

Introduction to Computational Neuroscience

Winter Term 2022
Course Syllabus

Place and time: DeGrandpre Auditorium, MNI, Wednesdays 13:00-16:00
Coordinator: Christopher Pack
Neurology & Neurosurgery
Email: christopher.pack@mcgill.ca
Office hours: by appointment

Instructors: Curtis Baker, Maurice Chacron, Paul Cisek, Erik Cook, Daniel Guitton, Suresh Krishna, Bratislav Mistic, Christopher Pack, Adrien Peyrache, Jesper Sjöström

Teaching Assistant: Yavar Korkian

OBJECTIVES: This course will present an introduction to computational neuroscience. Levels of analysis will span the range from dendrites and synapses to networks of neurons, with a particular focus on single-neuron models of sensory processing and motor control. Students will learn how to model the relationship between sensory stimuli and neuron activity, and between neuronal activity and behavior. These models will be introduced by the instructor in each lecture, and students will simulate the models during in-class programming labs. Basic mathematical concepts will be presented during tutorial sessions, and more advanced concepts will be covered during lectures.

ORGANIZATION: Each class will last three hours. The first part will be a formal lecture introducing an experimental observation along with a modeling framework. During the second part of the class, students will develop and/or modify Matlab code to perform simulations of the model under discussion. The last class will be devoted to presentation of students' final projects.

TEXT: *Theoretical Neuroscience* by P. Dayan and L. Abbott (MIT Press, 2001).

PREREQUISITES: Calculus, Linear Algebra, Differential Equations.
Some helpful material in the "Pre-reqs refresher" section here:
<https://compneuro.neuromatch.io/tutorials/intro.html>

GRADING: 50% weekly homework assignments, 50% final project.

DATE	THEME	INFORMATION
5 Jan 2022	Dr. Erik Cook: <i>Model Neurons:</i>	Reading: Chapter 5 of D & A

	<i>Neuroelectronics</i>	
12 Jan 2022	Dr. Maurice Chacron: <i>Neural Encoding</i>	Reading: Chapter 1 of D & A
19 Jan 2022	Dr. Suresh Krishna: <i>Auditory coding</i>	Reading: Hawkins chapter
26 Jan 2022	Dr. Chris Pack: <i>Visual coding</i>	Reading: Chapter 2 of D & A
2 Feb 2022	Dr. Curtis Baker: <i>Supervised Learning</i>	Reading: MacKay Chapters
9 Feb 2022	Dr. Jesper Sjöström: <i>Unsupervised Learning</i>	Reading: Song and Abbott (2001)
16 Feb 2022	Dr. Adrien Peyrache <i>Network mechanisms for learning and memory</i>	Reading: Wilson & McNaughton (1994)
23 Feb 2022	Dr. Adrien Peyrache <i>The geometry of neuronal population activity in vivo</i>	Reading: Chaudhuri et al. (2019)
2 Mar 2022	NO CLASS – study week	
9 Mar 2022	Dr. Dan Guitton <i>Models of the Oculomotor Plant</i>	Reading: Robinson (1964) <u>Term paper proposals due</u>
16 Mar 2022	Dr. Erik Cook <i>Neural decoding</i>	Reading: Chapter 3 of D & A
23 Mar 2022	Dr. Paul Cisek: <i>Models of decision-making</i>	Reading: Rushworth et al. (2012), Gold & Shadlen (2007)
30 Mar 2022	Dr. Bratislav Mišić <i>Network neuroscience</i>	Reading: Betzel and Bassett (2017)
6 Apr 2022	Student presentations	

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In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.