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) [for students who started in or after 2022] Artificial Intelligence and Computer Science [for students who started prior to 2022]
2	**Programme Code**	COMU119 (MComp), COMU117 (BSc)
3	**JACS Code**	I400
4	**Level of Study**	Undergraduate
5a	**Final Qualification**	Master of Computing with Honours (MComp), Bachelor of Science with Honours (BSc)
5b	**QAA FHEQ Level**	Masters (MComp), Bachelors (BSc)
6	**Intermediate Qualification**	Bachelor of Science (BSc) (for COMU119)
7	**Teaching Institution** (if not Sheffield)	Not applicable
8	**Faculty**	Engineering
9	**Department**	Computer Science
10	**Other Departments involved in teaching the programme**	Psychology, Philosophy for students commencing prior to 2021/22 academic year None for students commencing from September 2021
11	**Mode of Attendance**	Full-time
12	**Duration of the Programme**	4 years (MComp), 3 years (BSc)
13	**Accrediting Professional or Statutory Body**	British Computer Society
14	**Date of production/revision**	September 2023

15. Background to the programme and subject area

The programme title changed from "Artificial Intelligence and Computer Science" to "Computer Science (Artificial Intelligence)" in 2022/23 for new students. Students who started prior to 2022/23 retain the previous award title.

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) 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. 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 and machine learning, theoretical computer science, 3D graphics and distributed systems.

Our curriculum reflects the latest research developments and professional standards in Artificial Intelligence and Computer Science. 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, 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 provide a route to professional accreditation through the British Computer Society, leading to partial (BSc) and full (MComp) CITP, CEng and CSci accreditation;
4. To expose students to leading-edge world-class research in Artificial Intelligence (BSc) and engage students in advanced research areas and methods (MComp);
5. To produce immediately employable graduates with an industrially relevant mix of knowledge, practical skills and self-motivation (BSc) and with leadership and enterprise skills (MComp);
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 third (BEng and MEng) and fourth (MEng) years of the degree.

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	**(MComp only):** To demonstrate group initiative and enterprise within a group project.

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-S11* 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.

Dissertation 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-S11* 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 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.

Group projects are completed at Levels 1, 3 and 4, over two semesters. Student teams are given topics (Level 1) or negotiate topics with their clients (Level 3) or research sponsors (Level 4). Teams prepare analysis and design documents (Levels 1), or draft research papers (Level 4), demonstrate a working software system (Level 1, 3) or research solutions involving software, designs or theories (Level 3, 4), 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, interim documentation (all Levels) and reported client satisfaction (Level 3, 4). 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 *S11* 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 (all Levels) and *K8-K9*.

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

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 Levels 3 and 4 is 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 Levels 3-4. The common core satisfies the requirements for accreditation by the British Computer Society. It also permits direct transfers between the related degrees in *Computer Science*, *Computer Science (Software Engineering)* and *Computer Science (Artificial Intelligence)* and delayed transfers from related dual honours programmes.

Computer Science (Artificial Intelligence) 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.

Level 1 has a fixed core of 120 credits consisting of five modules running through the year: *Java Programming, Foundations of Computer Science* (the underlying mathematics)*, Devices and Networks, Machines and Intelligence,* and *Introduction to Software Engineering*, a group systems development exercise which forms the foundation for other group software development modules in later years. There are also two single-semester topics: *Web and Internet Technology*, and *Introduction to Algorithms and Data Structures.* Students take part in a Faculty-wide project. the *Global Engineering Challenge*, which runs for one week prior to the start of Semester 2. In this week-long project, all first year students in the Engineering Faculty tackle real-world problems from a global perspective, working in interdisciplinary teams to develop solutions to real-life problems faced by developing communities.

Level 2 contributes to the final degree classification (1/3 BSc, 1/5 MComp), consisting of a 120-credit core of one subject which is taught throughout the academic year: *Automata, Computation and Complexity*, and six topics which 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*.

Students may transfer freely between this programme and the single honours degree programmes listed above at any time up until the end of Level 1. 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 continue on the MComp, otherwise they must transfer to the BSc. 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.

Students take part in another Faculty-wide project. *Engineering – You're Hired*, which runs for one week prior to the start of Semester 2. Building on the 1st year 'Global Engineering Challenge' project, students again work in interdisciplinary teams and are expected to draw on subject knowledge to work on projects that have been devised in conjunction with industry.

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). MComp students must maintain a higher standard (no lower than class 2/ii) to proceed to Level 4, otherwise they may seek to graduate immediately under the BSc regulations. The *Individual 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.

Level 4 contributes to the final degree classification (2/5 MComp) and has a 30-credit core group project (*Darwin).* Units to the value of 90 credits are taken from an approved list of research-led modules such as *Testing and Verification in Safety Critical Systems*, *Machine Learning and Adaptive Intelligence, Software Development for Mobile Devices, Network Performance Analysis and Parallel Computing with Graphical Processing Units.* There are also three follow on courses from advanced modules in level 3; *Natural Language Processing, Software and Hardware Verification, and Speech Technology.* Finally, a variety of Level 4 versions of level three modules are offered in case a student regretted his/her module choice at Level 3. The extra modules are *Text Processing, Speech Processing, 3D Computer Graphics* and *Computer Security and Forensics.* Students can also choose the 45-credit group project *Genesys*.

MComp students graduate on completing Level 4 successfully (see full regulations below). A student who, exceptionally, fails to meet the required standard (no lower than class 2/ii) may graduate with a BSc.

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 *Introduction to Software Engineering*, 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, probability and statistics, aided by the MatLab tool. 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. 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 Levels 3 and 4. 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 take part in a group project developing software for a real client in a competitive environment.

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 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.

Level 4: The capstone achievement is the group research project, *Darwin,* which occupies a quarter of a student's time during the year. In this module, the group develops a research proposal initially and generates a publishable paper at the end. Other knowledge and skills depend on the particular additional subject threads followed (see above).

Upon Graduation: Students successfully completing the 3-year BSc programme graduate with the title: *Bachelor of Science with Honours (BSc Hons) in Artificial Intelligence and Computer Science*. Students successfully completing the 4-year MComp programme graduate with the title: *Master of Computing (MComp) in Artificial Intelligence and Computer Science*.

Professional Development: The Artificial Intelligence and Computer Science degree programme (MComp, BSc) is 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. Similarly, students graduating with MComp in Artificial Intelligence and Computer Science may obtain *Full CITP, CEng and CSci Accreditation,* depending on the choice of modules studied.

After gaining at least three years' professional work experience in the computing and information systems field, MComp graduates may 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. BSc graduates who subsequently complete a further advanced study programme (such as an accredited MSc in Computer Science) may likewise apply after gaining similar professional work experience.

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) and has particular research strengths in the fields of verification and testing, natural language processing, speech technology, computational biology, machine learning, robotics and computer graphics. Its project-led teaching has been copied at other universities and the enterprise culture has been personally endorsed by the Secretary of State for Education.

An international dimension is offered through the *Study Abroad* programme, in which students may spend part of their degree at an overseas University. 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/.