Curriculum 2020 – Unit paperwork

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| **Unit Title:**  Information Processing and the Brain |
| **Unit Director:**  Conor Houghton |
| **Research Group connected to the Unit:**  Computational Neuroscience |
| **Description, including the unit aims** (this will be the description for the University Unit catalogue) Please see example form and [Unit Catalogue](https://www.bris.ac.uk/unit-programme-catalogue/AboutUnits.jsa?ayrCode=20%2F21) for examples  For reference – current unit:  *This unit explores information processing, statistical and deep learning in neuroscience. It starts out with an overview of information, statistical theory and the probabilistic brain before focusing on computational models of neural circuits and learning, including unsupervised, supervised and reinforcement learning, visual and auditory system, convolution and recurrent neural networks and the backpropagation algorithm in the brain. Finally the unit explains how to relate these models to neural data. Overall, the unit will enable students to understand how concepts from data science, machine learning and computational modelling are being used to solve one of the most challenging problems in science: how do our brains work.* |
| **Description for CS Department Options Booklet** - this is the booklet 2nd year Computer Science students currently get to help them choose their 3rd Year Units  Please example form and current [Options Booklet](https://uob.sharepoint.com/:b:/t/mvseschoolteam/EYvD2MhqX75FvX7BuBQIerABVkGyoJOwfQsF3HWhKD8mKQ?e=4VLLFE)  The new name for Neural Information Processing.In this unit we discuss how the brain processes information; we see this as an opportunity to discuss the two-way conversation between neuroscience and machine learning, it includes, for example, reinforcement learning, an important part of cutting-edge discussion of machine intelligence as well as a good description of how animals often learn and behave. The unit material is based on research papers but aims to be self-contained, with broad introductions to the main topics. We see this both as a follow-on unit to COMS30127, though that isn't a prerequisite, and a unit that complements the existing machine learning units.The unit material is available at  https://comsm0034.github.io |
| **Credit Points:**  10 if assessed by examination, 15 if assessed by coursework |
| **Academic year**  4th academic year of entry for students |
| RationaleIn the case of a change to an existing unit, please also explain exactly what changes are proposed.   These changes have been made in line with a comprehensive programme review, in which the Department is simplifying its structures and lowering the assessment load on students. |
| **Assessment Details**  Please link the assessment to the intended learning outcomes bearing in mind that it is expected that all intended learning outcomes are assessed.  Unit can be assessed either by 100% examination (10 credits) or 100% Coursework (15 credits). The Coursework is a stand-alone, take-home examination, and must be able to be completed in the specific 3-week block. There will be two formative worksheets.  Examination details:  The exam will have a short answer section of 20 questions, worth two marks each, to examine knowledge, and a choice of two out of three questions, to examine skills.  Coursework details:  There will be two challenges based on the simulation of neuronal computation at different levels. |
| **Resources needed** These should be for the full Unit – please add any extra resources needed for specific weeks (eg if Coursework would need access to robots, specific software in specific labs etc)  **Academic staff:** Three lectures per week  **Hourly Paid Teaching:** Two TAs for three two hour workshops for the coursework unit.  **Teaching spaces:** A lecture theatre with a blackboard  **Specific software:**  **Specific hardware:**  **Other:** |
| **Do you envisage this unit being offered to Maths and Computer Science students?** (please pick) YES |
| **Pre-requisites:** (Please include any specific units that are pre-requisites for this unit, as well as any knowledge a student a student would need to take the unit if they haven’t taken the full Computer Science degree so far – eg Erasmus Students, 4th Year students returning from Study Abroad, non Computer Science students etc)  There are no pre-requisites.  **Knowledge needed to take the Unit**  A knowledge of Python or Julia; a basic knowledge of probability theory and of differential equations. |
| **Would this unit be a pre-requisite for a future unit? If yes, which?** No |
| **Intended Learning Outcomes -** please see examples of good and bad ILOs and if necessary, refer to the [Guidance on Intended Learning Outcomes on the University website](http://www.bristol.ac.uk/academic-quality/approve/approvalguidance/intendedlearningoutcomes/)  General:  *On successful completion of this unit, students will be able to:*   * *Understand state-of-the-art computational models being used to understand brain functioning;* * *Understand different forms of modelling in neuroscience, from probabilistic models to neural networks* * *Understand how deep learning networks relate to the brain* * *Become familiar with different forms of learning in the brain (and machine learning)* * *Understand how to perform advanced data analysis for real-world problems* * *Read current research literature in models of cognition*   When assessed by Examination: *students will be able to demonstrate an understanding of computational models of brain functioning and of information theory and will be able to use tools from information theory, probability and deep learning to interpret the behaviour of neuronal and neural networks.*  When assessed by Coursework: *students will be able simulate and interpret cognitive and electrophysiological data using modern models of brain functioning.* |
| **Reading and References (to go into the Unit Catalogue)** - see example paperwork  *A list of textbooks and of relevant research papers will be provided* |

**Planned teaching – Y4 TB1**

Please give a brief outline of the topics that will be taught in each week, including lectures, labs, demonstrations, seminars, tutorials and in-class tests (un-assessed).

Each Y3 and Y4 TB1 Unit will have the teaching taking over place of 3 contact hours a week over Week 1-7. Weeks 9-11 will be the time students should be completing their coursework, if they have chosen that assessment option, but there should be opportunities for emergency drop-in sessions to support the coursework.

Please include what support you’d want to offer for the Revision Week (eg drop-ins, and/or running optional revision classes)

This can change in the future, so if there are parts you are unsure of at this stage, please note that.

**Teaching Block 1**

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| **Week** | **Topics to be taught** | **Teaching format**  (eg 1 lecture, 1 x seminar, 1x 1 hour labs, in-class non-assessed test) | **Optional activities**  (eg drop-ins, lab sheets, reading) | **Extra resources needed**  (eg teaching staff, access to labs, software, robots etc) |
| **Week 1** | Information theory I | Three lectures |  |  |
| **Week 2** | Information theory II | Three lectures | Formative worksheet |  |
| **Week 3** | The probabilistic brain I | Three lectures |  |  |
| **Week 4** | The probabilistic brain II / Neural circuits | Three lectures |  |  |
| **Week 5** | Unsupervised and reinforcement learning | Three lectures | Formative worksheet |  |
| **Week 6** | Recurrent neural networks and meta-learning | Three lectures |  |  |
| **Week 7** | Neural data analysis | Three lectures |  |  |
| **Week 8**  **CS Explore Week** |  |  |  |  |
| **Week 9** |  | Two-hour workshop |  |  |
| **Week 10** |  | Two-hour workshop |  |  |
| **Week 11** |  | Two-hour workshop |  |  |
| **Week 12** |  | Two revision lectures and one revision Q&A |  |  |

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| **Extra information**  Please add anything that you’d like to be considered, or would help as part of the approvals and implementation processes. |

**BCS Accreditation information**

In order to help us with our next British Computing Society course accreditation, please can you tick if you Unit can help us meet any of these criteria. If you would like any advice about the information on this page, please contact Simon Lock.

**Discipline**

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| Computer Science | Unit is primarily Computer Science (as opposed to Mathematical) | X |
| Mathematical | Unit is primarily Mathematical (as opposed to Computer Science) | X |
| Trans Disciplinary | Unit also covers a supporting discipline (in addition to Computer Science and Maths) | X |

**Topics**

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| Software Engineering | Unit focuses on key stages of the software lifecycle (analysis, design, implementation, testing etc) |  |
| LESPI | Unit explicitly covers Legal, Ethical, Social, Political issues |  |
| Industry | Unit incorporates commercial, business and industrial issues, goals and approaches |  |
| Security | Unit covers topics relating to system and data security |  |
| Risk | Unit covers topics risk management (relating to safety or business criticality) |  |
| Data | Unit covers issues relating to databases, datastores and datafeeds |  |
| Simulation | Unit addresses the topics of modelling and simulation | X |
| Management | Unit covers topics relating to the planning and management of systems development |  |
| Verification & Validation | Unit involves verification, validation, testing and evaluation (including human-centred evaluation) |  |
| Architecture | Unit covers the design of systems architecture at various levels of abstraction (from network to processor) |  |

**Perspective**

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| Cutting Edge | Unit is heavily informed by insights and research at the fore-front of the field | X |
| Innovation | Unit requires students to be entrepreneurial and demonstrate business innovation |  |

**Style of Unit**

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| Project | Unit involves a significant project element (involving research activities and application of creativity) | X |
| Group | Unit requires students to work in teams to achieve an objective |  |
| Peer review | Unit requires students to critically review each other’s work |  |
| PG Context | Unit (at level 7) that explores context of computer science, including both foundations as well as forefront of professional practice |  |