MSc Computational Neuroscience & Cognitive Robotics Modules 2018/19

Disclaimer: The information contained in this document provides general guidance only. While every care has been taken to provide correct information at the date of authoring (August 2018), information may be subject to revision from time to time.

Course Structure (Full-time)

Credits	Term 1	Term 2	Term 3
10	Foundation CN-CR Issues	Mind, Brain, & Models	MSc Research Project
	Options: • Introduction to Computational Methods • Matlab Programming • Introduction to Neural Computation • Introduction to Neuroscientific Methods	**Options:** • Advanced Computational Methods	
20	Practical Research Skills for CNCR	Proposing Research In Psychology	
	Options: • Fundamentals in Brain Imaging • Intelligent Robotics Extended • Software Workshop	**Options** • Advanced Brain Imaging Methods • Advanced Robotics • Robot Vision	
Total credits	Minimum 30	Minimum 30	60

Typically, part-time students take the some taught modules in Year 1 and complete the research modules (Proposing Research in Psychology and MSc Research Project) in Year 2. There are some restrictions to how the modules are organised (e.g., Proposing Research must be studied before or at the same time as the MSc Research Project). At the beginning of the academic year, part-time students meet with their Course Director to discuss their study plan.

Compulsory Modules

Module title:	**Foundation CN-CR Issues**
Module code:	03 24302
Module Lead:	to be confirmed
Term:	1 and 2
Credit value:	10
Delivery method:	School seminars and CN-CR meetings
Assessment method: Diary of seminar attendance: students hand in a concise written summary of the attended regular School seminars and journals.	
Marks required to pass module: 50%	
Aims and learning objectives of this module: CNCR staff will have weekly meetings to discuss current literature as well as their own work. Students will have a chance to discuss with researchers about their work. Attendance to the School's main seminar (which will feature CNCR content regularly) will provide them with a broader view of scientific context. A diary detailing their attendance of the seminar has to be produced.	
Learning outcomes: By the end of the modules students should be able to: understand literature at the forefront of research and contribute to scientific discussions, analyse critically a current publication in the field of CNCR, and put novel information and results into the broader context of CNCR studies.	
Recommended reading list: Every year we try to present current literature, so this list might change substantially. Recommended literature is given for individual lectures.	

Module title:	Minds, Brain, and Models
Module code:	03 24299
Module Lead:	to be confirmed
Term:	2
Credit value:	10
Delivery method:	Lectures, computer labs and tutorials
Assessment method: Topical practical assignments (100%): students hand in weekly written exercises, e.g. lab reports, solutions of problems, or minor essays	
Marks required to pass module: 50%	
Aims and learning objectives of this module: Lectures will provide an overview of computational / mathematical modelling in neuroscience, psychophysics and psychology. Basic methods and common models will be covered, but CN-CR staff will also introduce students to their current research. Students will gain practical experience in computer labs and by working on exercises, which will be discussed in tutorials	
Learning outcomes: By the end of the module students should be able to: understand basic methods and common approaches in computational/ mathematical modelling; use computers to implement and analyse models; demonstrate basic procedural programming skills e.g. in Matlab, Java or C, and evaluate models by comparing them to empirical data and observations.	
Recommended reading list: Trappenberg T (2009) Fundamentals of Computational Neuroscience, Oxford University press (Introduction and Chapter 1) Marr D (2010) Vision, MIT Press (chapter 1 & 2) Kinll D Pouget A (2004) The Bayesian brain, Trends in neuroscience, 27 12, 712- Bolton W (2002) Control systems, Elsevier (chapter 1) Ermentrout B, Terman D (2010) Foundations of mathematical neuroscience, Springer (chapters 1, 2 & 4)	

Module title:	Practical Skills for CNCR
Module code:	03 3080
Module Lead:	to be confirmed
Term:	2
Credit value:	20
Delivery method:	Lectures, practical classes, project supervision, and computer-based exercises
Assessment method: 3,000-word research report (80%) and online assessment of key skills and issues (20%)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: This module will cover how to systematically approach conducting research. Topics will include methods and analysis techniques; reporting research effectively in writing; training in IT and administrative skills useful for research activities (e.g., file management); and key ethical, legal, health and safety issues in psychology and neuroscience research	
Learning outcomes: By the end of the module, students should be able to: Design a research project(s) using methods relevant to specific research area(s); write a research report using professionally accepted formats; demonstrate a working knowledge of IT and administrative skills and ethical, legal, and health and safety issues when conducting psychology and neuroscience research	
Recommended reading list: A reading list will be provided at the start of the module.	

Module title:	Proposing Research in Psychology
Module code:	03 26539
Module Lead:	Dr Fay Julal
Term:	1
Credit value:	20
Delivery method:	Lectures, tutorials
Assessment method: A written research proposal of 3000 words in two parts. Part 1 will be formative and Part 2 summative (contributes 100% to module mark)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: Lectures will provide an overview of approaches to planning research and the process of planning and proposing research projects (e.g., grant writing) and ways in which research can be reported (e.g., oral and poster presentations). Then students will work in small groups or one-to-one with a staff member to develop and write a research proposal. Students will also develop relevant IT, administrative, and research skills. Students will work in small groups or one-to-one with a staff member to develop and write a research proposal. The proposal will typically involve pilot studies and require a lab placement with a staff member. The proposal will typically involve pilot studies and require a lab placement with a staff member.	
Learning outcomes: By the end of the module students should be able to: write a research proposal; demonstrate a working knowledge of the key skills and issues useful for research; visually present research in a concise and clear manner, in the form of a professional conference-style poster presentation; , and understand the methodologies and background knowledge relevant to specific research area.	
Recommended reading list: For this module, there is no set reading list. Instead, students are advised to engage in general study of the key scientific thinking, writing, and presentation skills (see above), and to engage in critical reading of academic sources for the subject-specific content. Some academic sources will be recommended by the module leads.	

Module title:	**MSc Research Project**
Module code:	03 28503
Module Lead:	Dr Fay Julal
Term:	3
Credit value:	60
Delivery method:	Student-centred research dissertation

Assessment method: Written dissertation (6,000 words max) (100%contributes 80% to module mark); poster presentation, with oral walk-through (contributes 20%)

Marks required to pass module: 50%

Aims and learning objectives of this module: Students will conduct a substantial empirical inquiry, with some aspect of originality, into a topic under supervision. Students will be assigned to a research supervisor, with whom the student will negotiate a contract setting out the project's aims, the relevant knowledge and skills, and milestones for conducting the research.

Learning outcomes: By the end of the module students should be able to: systematically conduct a substantial empirical inquiry using research methods and analysis techniques appropriate to the field of research and level of study; communicate effectively in writing, using professionally accepted protocols, to a standard that would be suitable for publication in a research journal; visually and orally present research in a concise and clear manner; develop a research project that entails some aspect of originality, and show independence in managing the research project.

Recommended reading list:

Beins, B. C., & Beins, A. M. (2008). Effective writing in psychology: Papers, posters, and presentations. Blackwell: Oxford.

Hartley, J. (2008). Academic writing and publishing: A practical handbook. Abingdon: Routledge.

Smyth, T. R. (2004). The principles of writing in psychology. Basingstoke: Palgrave Macmillan.

Wood, C., Giles, D., & Percy, C. (2012). Your psychology project handbook: Becoming a researcher (2nd ed.). Essex: Pearson Education Limited.

* For this module, you will also be expected to engage in extensive, critical reading of the academic sources underpinning your research. Your research supervisors will often provide you with some seed references to get you started.

Optional Modules

With the help of your Supervisor and the Course Director you will select a number of optional modules from a range of available ones offered in the schools of Computer Science and Psychology. The total number of credits you need for this component is 60. The modules should be selected by the end of the second day of the course, but extensions could be granted by contacting the Course Director

	Term 1	**Term 2**
Credits: 10	Introduction to Computational Methods 03 25124	Advanced Computational Methods 03 25123
	Matlab Programming 03 20516	
	Introduction to Neuroscientific Methods	
	Introduction to Neural Computation 06 12412	
Credits: 20	Intelligent Robotics Extended 06 15267	Advanced Robotics 06 25021
	Software Workshop 06 06994	Robot Vision 05 25024
	Fundamentals in Brain Imaging 03 30124	Advanced Brain Imaging Methods 03 30120

Modules in green cells: School of Psychology

Modules in blue cells: School of Computer Science

Module title:	**Matlab Programming**
Module code:	03 20516
Module Lead:	Dr Peter Hansen
Term:	1
Credit value:	10
Delivery method:	Computer-based seminar/workshops
Assessment method: Structured programming exercise (100%)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: The module will provide an introduction to the Matlab package. Topics covered will include: what exactly is Matlab, and why it is so useful; interacting with the Matlab IDE and command line environment; basic Matlab concepts (commands, data structures including vectors and matrices, calculations, programming); Matlab programming techniques (flow control, modules, functions and .m files, file input/output, graphics), and finally, students will complete a structured programming exercise, aimed at producing a simple visual experiment in Matlab. This will form the basis of the course assessment.	
Learning outcomes: By the end of the module the student should be able to: demonstrate a working knowledge of Matlab, including the ability to build and use simple functions to manipulate and display data.	
Recommended reading list: A reading list will be available at beginning of module.	

Module title:	**Advanced Computational Methods**
Module code:	03 25123
Module Lead:	to be confirmed
Term:	2
Credit value:	10
Delivery method:	Lectures, computer labs and tutorials
Assessment method: Weekly practical assignments (80%) and group assignment (20%)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: This module introduces advanced mathematical tools and methods relevant to research in model-based psychology, psychophysics, computational neuroscience and cognitive robotics. Through the discussion of three separate topics it will provide students with the practical ability to do modelling and interdisciplinary research through computer-labs and exercises.	
Learning outcomes: On successful completion of this module, the student should be able to: recognise the appropriate methods to address advanced computational problems; demonstrate the ability to formulate a solution strategy for said problems, and use computers (and Matlab in particular) for complex mathematical analyses.	
Recommended reading list: A reading list will be available at beginning of module.	

Module title:	**Introduction to Computational Methods**
Module code:	03 25124
Module Lead:	to be confirmed
Term:	1
Credit value:	10
Delivery method:	Lectures, computer labs and tutorials
Assessment method: Weekly practical assignments (60%) and final exam (40%)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: This module introduces fundamental mathematical tools and methods relevant to research in model-based psychology, psychophysics, computational neuroscience and cognitive robotics. It will provide students with the practical ability to do modelling and interdisciplinary research through computer-labs and exercises.	
Learning outcomes: On successful completion of this module, the student should be able to: recognise the appropriate methods to address basic computational problems; demonstrate the ability to formulate a solution strategy for basic computational problems; solve simple problems without the aid of a computer, and use computers (and Matlab in particular) for more complex mathematical analyses.	
Recommended reading list: Kreyszig E., (2005). Advanced Engineering Mathematics, John Wiley and Sons Mackay, D. (2003). Information Theory, Inference and Learning Algorithms, Cambridge University Press. Bishop, C. (1995). Neural Networks for Pattern Recognition. Oxford, U.K.: Oxford University Press.	

Module title:	**Advanced Brain Imaging Methods**
Module code:	03 30120
Module Lead:	Professor Uta Noppeney
Term:	2
Credit value:	20
Delivery method:	Lectures, workshops and computer-based exercises
Assessment method: Written exam (100%)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: Lectures will cover advanced methods of data analysis and statistics for MRI and M/EEG. In addition, students will perform computer-based data analysis. The data analysis will be predominantly based on Matlab and the academic software package SPM. http://www.fil.ion.ucl.ac.uk/spm/software/spm8/.	
Learning outcomes: By the end of the module the student should be able to: design and analyse functional imaging experiments to address experimental questions in neuroscience; understand univariate and multivariate analysis approaches, and describe functional and effective connectivity methods.	
Recommended reading list: A reading list will be available at beginning of module.	

Module title	**Introduction to Neural Computation**
Module code:	06 12412
Module Lead:	John Bullinaria
Credit value:	10
Delivery method	Lectures, Assigned course work.
Assessment method	1.5 hour examination (80%), continuous assessment (20%)
Marks required to pass module	50%

Module Description Through both lectures and practical work, the module introduces the basic concepts and techniques of neural computation and, more generally, automated learning in computing machines. It covers various forms of formal neurons and their relation to neurobiology, showing how to construct larger networks of formal neurons and study their learning and generalisation in the context of practical application. Finally, neural--based learning techniques are contrasted with other state of the art techniques of automated learning.

Learning outcomes

1. Understand the relationship between real brains and simple artificial neural network models.
2. Describe and explain the learning and generalisation aspects of neural computation.
3. Apply neural computation algorithms to specific technical and scientific problems.
4. Demonstrate an understanding of the benefits and limitations of neural based learning techniques in context of other state of the art methods of automated learning.

Reading List

Gurney K, An Introduction to Neural Networks 1997

Haykin S, 1999, Neural Networks: A Comprehensive Foundation (second edition), Prentice Hall

Hastie T, Tibshirani R & Friedman J, 2001, the Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer

CM Bishop, 1995, Neural Networks for Pattern Recognition, Oxford University Press

Module title:	Fundamentals in Brain Imaging
Module code:	03 30124
Module Lead:	Dr Peter Hansen
Term:	1
Credit value:	20
Delivery method:	Lectures, and workshops
Assessment method: 1,500-word Critical review (30%) and data analysis (70%)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: Lectures will cover the main techniques of brain mapping using MRI with emphasis on functional MRI. Topics will also include the physics of NMR and MRI, introduction to fMRI experimental design and analysis. Students will have computer-based training in analysis of brain images, including processing of basic fMRI studies.	
Learning outcomes: By the end of the module students should be able to: demonstrate a broad knowledge of the strengths and weaknesses of MRI for mapping brain functions in cognitive neuroscience; show an appreciation of the design and analysis of fMRI experiments, and be able to design and analyse simple imaging experiments.	
Recommended reading list: A reading list will be available at beginning of module.	

Module title	**Intelligent Robotics (Extended)**
Module code	06 15267
Course Tutors	Jeremy Wyatt
Credit value	20
Delivery method	Lectures and Laboratory sessions.
Assessment method	2 hour examination (40%), continuous assessment (60%)
Marks required to pass module	50%

Module Description Artificial Intelligence is concerned with mechanisms for generating intelligent behaviour. When this behaviour occurs in the everyday physical world, with its uncertainty and rapid change, we find that all kinds of new problems and opportunities arise. We will try to understand some of these in the context of robotics. In a series of lectures we will look at some theories of how to sense the real world, and act intelligently in it. In a series of labs you will build your own robots to see how well (or badly) these theories actually work.

Learning outcomes

1. Design, build and program simple autonomous robots.
2. Implement standard signal processing and control algorithms.
3. Describe and analyse robot processes using appropriate methods.
4. Write a detailed report on a robot project.
5. Carry out and write up investigations using appropriate experimental methods.
6. Be able to describe, use, analyse and discuss the properties of a variety of algorithms in the robotics literature.

Reading List

Jones J, Seiger B & Flynn A, 1999, Mobile Robots: Inspiration to Implementation, AK Peters.

Braitenberg V, Vehicles: Experiments in Synthetic Psychology MIT Press,1984

Wyatt J, Lecture notes on intelligent robotic and lab handouts

Mahadevan S & Connell J, 1993, Robot Learning, Kluwer Academic

Martin F, Robotic Explorations: A Hands--on Introduction to Engineering Addison--Wesley, 2001

Nahmzow U, 2000, Mobile Robotics: A Practical introduction, Springer Verlag

Arkin R, Behaviour Based Robotics MIT Press, 1998

Module title	**Robot Vision**
Module code	06 25024
Course Tutors Aleš Leonardis	
Credit value 20	
Delivery method Lectures, Presentations and Laboratory sessions.	
Assessment method 1.5 hour examination (40%), continuous assessment (team project and presentation) (60%)	
Marks required to pass module 50%	
Aims and learning objectives of this module Vision is one of the major senses that enables humans to act (and interact) in (ever)changing environments. In a similar vein, computer vision should play an equally important role in relation to intelligent robotics. This module will focus on the fundamental computational principles that enable to convert an array of picture elements into structural and semantic entities necessary to accomplish various perceptual tasks. In a series of lectures, we will study the problems of low level image processing, recognition, categorisation, stereo vision, motion analysis, tracking and active vision. The lectures will be accompanied by a series of laboratory exercises where many of these computational models will be designed, implemented and tested in real-- world scenarios.	
Learning outcomes 1. Design, implement and test simple computer vision algorithms 2. Write a detailed report on a computer vision project 3. Survey and critically discuss the research literature in one subfield of computer vision 4. Demonstrate an understanding of the main computer vision methods and computational models	

Module title Software Workshop
Module code 06 18190
Course Tutors Jon Rowe and Martin Escardo
Credit value 20
Delivery method Lectures, tutorials and assisted lab sessions
Assessment method Sessional: 1.5 hour examination (80%), continuous assessment (20%).
Marks required to pass module 50%
Aims and learning objectives of this module This module introduces and develops object oriented design and programming skills. It introduces the Java programming language as an example of an object oriented programming language and develops software development skills through Java.
Learning outcomes 1. Demonstrate an understanding of types, classes, objects, methods, inheritance, and exceptions 2. Demonstrate an understanding of and use object oriented analysis and design processes 3. Demonstrate an understanding of recursion and the use of recursive data structures **4.** Explain methods and techniques for program testing

Module title	**Advanced Robotics**
Module code	06 25021
Course Tutors Dr Michael Mistry	
Credit value	20
Delivery method Lectures and Laboratory sessions	
Assessment method Sessional: 2 hour examination (40%), continuous assessment (team project) (60%)	
Marks required to pass module 50%	
Module Description This module is concerned with robot motion in a physical world. We will introduce the concepts and tools for modelling, simulating, and controlling dynamic robots. In a series of lectures we will study the fundamentals of manipulation including kinematics, dynamics, and control. Lab exercises will reinforce learned concepts by means of evaluation on a (real/simulated) physical robot.	
Learning outcomes 1. Develop and formulate models of a dynamic robot, such as a manipulator. 2. Implement algorithms for solving robot manipulation problems. 3. Investigate and analyse control methods for robot motion (on a simulator or real robot). 4. Demonstrate an understanding of the main methods of modelling and controlling dynamic robots.	

Module title:	Introduction to Neuroscientific Methods
Module code:	03 30806
Module Lead:	Dr Wieske van Zoest
Term:	1
Credit value:	10
Delivery method:	Lectures, workshops, and computer-based exercises
Assessment method: Time-limited assignment (120-minutes) (50%) and workshop-based exam (60-minutes) (50%)	
Marks required to pass module: 50%	
Aims and learning objectives of this module: This module will cover the main techniques of brain mapping used in cognitive neuroscience (e.g., MRI, fMRI, DTI, EEG, TMS, MEG). Topics will also include the physics of NMR and MRI, introduction to fMRI experimental design and analysis. Students will have computer based training in data analysis and seminar-based workshop sessions discussion imaging methods	
Learning outcomes: By the end of the module the student should be able to: demonstrate a broad knowledge of the main methods used for mapping brain functions in cognitive neuroscience; show an appreciation of the design and analysis of fMRI experiments; and, understand the methods used in published imaging papers, and be able to design simple imaging experiments	
Recommended reading list: A reading list will be provided at the start of the module	