Introduction to Computational Neuroscience

Winter Term 2021
Course Syllabus

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

Instructors: Curtis Baker, Stefanie Blain-Moraes, Maurice Chacron, Paul Cisek, Erik Cook, Daniel Guitton, Bratislav Misic, Christopher Pack, Adrien Peyrache, Jesper Sjöström

Teaching Assistant: Nardin Nakhla (nardin.nakhla@mail.mcgill.ca)

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.

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

DATE	THEME	INFORMATION
6 Jan 2021	Dr. Erik Cook: *Model Neurons: Neuroelectronics*	**Reading:** Chapter 5 of D & A

13 Jan 2021	Dr. Maurice Chacron: *Neural Encoding*	**Reading:** Chapter 1 of D & A
20 Jan 2021	Erik Cook: *Neural Decoding*	**Reading:** Chapter 3 of D & A
27 Jan 2021	Dr. Chris Pack: *Reverse Correlation and Visual Receptive Fields* Dr.	**Reading:** Chapter 2 of D & A
3 Feb 2021	Dr. Curtis Baker: *Supervised Learning*	**Reading:** MacKay Chapters
10 Feb 2021	Dr. Jesper Sjöström: *Unsupervised Learning*	**Reading:** Song and Abbott (2001)
17 Feb 2021	Dr. Dan Guitton *Models of the Oculomotor Plant*	**Reading:** Robinson (1964)
24 Feb 2021	Dr. Paul Cisek: *Models of decision-making*	**Reading:** Rushworth et al. (2012), Gold & Shadlen (2007)
3 Mar 2021	NO CLASS – study week	
10 Mar 2021	Dr. Bratislav Mišić *Network neuroscience*	**Reading:** Betzel and Bassett (2017) ***Term paper proposals due***
17 Mar 2021	Dr. Stefanie Blain-Moraes *States of consciousness*	**Reading:**
24 Mar 2021	Dr. Adrien Peyrache *The geometry of neuronal population activity in vivo*	**Reading:**
31 Mar 2021	Dr. Adrien Peyrache *Network mechanisms for learning and memory*	**Reading:**
7 Apr 2021	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.