understanding of artificial intelligence and biologically-inspired models of machine reasoning.
K5	An appreciation of computer hardware design and computer network architectures.
K6	An appreciation of the wider context of professional practice, including the relationship between computer science and society, the environment and the Law.
K7	An appreciation of the commercial and industrial dimension to computing.
K8	A deep understanding of issues in AI, such as robotics and adaptive intelligence (core topic for the degree).
K9	A deep understanding in a range of research-led topics taught in the final year of the degree.
K10	Work experience and appreciation of how subject-specific knowledge gained during the degree is applied in the workplace.

Skills and other attributes - On successful completion of the programme, students will be able:

S1	To function in an Information and Communication Technology (ICT) environment using appropriate technology such as email, the Internet, shared data and code repositories.
S2	To conceive, design and write correct working computer programs in several different programming styles, using a variety of compilers and development environments.
S3	To construct and manipulate formal and mathematical models.
S4	To apply a software engineering process and take a project through the stages of the software lifecycle, using design notations and software engineering tools selectively.
S5	To communicate effectively in writing, present a two-sided argument, expose technical information clearly, comprehend and summarise research-level material with proper citation of sources.
S6	To communicate effectively in speaking, interview and interact productively with a client, present and defend a substantial piece of work, engage with others and respond effectively to questions.
S7	To work effectively in a team, demonstrating personal responsibility and group management ability, interpersonal skills, leadership and delegation, and plan to meet deadlines.
S8	To design solutions for complex problems to meet a customer's needs within the context of a wider business practice.
S9	To research material from multiple published sources, comprehend and filter such material and from it synthesize theories, principles or designs pertinent to a practical, problem-solving project.
S10	To demonstrate personal initiative, self-motivation and problem-solving skills, through the selection and taking through to completion of a practical, problem-solving individual project with a research dimension.
S11	To work effectively in an industrial environment.

18. Teaching, learning and assessment

Development of the learning outcomes is promoted through the following teaching and learning methods:

The Department fosters an environment with many opportunities for individual and group learning, but the responsibility for learning rests with the student, who must be personally organised and self-motivated to make the most of the programme. Teaching is offered through formal lectures, seminars, computer laboratories, problem-solving classes and project supervision.

Lectures are formal presentations to a large class of students by a lecturer. The purpose of a lecture is to motivate interest in a subject, to convey the core concepts and information content succinctly and to point students towards further sources of information. Lectures are interactive and students are encouraged to ask questions at suitable points. Students are expected to take notes during lectures, adding detail to published course materials (which should be printed and brought to the lecture, when provided in advance on electronic media). The learning outcomes *K1-K9* are supported mainly through this mode.

Seminars are longer semi-formal presentations to a class of students by a lecturer, researcher, industrial partner or student, describing an area of their current research or business. There is typically more opportunity than in a lecture to structure the session internally with questions, problem solving and other kinds of interactive or shared learning experience, in which the students may also participate in the teaching and lead discussions. The learning outcomes *K7* and *S5-S9* are directly promoted through this mode, with indirect support for *K1-K6*, *K8-K9*.

Computer laboratories are sessions supervised by teaching assistants (under the direction of the responsible lecturer) in which students work at a computer, to develop a specific practical skill, such as familiarisation, computer programming, or the use of a software engineering or mathematical modelling tool. The learning outcomes *S1-S4* are promoted mainly through this mode, with indirect support for *K1-K3*.

Problem-solving classes are sessions conducted by a lecturer with a class of students, in which exercises are completed interactively and solutions are provided within the period. The purpose of such a class is to help students engage with, and assimilate the material presented in lectures and start to apply this knowledge. The learning outcomes *K2-K6* and *K8* are supported through this mode.

Project supervision involves regular meetings with a student's individual or group project supervisor, who may also be their personal tutor. During each session, students report on their progress to the supervisor, who highlights further areas of investigation, helps with technical problems, advises about the content and structure of technical reports and generally encourages the students to organise their time effectively. The learning outcomes *S5-S10* are directly promoted through this mode, with *S1-S4* supported indirectly.

The transition to self-motivated learning is encouraged through specialist teaching materials such as lecture handouts or copies of lecture slides, supplied via the Department's website. Set course texts and background materials are available through the University libraries, at bookshops and also via the Internet. Active learning is fostered and promoted through engagement in practical work, such as exercises, assignments and projects.

Exercises are short tasks, either writing computer programs or working out solutions to other kinds of set problem, which are typically reviewed at the end of the session. Learning outcomes *K1-K9* and *S1-S4* may be supported this way.

Assignments are typically offered in stages over a number of weeks, involving the design and implementation of a software system to perform a given task, or the researching of a body of information leading to the writing of a discursive essay on a given topic. Learning outcomes *S2-S5* are supported by this; indirectly *K1-K9* are reinforced.

Individual industrial placement: The penultimate year of the degree is spent in industry. This provides students with experience of working in a company relevant to the degree, consolidates knowledge gained during their academic studies, and enhances their understanding of how to apply this in practice. It also provides students with opportunities to develop professionally and plan for further development towards a professional qualification. Learning outcomes *K10* and *S11* are supported by this.

Projects are undertaken individually or in groups over one or two semesters. Projects typically solve a larger problem, possibly for an industrial client, possibly with a research dimension. Individual projects require personal organisation and presentation skills; group projects also require group organisational and communication skills. Learning outcomes *K6-K7* and *S1-S10* are supported by this; indirectly, *K1-K5*, *K8-K9* are reinforced.

Private study makes up more than half of the time allocated to each module. Students are expected to read around the topics of each module and follow especially any directed reading from recommended course texts. Private study will include further investigations prior to exercises or projects and also consolidation of lecture notes.

Opportunities to demonstrate achievement of the learning outcomes are provided through the following assessment methods:

Modules may be assessed by formal examination, by practical assignments, by an individual or group project, or by some combination of these methods.

Examinations are typically 2-hour question papers, in which students' answer 3 from a choice of 4 questions. A typical question has 40% of the credit devoted to the recall of knowledge and information and 60% of the credit devoted to applying this knowledge actively to solve a short problem. Examinations test the knowledge learning outcomes *K2-K9*, but also provide evidence of practical skills *S3* and *S5*, and, to a lesser extent, evidence of previous engagement in *S2* and *S4*.

Assignments are typically 10-20 hour pieces of continuously assessed coursework, which students complete individually or in groups as directed. An assignment may have multiple stages, each offered over a 2-3 week period, delivered to separate deadlines. Assignments both develop and assess the practical skills *S2-S5* and they are the main means of assessing programming ability *K1*, *S2*. ICT skills *S1* are assessed indirectly.

Individual dissertation projects are completed at Level 3, typically over two semesters. Students select a topic, research the background literature, prepare a survey/analysis report at the interim assessment stage, and apply this knowledge in a practical, problem-solving project which typically involves the design, implementation and testing of a substantial piece of software. The final assessment stage is by dissertation and poster session, assessed independently by two examiners. A *viva voce* examination may be held to form a common view in cases of insufficient evidence or divergent opinions. The learning outcomes *S5-S6*, *S9-S10* are directly assessed, together with specialist areas of knowledge from *K8-K9*. Practical skills in *S2-S4* and knowledge in *K1-K7* may be assessed indirectly.

Industrial placement – A variety of methods are used to assess the placement undertaken in the penultimate year. These include two written reports describing and reflecting on personal professional development through experience gained in the year in industry (from an online skills-based placement journal), and an oral presentation to their peers and staff on return from the year in industry. *K10* and *S11* are assessed via reports and a presentation.

Group projects are completed at Level 1, over two semesters. Student teams are given topics, and prepare analysis and design documents, demonstrate a working software system, and provide a final report, together with timesheets, minutes and other evidence of their group management strategy. Credit is awarded to the team as a whole on the basis of the quality of the work, as evidenced in the final report and interim documentation. Credit is weighted towards individual team members based on their participation, as evidenced in the minutes, timesheets and other indicators of the division of workload and responsibility, which may include *viva voce* interviews. The learning outcomes *S2*, *S4-S8* are directly assessed in software projects, together with *K6-K7* in industrial projects. The learning outcomes *S5-S7*, *S9* and are directly assessed in research projects, which may also assess *S2-S4* according to the type of project. Indirectly, *K1-5*, *S1* may be assessed.

Proportions of types of assessment by level can be found on the UniStats website: <http://unistats.direct.gov.uk/>

19. Reference points

The learning outcomes have been developed to reflect the following points of reference:

Subject Benchmark Statements

<https://www.qaa.ac.uk/quality-code/subject-benchmark-statements>

Framework for Higher Education Qualifications (2014)

<https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf>

University Vision and Strategic Plan

<http://www.sheffield.ac.uk/strategicplan>

[Faculty of Engineering Placement Guidelines and Checklist](#)

The pathway structure through the degree programme was determined originally by *SARTOR, 3rd Edition, 1997*, and updated in the light of the UK Standard for Professional Engineering Competence, which is the primary point of reference for degrees offering professional accreditation in engineering and related areas, such as computing.

The degree programme is formally accredited by the British Computer Society (BCS). The prominence given to practical, industrially related project work is supported by the BCS and our *Industrial Advisory Board*, which includes leading companies such as IBM, Nvidia and ARM.

The content of the modules at Level 3 are directly informed by the *research interests* of the Department and so conforms to the *University Mission Statement* to provide research-led teaching.

The workload fits comfortably within the guidelines laid down by the University, and is monitored by *external examiners*, who also review the content and standards of the programme.

20. Programme structure and regulations

Our degree programmes are designed with a common curriculum at Levels 1-2, broadening out into many advanced study paths at Level 3. The common core, which is used on our existing Software Engineering degrees, satisfies the requirements for accreditation by the British Computer Society. It also permits direct transfers between the related degrees in *Computer Science*, *Software Engineering* and *Artificial Intelligence and Computer Science* and delayed transfers from related dual honours programmes.

The Artificial Intelligence and Computer Science with an Industrial Placement Year degree offers less choice but more breadth than our other core degrees because it is essential to fit components from other disciplines into the curriculum.

Year 1 (Level 1) has a fixed core of 100 credits, and 20 approved credits in *Psychology* or *Philosophy*. The core consists of four modules running through the year: *Java Programming*, *Foundations of Computer Science* (the underlying mathematics), *Machines and Intelligence*, and *Introduction to Software Engineering*, which involves a group systems development exercise which forms the foundation for other (optional) group software development modules in later years, and two single-semester modules: *Web and Internet Technology*, *Introduction to Algorithms and Data Structures*.

Students also participate in a compulsory week-long “Global Engineering Challenge”. Based on the Engineers without Borders Challenge (a national challenge for engineering undergraduates), students from across the Faculty of Engineering work together in multi-disciplinary teams to tackle a real-world problem with a global perspective.

Year 2 (Level 2) contributes to the final degree classification, consisting of a 120-credit core of one subject which is taught throughout the academic year: *Automata, Computation and Complexity*. The remaining six topics are taught in single semester blocks. In the first semester the topics taught are *Systems Design and Security*, *Functional Programming*, and *Data Driven Computing*. In the Spring semester students cover *Robotics*, *Logic in Computer Science* and the *AI Group Project*.

Prior to 2018 entry, Level 2 consisted of a 100-credit core and either 20 approved credits in Psychology or Philosophy, or a 20-credit group project. The core consists of one subject which is taught throughout the academic year: *Automata, Computation and Complexity*. The remaining five topics are taught in single semester blocks. In the first semester the topics taught are *Systems Design and Security*, *Functional Programming*, and *Data Driven Computing*. In the Spring semester students cover *Robotics*, and *Logic in Computer Science*. Prior to 2018 entry, the *Software Hut*, an industry-oriented group project developing software systems for external clients, may optionally be taken in semester 2 instead of the approved credits in Psychology or Philosophy. (For entry from 2018 to 2020, this module becomes core in level 3 and is not available in level 2. From 2021 entry, students take the AI Group Project in Level 2 instead of taking Software Hut.

Students also take part in the compulsory week-long project “Engineering: You’re Hired”. Again working with students from other engineering disciplines, this project requires them to apply their technical skills and engineering judgement to develop proposals for a technical, industrially-relevant problem. Neither this cross-faculty group project nor the Level 1 ‘Global Engineering Challenge’ are credit bearing, but both are compulsory for progression to level 3. The projects enable students to develop a range of professional and technical competences, including awareness of the global context of their decisions, communication skills, cultural agility and enterprising problem solving.

Students may transfer freely between this programme and the single honours degree programmes (in *Computer Science*, *Computer Science (Software Engineering)* and *Computer Science (Artificial Intelligence)*) at any time up until the end of Level 1. Dual honours students may transfer back into the single honours programme at the previous Level. Transfers between MComp and BSc are also freely permitted up until the end of Level 2, at which point students must maintain a higher standard to transfer on to the MComp degree. Students must satisfy the prerequisites for *Adaptive Intelligence* at the end of Level 2 to remain on the Computer Science (Artificial Intelligence) with an Industrial Placement Year degree, otherwise they are advised to transfer to one of the related degrees. In order to remain on (or transfer to) the Year in Industry degree, students will normally be required to attain an average of 55 or above at the end of years 1 and 2, before going on placement after the second year of academic study. This requirement was removed in 2022/23.

Resit examinations are held in August for Levels 1 and 2, though project-based assessments and some coursework cannot be repeated within the same year.

Year 3 (Industrial Placement Year): In their penultimate year, students work in a company relevant to their degree for a minimum of 38 weeks. Throughout the placement year, students maintain an online skills-based journal. At the end of the placement, they use the journal to write a reflection report and give a presentation on the skills they have developed. The placement is assessed on a pass/fail basis and does not contribute to the degree classification: a pass in this placement year is required for the degree title to reflect the industry experience.

Year 4 (Level 3) contributes to the final degree classification (2/3 BSc, 2/5 MComp) and consists of the core 40-credit *Dissertation Project* and *Finance and Law for Engineers*. In addition, students select further approved units, which must include at least 40 credits from *Adaptive Intelligence*, *Speech Processing*, *Text Processing*, *Modelling and Simulation of Natural Systems*, *Bio-inspired Computing*, *Cognitive and Biomimetic Robotics* or *The Intelligent*

Web, and a further 30 credits of approved modules such as *Advanced Algorithms, Software Re-engineering, Computer Security and Forensics, 3D Computer Graphics, Theory of Distributed Systems* and *Undergraduate Ambassadors Scheme in Computer Science*. BSc students graduate on completing Level 3 successfully (see full regulations). The *Dissertation Project* must be passed at the first attempt to gain Honours and accreditation (see section 21). A student failing to graduate on the first attempt may repeat Level 3 once and hopefully graduate, but without Honours.

Detailed information about the structure of programmes, regulations concerning assessment and progression and descriptions of individual modules are published in the University Calendar available on-line at <http://www.sheffield.ac.uk/calendar>.

21. Student development over the course of study

Level 1: Students learn the Java programming language, covering the basics of syntax, program construction and compiler tools. Later, they learn about object-oriented design, standard library packages, and how to use Java's self-documentation. Students learn about software lifecycles, the Unified Modelling Language (UML) design notation and the use of various Computer-Aided Software Engineering (CASE) tools. Through the *Introduction to Software Engineering* module, student teams learn how to pick up projects partway through the software lifecycle and progress them to the next stage. Students also acquire discrete mathematics for logic and formal specification, followed by matrix manipulation and probability and statistics. Students also learn about the software and protocols essential in today's Web based world. Students learn about human and machine intelligence, and are trained in how to present a reasoned argument. Later, they learn how to program intelligent search algorithms in Java, and are introduced to data structures and algorithms in Computer Science. Students broaden their knowledge of human intelligence and reasoning by studying introductory psychology or philosophy.

Level 2: Forms a foundation for the more advanced courses in Level 3. Students learn the essential skills they will require as professional software engineers or computer scientists. The topics covered include the functional style of programming currently through the vehicle of Haskell. They learn about automata, formal languages and the theory of computation. The *Systems Design and Security* module extends their knowledge of program design techniques and includes an introduction to databases and security concerns. They are introduced to machine learning and pattern processing in a module themed around the notion of data as a resource, and to robotics. Students also have the opportunity to develop a complementary path in cognitive psychology, perception and learning, or the philosophy of mind, knowledge and rationalism.

Industrial Placement Year: Students will spend a year in a company relevant to their degree, working with an employer on graduate-level projects (or series of projects), applying and developing their knowledge and skills in the context of the employer's area of work and within relevant time and funding constraints. In addition to an industry mentor, a university tutor will be in contact during the year, and where possible, will visit the student in their place of employment. The student will keep a skills-based journal of their professional development and will produce reports and a presentation covering their industry experience.

Level 3: The capstone achievement is the *Dissertation Project*, a major piece of research and development requiring initiative and problem-solving skills. The project starts with a review of relevant literature and technology followed by detailed analysis, design, implementation and testing, and a written dissertation. Students demonstrate their working systems at a poster session, run like a technology fair with industrial visitors. Students are also required to study *Finance and Law for Engineers* which covers the legal and ethical framework in which software is developed and used. The COM third year taught modules are research led and the choice of module depends on the student's interests and sometimes their choice of project.

Upon Graduation: Students successfully completing the programme graduate with the title: *Bachelor of Science with Honours (BSc Hons) in Computer Science (Artificial Intelligence) with an Industrial Placement Year*.

Professional Development: Our degrees are accredited by the British Computer Society (BCS), the Chartered Institute for Computing and Information Systems. *Accreditation* recognises that a degree programme meets the requirement for the professional formation of a Chartered Information technology Professional, a Chartered Engineer or a Chartered Scientist, and so opens the way to these professional statuses.

Students graduating with BSc Hons. in Artificial Intelligence and Computer Science may obtain *Partial CITP, CEng and CSci Accreditation*, depending on the choice of modules studied. BSc graduates who subsequently complete a further advanced study programme (such as an accredited MSc in Software Engineering or Computer Science), and after gaining at least three years' professional work experience in the computing and information systems field, will be able to apply to the British Computer Society to obtain the status of Chartered Information Technology Professional and either Chartered Engineer or Chartered Scientist, as appropriate to their work.

22. Criteria for admission to the programme

Detailed information regarding admission to the programme is available at <http://www.shef.ac.uk/prospective/>

The standard requirement is three A-levels, of which one must be in *Mathematics*. Other equivalent national and international qualifications are accepted; see <http://www.shef.ac.uk/dcs> for more details. Wider access is also offered to students lacking suitable A-level qualifications for science and engineering through the Foundation Year; see <https://www.sheffield.ac.uk/dcs/undergraduate/courses/foundationyear> for more details.

A general University of Sheffield admissions requirement is GCSE English. Non-native speakers of English must demonstrate suitable competence in the language. The preferred test is IELTS, though others are accepted. See the English Language Teaching Centre website <http://www.shef.ac.uk/eltc/> for more information.

23. Additional information

The Department of Computer Science is housed in the modern, purpose-built Regent Court building and has its own dedicated computing facilities. The Department is internationally recognised for its teaching and research (in the 2021 Research Excellence Framework (REF), 99% of our research was rated in the top two categories, meaning it is classed as world-leading or internationally excellent).

Students are expected to find their own placement (either in the UK or abroad), although we are able to assist through the many contacts University staff have with industry. We regularly update students with details of companies with suitable placements. The University has a Student Placement Officer and Careers Officers, who brief students in Years 2 and 3 on CV writing, strategies for securing a placement and the practicalities of placement work. It is expected that students receive a salary for their work. The Year in Industry Tutor and the administrative staff maintain regular contact with the student and the placement provider throughout the year to check that the placement is going well. For all UK-based placements, a member of academic staff also visits the company.

An international dimension is offered through the *Study Abroad* programme, in which students may spend part of their degree outside of the EU, or through the *Erasmus+* programme, in which students may spend part of their degree in another EU/EEA country. See <http://www.sheffield.ac.uk/globalopps> for more details.

The Department offers course materials and information services to students via the departmental intranet. The *Department of Computer Science Undergraduate Student Handbook* governs all local aspects of academic student life, with regard to services offered, computer etiquette, and local regulations. See the Department of Computer Science website: <http://www.shef.ac.uk/dcs> for more information.

This specification represents a concise statement about the main features of the programme and should be considered alongside other sources of information provided by the teaching department(s) and the University. In addition to programme specific information, further information about studying at The University of Sheffield can be accessed via our Student Services web site at <http://www.shef.ac.uk/ssid/>.