UNIVERSITY OF CALGARY

DEPARTMENT OF PSYCHOLOGY
Faculty of Arts

Psychology 503	Computational Neuroscience	Winter 2024

Instructor:	Jackson J. Cone PhD	**Lecture Location:**	SH 274
Phone:	403-220-3469	**Lecture Days/Time:**	MWF 11-11:50
Email:	jackson.cone@ucalgary.ca		
Office:	AD30		
Office Hours:	By Appointment		

Course Description

Advanced computational techniques are ever-present in modern neuroscience, ranging from aspects of software development, data science, modeling, and machine learning (to name only a few). Students of psychology and neuroscience are increasingly required to develop proficiency in one or more of these areas as part of their scientific training. This course is intended to introduce students of neuroscience and psychology to computational approaches in modern neuroscience, including - but not limited to - scientific programming, simulation, modeling, and software development. This is intended to be a practical course and practical skills can only be honed through…*practice*. As such, the course features many hands-on programming assignments using both real and simulated data to reinforce neuroscience concepts that are covered in class. In some respects, this is a methods course masquerading as a special topics course. However, we will also survey important literature from across systems neuroscience that illustrate how neuronal populations implement specific computations that are used to guide behaviour.

Course Learning Outcomes

The Department of Psychology is committed to student knowledge and skill development. The table below lists the key learning outcomes for this course, the program-learning outcomes they facilitate (see https://live-arts.ucalgary.ca/psychology/about#program-learning-outcomes), and the expected level of achievement.

Course Learning Outcomes	Assessment Methods	PLO(s)	Level(s)
Develop computational problem solving skills	Coding Assignments	2,5	C
Explain relationships between brain signals and behaviour	Coding Assignments Thought Questions Paper Discussions	1,2,4,5	A
Refine critical thinking and scientific communication skills	Coding Assignments Paper Discussions	1,2,4,5	A
Use MATLAB for data analysis in neuroscience research	Thought Questions Coding Assignments	1,2,4,5	C
Explain how neurobiological and behavioural phenomena can be modeled using simple mathematics	Thought Questions Coding Assignments	1,2,4,5	C

Notes. PLOs = Program-Learning Outcomes: 1 = demonstrate knowledge of psychological sciences, 2 = think critically and solve problems, 3 = conduct research and analyze data, 4 = communicate effectively, 5 = demonstrate information literacy, 6 = understand and implement ethical principles in a diverse world, 7 = apply psychological knowledge and skills, 8 = Demonstrate multicultural competence and awareness of issues related to equity,

diversity, and inclusion. Level of PLO achievement facilitated by this course: I = introductory, C = competency, A = advanced.

Acknowledgments and Respect for Diversity

Our classrooms view diversity of identity as a strength and resource. Your experiences and different perspectives are encouraged and add to a rich learning environment that fosters critical thought through respectful discussion and inclusion. The Department of Psychology would also like to acknowledge the traditional territories of the people of the Treaty 7 region in southern Alberta. The City of Calgary is also home to Métis Nation of Alberta (Districts 5 and 6).

Course Format

This is an in-person class held on campus.

Prerequisites

Psyc 300, 301 and admission to the Psychology major or Honours program

Required Text

This is an advanced-level, special topics course. There is no textbook. All required readings will be provided by the instructor and will draw from books, journal articles, and web pages.

Assessment Methods

Your grade in this course will be based on 3 factors

1) 9 Homework Assignments (60% of total grade)
    a. There are 9 homework assignments. They are due approximately every week. The only exceptions is the first homework which you are given two weeks to complete. Your lowest homework score will be dropped so you can skip one assignment without penalty.
    b. Homework must be submitted before class on the due date specified in the schedule.
    c. Homework consists of coding and analysis questions in MATLAB as well as some thought questions that require written responses.
    d. <u>Get started early.</u> Homework will cover material specific to each module (see schedule) and will require significant time, especially if you are new to MATLAB.
    e. Homework assignments are open book. For this course, open book means that the use of class notes, readings, and consulting the web are permitted. The use of online resources and calculators is permitted. You may discuss the problem sets with other students and search the web for help. In fact, you will almost certainly need to do this, so study groups are encouraged. However, don't plagiarize math or code as all assignments are manually inspected. ChatGPT won't be much help as the assignments are all fairly bespoke.
    f. You are automatically granted a one week grace period on all homework. You can submit assignments up to one week late without penalty. *NOTE: No additional extensions will be granted after submission closes and answers are posted on D2L.*
    g. Homework assignments will be submitted digitally via D2L.

2) Participation in Class and Paper Discussions (25% of total grade)
    a. We will discuss some of the assigned readings in class. Students are expected to have read the papers prior to the class discussions and be prepared to present the figures.
    b. To encourage lively discussions, I will use a random number generator to call on students to present figures during class.
    c. I will provide you with instructions on how to read and critically think about scientific research papers and what you might be expected to cover in class.
3) Final Project (15% of total grade)
    a. The details of the final project will be discussed in class Monday March 25th.
    b. It is due on April 9th, the last day of instruction.
    c. The project is a large coding assignment that brings together everything you learn during the term. Think of it like a deluxe homework.

Once approved by the course instructor, and at their discretion, alternative arrangements for missed assessments may be considered https://www.ucalgary.ca/pubs/calendar/current/g-1-2.html.Students may be asked for documentation https://www.ucalgary.ca/pubs/calendar/current/m-1.html.

University of Calgary Academic Integrity Policy
Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity.
Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional code of conduct and promote academic integrity in upholding the University of Calgary's reputation of excellence. It is your responsibility to ensure that you have read and are familiar with the student academic misconduct policy: https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Academic-Misconduct-Policy.pdf.

Department of Psychology Criteria for Letter Grades
Psychology course instructors use the following criteria when assigning letter grades:
A+ grade: *Exceptional Performance.* An A+ grade indicates near perfect performance on multiple choice and short answer exams. For research papers/essays/course projects/presentations, an A+ grade is awarded for exceptional work deserving of special recognition and is therefore not a common grade.

A, A- Range: *Excellent Performance.* Superior understanding of course material. Written work is very strong in terms of critical and original thinking, content, organization, and the expression of ideas, and demonstrates student's thorough knowledge of subject matter.

B Range: *Good Performance.* Above average understanding of course material. Written work shows evidence of critical thinking and attention to organization and editing but could be improved in form and/or content.

C Range: *Satisfactory Performance.* Adequate understanding of course material. Knowledge of basic concepts and terminology is demonstrated. Written work is satisfactory and meets essential

requirements but could be improved significantly in form and content. Note: All prerequisites for courses offered by the Faculty of Arts must be met with a minimum grade of C-.

D range: *Marginally meets standards.* Minimal understanding of subject matter. Written work is marginally acceptable and meets basic requirements but requires substantial improvements in form and content. Student has not mastered course material at a level sufficient for advancement into more senior courses in the same or related subjects.

F grade: *Course standards not met.* Inadequate understanding of subject matter. Written work does not meet basic requirements. Student has not demonstrated knowledge of course material at a level sufficient for course credit.

Grading Scale

A+	96-100%	B+	80-84%	C+	67-71%	D+	54-58%
A	90-95%	B	76-79%	C	63-66%	D	50-53%
A-	85-89%	B-	72-75%	C-	59-62%	F	0-49%

It is at the instructor's discretion to round off either upward or downward to determine a final grade when the average of term work and final examinations is between two letter grades. To determine final letter grades, final percentage grades will be rounded up or down to the nearest whole percentage (e.g., 89.5% will be rounded up to 90% = A but 89.4% will be rounded down to 89% = A-).

Tentative Lecture Schedule

Date	Topic/Activity/Readings/Due Date
M Jan 8	What is Computational Neuroscience?
W Jan 10	**Module I: Coding, Data Analysis, and Simulation Bootcamp** *Topics covered in this module:* • Using MATLAB • Computational Problem Solving • Data Preprocessing • Probability Distributions and Random Sampling • Simulating Neurons and Networks • Visualizing Data *Readings for this module:* • *Vision by David Marr Chapter 1* • *MATLAB Help Menu* • *Wang et al. 2020*
F Jan 12	Module I: Coding, Data Analysis, and Simulation Bootcamp
M Jan 15	Module I: Coding, Data Analysis, and Simulation Bootcamp
W Jan 17	Module I: Coding, Data Analysis, and Simulation Bootcamp
R Jan 18	*Last day to drop a class without a penalty*
F Jan 19	Module I: Coding, Data Analysis, and Simulation Bootcamp *Last day to add or swap a course*

M Jan 22	Module I: Coding, Data Analysis, and Simulation Bootcamp ***Homework #1 Due***
W Jan 24	Module I: Coding, Data Analysis, and Simulation Bootcamp
F Jan 26	Module I: Coding, Data Analysis, and Simulation Bootcamp *Fee payment deadline for Winter Term full and half courses*.
M Jan 29	**Module II: Sensory Processing** *Topics covered in this module:* • Primate Visual Hierarchy • Feature Encoding and Maximum Likelihood • Color Vision • Bayesian Priors • Real vs. Artificial Neural Networks • Object Recognition *Readings for this module:* • *Yamins, et al. 2014* • *Hansen et al. 2005* • *Wallisch 2015* ***Homework #2 Due***
W Jan 31	Module II: Sensory Processing
F Feb 2	Module II: Sensory Processing
M Feb 5	Module II: Sensory Processing ***Homework #3 Due***
W Feb 7	Module II: Sensory Processing
F Feb 9	Module II: Sensory Processing
M Feb 12	Module II: Sensory Processing ***Homework #4 Due***
W Feb 14	Module II: Sensory Processing
F Feb 16	Module II: Sensory Processing
Feb 18-24	Term Break, no classes
M Feb 26	Module II: Sensory Processing ***Homework #5 Due***
W Feb 28	Module II: Sensory Processing
F Mar 1	Module II: Sensory Processing
M Mar 4	**Module III: Perception** *Topics covered in this module:* • Signal Detection Theory • Perceptual Decision Making • ROC Analysis • Brain Stimulation • Choice Probability • Attention and Cognition • Drift Diffusion Models

	• Perceptual Learning *Readings for this module:* • *Luo and Maunsell 2015* • *Salzman, Britten, and Newsome 1990* • *Cohen and Newsome 2008* ***Homework #6 Due***
W Mar 6	Module III: Perception
F Mar 8	Module III: Perception
M Mar 11	Module III: Perception ***Homework #7 Due***
W Mar 13	Module III: Perception
F Mar 15	Module III: Perception
M Mar 18	Module III: Perception ***Homework #8 Due***
W Mar 20	Module III: Perception
F Mar 22	Module III: Perception
M Mar 25	Final Project Q&A ***Homework #9 Due***
W Mar 27	Module III: Perception
F Mar 29	UNIVERSITY CLOSED
M Apr 1	UNIVERSITY CLOSED
W Apr 3	Module III: Perception
F Apr 5	Work on Project
M Apr 8	Course Wrap Up Discussion
T Apr 9	***Final Project Due*** Winter Term Lectures End. *Last day to withdraw with permission from Winter Term half courses.*
Apr 12-23	*Winter Final Exam Period*

Extra Research Participation Course Credit is Not Offered for this Course

Seating During Exams

There are no exams in this course (you're welcome).

Absence From Test/Exam

See above (you're still welcome).

Travel During Exams

See above.

Reappraisal of Graded Term Work http://www.ucalgary.ca/pubs/calendar/current/i-2.html

Reappraisal of Final Grade http://www.ucalgary.ca/pubs/calendar/current/i-3.html

Academic Accommodations

Students seeking an accommodation based on disability or medical concerns should contact Student Accessibility Services; SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/. Students who require an accommodation in relation to their coursework based on a protected ground other than disability should communicate this need in writing to their Instructor. The full policy on Student Accommodations is available at https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf.

Academic Misconduct

For information on academic misconduct and its consequences, please see the University of Calgary Calendar at http://www.ucalgary.ca/pubs/calendar/current/k.html

Instructor Intellectual Property

Course materials created by professor(s) (including course outlines, presentations and posted notes, labs, case studies, assignments, and exams) remain the intellectual property of the professor(s). These materials may NOT be reproduced, redistributed, or copied without the explicit consent of the professor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing of extracts of these course materials with other students enrolled in the course at the same time may be allowed under fair dealing.

Copyright Legislation

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (https://library.ucalgary.ca/services/copyright?_gl=1*bcjlpn*_ga*OTY1ODc0Njg0LjE2NjkxNTA1NTM.*_ga_X4GN9Y4W7D*MTY3Nzc5MjM3Ni4xNy4xLjE2Nzc3OTI4MDYuMC4wLjA) and requirements of the copyright act (https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html) to ensure they are aware of the consequences of unauthorized sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy.

Freedom of Information and Protection of Privacy

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary

Student Support and Resources

https://www.ucalgary.ca/registrar/registration/course-outlines

Important Dates

The last day to drop this course with no "W" notation and **still receive a tuition fee refund** is **Thursday, January 18th, 2024**. Last day add/swap a course is **Friday, January 19th, 2024**. The last day to withdraw from this course is **Tuesday, April 9th, 2024**.