COGS3020

Computational Neuroscience

Session 1, In person-scheduled-weekday, North Ryde 2023

School of Psychological Sciences

Contents

General Information

Unit convenor and teaching staff
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Credit points
10

Prerequisites
130cp including ((COGS1000 or COGS100) or (BIOL2230 or BIOL257) or (MEDI2300 or MEDI204)) and (COGS2020 or (STAT2170 or STAT270))

Corequisites

Co-badged status

Unit description
Computational modelling is increasingly important for understanding brain function at the single neuron, circuit, and network levels. This unit provides students with a rigorous introduction to the exciting field of computational neuroscience including topics such as the mathematical description of neurons, simple neural networks, statistical inference, reinforcement learning, and decision making. Students will learn the Python programming language and use it to explore some of the most influential models in computational neuroscience to deepen their understanding of the relationship between the brain, behaviour, and neural computation.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

ULO1: Demonstrate advanced knowledge of key computational models in neuroscience.

ULO2: Simulate and analyse models of individual neurons and brain circuits.

ULO3: Fit computational models to experimental data to find best fitting parameters.

ULO4: Compare different computational models using statistical model comparison techniques.

General Assessment Information

Grade descriptors and other information concerning grading are contained in the Macquarie University Assessment Policy.

All final grades are determined by a grading committee, in accordance with the Macquarie University Assessment Policy, and are not the sole responsibility of the Unit Convenor.

Students will be awarded a final grade and a mark which must correspond to the grade descriptors specified in the Assessment Procedure (clause 128).

To pass this unit, you must demonstrate sufficient evidence of achievement of the learning outcomes, meet any ungraded requirements, and achieve a final mark of 50 or better.

Further details for each assessment task will be available on iLearn.

Late Submissions

Unless a Special Consideration request has been submitted and approved, a 5% penalty (OF THE TOTAL POSSIBLE MARK) will be applied each day a written assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of '0' will be awarded even if the assessment is submitted. Submission time for all written assessments is set at 11.55pm. A 1-hour grace period is provided to students who experience a technical concern.

For example:

Number of days (hours) late	Total Possible Marks	Deduction	Raw mark	Final mark
1 day (1-24 hours)	100	5	75	70
2 days (24-48 hours)	100	10	75	65
3 days (48-72 hours)	100	15	75	60
7 days (144-168 hours)	100	35	75	40
>7 days (>168 hours)	100	-	75	0

For any late submissions of time-sensitive tasks, such as scheduled tests/exams, performance assessments/presentations, and/or scheduled practical assessments/labs, students need to submit an application for Special Consideration.

Assessment Tasks

Name	Weighting	Hurdle	Due
Problem sets	40%	No	Approximately once every four weeks
Weekly online quizzes	25%	No	Approximately weekly
Final project	35%	No	Week 13

Problem sets

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 35 hours
Due: **Approximately once every four weeks**
Weighting: **40%**

Problem sets designed for students to demonstrate python coding knowledge and apply learned code to a novel context.

On successful completion you will be able to:

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- Fit computational models to experimental data to find best fitting parameters.
- Compare different computational models using statistical model comparison techniques.

Weekly online quizzes

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 20 hours
Due: **Approximately weekly**
Weighting: **25%**

Graded weekly online multiple choice quizzes designed to provide routine assessment and feedback. The 2 lowest quizzes (missed or lowest mark) may be dropped without penalty.

On successful completion you will be able to:

- Demonstrate advanced knowledge of key computational models in neuroscience.

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- Fit computational models to experimental data to find best fitting parameters.
- Compare different computational models using statistical model comparison techniques.

Final project

Assessment Type [1]: Project
Indicative Time on Task [2]: 30 hours
Due: **Week 13**
Weighting: **35%**

A final project that requires students to apply the skills and knowledge obtained throughout the unit to implement a computational model.

On successful completion you will be able to:

- Demonstrate advanced knowledge of key computational models in neuroscience.
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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

As a student enrolled in this unit, you will engage in a range of online and face-to-face learning activities, including readings, videos and lectures etc. Details can be found on the iLearn site for this unit.

Recommended Readings

Please consult the iLearn site for this unit.

Technology Used

Active participation in the learning activities throughout the unit will require students to have

access to a tablet, laptop or similar device. Students who do not own their own laptop computer may borrow one from the university library.

Unit Schedule

	Topic/Theme
Week 1	Intro to unit and Python programming
Week 2	Intro to numpy, pandas, and matplotlib
Week 3	Intro to dynamical systems (Euler's method and differential equations)
Week 4	Hodgkin-Huxley neuron model
Week 5	Simple neuron models
Week 6	Postsynaptic potentials and Spiking networks
Week 7	Synaptic plasticity: Hebbian learning
Week 8	Synaptic plasticity: Spike-timing-dependent learning
Week 9	Synaptic plasticity: Reinforcement learning
Week 10	Computational models of action selection in the basal ganglia
Week 11	Computational models of action execution in the cerebellum
Week 12	Computational models of vision
Week 13	Parameter estimation and model comparison

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Assessment Procedure

- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

The Writing Centre

The Writing Centre provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues
- Student Advocacy provides independent advice on MQ policies, procedures, and processes

Student Enquiries

Got a question? Ask us via AskMQ, or contact Service Connect.

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

INCLUSION AND DIVERSITY

Social inclusion at Macquarie University is about giving everyone who has the potential to benefit from higher education the opportunity to study at university, participate in campus life and flourish in their chosen field. The University has made significant moves to promote an equitable, diverse and exciting campus community for the benefit of staff and students. It is your responsibility to contribute towards the development of an inclusive culture and practice in the areas of learning and teaching, research, and service orientation and delivery. As a member of the Macquarie University community, you must not discriminate against or harass others based on their sex, gender, race, marital status, carers' responsibilities, disability, sexual orientation, age, political conviction or religious belief. All staff and students are expected to display appropriate behaviour that is conducive to a healthy learning environment for everyone.

PROFESSIONALISM

In the Faculty of Medicine, Health and Human Sciences, professionalism is a key capability embedded in all our courses.

As part of developing professionalism, students are expected to attend all small group interactive

sessions including clinical, practical, laboratory, work-integrated learning (e.g., PACE placements), and team-based learning activities. Some learning activities are recorded (e.g., face-to-face lectures), however you are encouraged to avoid relying upon such material as they do not recreate the whole learning experience and technical issues can and do occur. As an adult learner, we respect your decision to choose how you engage with your learning, but we would remind you that the learning opportunities we create for you have been done so to enable your success, and that by not engaging you may impact your ability to successfully complete this unit. We equally expect that you show respect for the academic staff who have worked hard to develop meaningful activities and prioritise your learning by communicating with them in advance if you are unable to attend a small group interactive session.

Another dimension of professionalism is having respect for your peers. It is the right of every student to learn in an environment that is free of disruption and distraction. Please arrive to all learning activities on time, and if you are unavoidably detained, please join activity as quietly as possible to minimise disruption. Phones and other electronic devices that produce noise and other distractions must be turned off prior to entering class. Where your own device (e.g., laptop) is being used for class-related activities, you are asked to close down all other applications to avoid distraction to you and others. Please treat your fellow students with the utmost respect. If you are uncomfortable participating in any specific activity, please let the relevant academic know.