MSc Computational Neuroscience & Cognitive Robotics Modules

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, information may be subject to revision from time to time.

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 **Course Structure (Full-time)**

Compulsory Modules

Term 1	Credits	Term 2	Credits	Term 3	Credits
Current Research and Practice in Psychology	20	Proposing Research	20	MSc Research Project	60
		Mind, Brain and Models	20		

Optional Modules

Term 1	Credits	Term 2	Credits	Term 3	Credits	
Matlab Programming	10	Foundations of Data Science	10			
Introduction to Data Science	10					
Introduction to Neuroscientific Methods	10					
Introduction to Computational methods	20	Applications of Electrophysiological Approaches in Cognitive Neuroscience	20			
Fundamentals in Brain Imaging	20					

Optionals Modules from the School of Computer Science

Term 1	Credits	Term 2	Credits	Term 3	Credits	
Intelligent Robotics	20	Advanced robotics	20			
Robot vision	20	Robot vision	20			

Software workshop 1	20					
Neural Computation	20					

NOTE - This is a tentative lists of modules open to CNCR students from Computer Science, an up to date list will provided during welcome week.

- **Credits** CNCR students take a minimum of 40 credits in semester 1 and 40 credits in semester 2. A normal load is 60 credits in each semester. Students can choose to put more credits in one term than the other, but should recognize that they will have to manage the increased load. An unbalanced load is not a legitimate reason for asking for extenuating circumstances.

- Typically, part-time students take the some taught modules in Year 1, and complete Proposing Research in Psychology in the summer of Year 1 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.

Module title:	Current Research & Practice
Module code:	03 30807
Module Lead:	Dr Robin Thompson
Term:	1
Credit value:	20
Delivery method:	Lectures, seminars, practical classes, project supervision, and computer-based exercises
Assessment method:	• 2000-word research report • online assessment of key skills • seminar summaries
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, and legal 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, 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 Pia Rotshtein
Term:	1
Credit value:	20
Delivery method:	Lectures and 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 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). 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.

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;
- 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 lead.

Module title:	Mind, Brain and Models
Module code:	03 24299
Module Lead:	Dr Massimiliano Di Luca
Term:	2
Credit value:	20
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:	MSc Research Project
Module code:	03 28503
Module Lead:	Dr Pia Rotshtein
Term:	3
Credit value:	60
Delivery method:	Student-centred research dissertation
Assessment method:	• Written dissertation (6,000 words max) (80%) • Poster presentation, with oral walk-through (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: Baumeister, R. F., & Leary, M. R. (1997). Writing narrative literature reviews. Review of General Psychology, 1, 311–320.

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

Cooper, H., & Shoolbred, M. (2016). Where's your argument? Pocket study skills. Palgrave Macmillan.

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 provide you with some seed references to get you started.

Module title:	Matlab Programming
Module code:	03 awaiting new code until then use 25124
Module Lead:	Dr. Hyojin Park
Term:	1
Credit value:	10
Delivery method:	Lectures, workshops and computer-based exercises
Assessment method:	• Programming project (100%)
Marks required to pass module:	50%

Aims and learning objectives of this module: The module will introduce students to the MatLab programming environment so that they can make scripts to run experiments, create stimuli, explore datasets, and perform statistical analyses. The module will cover:

1. What is Matlab and why it is useful.
2. Interacting with Matlab IDE (Integrated Development Environment).
3. Matlab concepts (commands, data structures including vectors and matrices).
4. Matlab programming techniques (flow control, functions, graphics).
5. Students will complete a structured programming exercise.

Learning outcomes: By the end of the module students will be able to demonstrate a knowledge of Matlab, including:

- Build and use functions to manipulate and display data
- Explain and describe the workspace, variables, mathematical operations, graphs.
- Explain flow control (e.g., for loops, if statements) functions.
- Describe advanced variables, advanced flow control, file operations.
- Explain histograms, boxplots, and statistical measures for data analysis.

Recommended reading list: A reading list will be available at beginning of module.

Module title:	Introduction to Data Science
Module code:	36255
Module Lead:	Dr Matthew Brett
Term:	1
Credit value:	10
Delivery method:	Lectures and workshops
Assessment method:	• 2 X 10% Coursework assignments • 1 X 80% structured programming analysis assignment
Marks required to pass module:	50%

Aims and learning objectives of this module: The module will provide an introduction to the use of programming in data analysis. Topics covered will include: what exactly is programming, and why it is so useful; interacting with a programming language and command line environment; basic programming concepts (commands, data structures including vectors and matrices, calculations, programming); 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 program to perform a simple analysis. 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 a computer language program, 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:	Foundations of Data Science
Module code:	34417
Module Lead:	Matthew Brett
Term:	2
Credit value:	10
Delivery method:	Lectures and practical workshops
Assessment method:	• 4 X 10% coursework assignments • 1 X 60% independent group project
Marks required to pass module:	50%

Aims and learning objectives of this module: The module will provide a foundation in data science principles and techniques.
Topics covered will include:

1. Numerical optimization
2. Regression for prediction and inference
3. Bootstrap methods.
4. Machine learning methods for prediction.
5. Bayesian inference.

Finally, students will complete an independent group data analysis project in which they find, load, clean, explore and analyse a data set of their choice, using inference or prediction methods as necessary. This will be the primary basis of the course assessment.

Learning outcomes: By the end of the module the student should be able to:

- Understand and apply optimization methods for prediction and inference in regression problems.
- Understand the principles of confidence intervals and apply Bayesian reasoning to their interpretation.
- Understand and apply bootstrap resampling for effect size estimation and inference.
- Understand and apply basic machine learning classification methods.

Recommended reading list: A reading list will be available at beginning of module.

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%) • 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

Module title:	Introduction to Computational Methods
Module code:	03 25124
Module Lead:	Dr Dietmar Heinke
Term:	1
Credit value:	20
Delivery method:	Lectures, computer labs and tutorials
Assessment method:	• Topical practical assignments: e.g., lab reports, solutions of problems, or minor essays during term • Larger final assessment demonstrating ability to use computational solution to a problem
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 (i.e., programming in appropriate language) for more complex mathematical analyses.

Recommended reading list: https://www.mathsisfun.com/

Xin-She Yang (2017) Engineering Mathematics with Examples and Applications Farell & Lewandowsky (2018) Computational modelling of cognition and behaviour Bronson, Costa, & Saccoman (2014) Linear Algebra: Algorithms, Applications, and Techniques

Field (2005) Discovering Statistics Using SPSS.

Module title:	Application of Electrophysiological Approaches in Cognitive Neuroscience
Module code:	03 30125
Module Lead:	Professor Ole Jensen
Term:	2
Credit value:	20
Delivery method:	Lectures, workshops and computer-based exercises
Assessment method:	• 30% coursework • 70% exam
Marks required to pass module:	50%

Aims and learning objectives of this module: Lectures will cover the main techniques of human electrophysiological measures based on EEG/MEG and their application in cognitive neuroscience. Topics will include neurophysiology of human EEG/MEG data, introduction to experimental design and analysis (evoked responses, spectral analysis and source modeling). We will explain however these techniques are used to address mechanistic questions in cognitive neuroscience. Students will have computer-based exercises in Matlab involving analysis of EEG and MEG data. |

Learning outcomes: By the end of the module students should be able to: demonstrate a broad knowledge of the strengths and weaknesses of the use of electrophysiological methods for investigations in cognitive neuroscience; show an appreciation of the design and analysis of EEG/MEG experiments, and be able to design and analyse simple EEG/MEG experiments.

Recommended reading list:
The course requires basic knowledge of Matlab

Module title:	Fundamentals of 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%) • 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.