Fall 2020

PSY 403C/503C

Introduction to Computational Neuroscience: Neural Simulations

Jean-Marc Fellous Instructor
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Class website: http://amygdala.psychdept.arizona.edu/CompNeuro/
Time/Place: Thursdays, 1pm-4pm. Partly on Zoom, Partly in Psychology 321

Course Goals

Current neurophysiological techniques allow for the collection of very large amount of data. This data collection is however limited to only a few neurons at a time, or a few trials per neurons, and require labor-intensive experimental paradigms that are focused on very specific hypotheses. Computational neuroscience offers new tools to quickly formulate and test hypotheses about the neural mechanisms underlying behavior. This course will cover the basic simulation techniques available to biophysical modeling, using the NEURON simulator. The first part of the class will be devoted to single and multiple compartmental models, intrinsic neuron properties and dendritic integration. The second part of the class will focus on synaptic transmission and networks of biophysical neurons. Modeling papers will be discussed and evaluated for their explanatory and predictive potentials. Knowledge of a programming language (such as Matlab) and basic introductory Neuroscience is required. See Website for self-assessment of computational abilities. The class is hands on and a laptop computer is required. See website for **updated information**.

Texts: Papers distributed in class. Suggested support textbooks (not mandatory):

* Methods in Neuronal Modeling (Koch and Segev, 2nd Ed)
* Biophysics of Computation (Koch)
* Mathematics for Neuroscientists (Gabbiani and Cox)
Theoretical Neuroscience (Dayan and Abbott)
Spiking Neuron Models (Gerstner and Kistler)
Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting (Izhikevich)
Fundamentals of Computational Neuroscience (Trappenberg, 2nd Ed)
Introductory course in Computational Neuroscience (Miller)
[Spikes: Exploring the Neural Code (Rieke et al)]

Neuroscience, 6th edition (Purves et al.)
Foundations of Cellular Neurophysiology (Johnson and Wu)
Ionic Channels of Excitable Membranes (Hille)

Numerical Recipes in C (Press, et. al.)
Matlab for Neuroscientists (Wallisch et al, 2nd Ed)

Grading Policy:

There will be 1 midterm exam, 1 final and homeworks. Homeworks (indicated by **HW** below) will be given bi-weekly on average. Few quizzes will be for extra credits and will be given randomly during the semester. The final is comprehensive. Midterm and final exams cover assigned readings and lecture material. The final grade will be assigned as follows:

Undergraduate grading scale (403c):

- Final	**30 %**
- Midterm	**20 %**
- Homeworks + class participation	**50%**

Graduate grading scale (503c):

- Final	**30 %**
- Midterm	**20 %**
- Homeworks + class participation	**20%**
- Final project	**30%**

Syllabus Outline (subject to changes)

Week1	Introduction to modeling: The different kinds of models.
Week2	Basic Neuroscience.

Part I: Simulations of single neurons

Week3	Introduction to the NEURON simulator.
Week4	Models of individual currents: activation, inactivation. **HW1.**
Week5	The currents flora and their functional significance.
Week6	Multiple channels and calcium dynamics. **HW2.**
Week7	Morphology and passive dendritic integration.
Week8	**Midterm** and active dendritic computations.

Part II: Simulations of neural networks

Week9	Kinetics models of synaptic transmission. The receptor flora. **HW3.**
Week10	Stochastic synapses, short-term synaptic dynamics and synaptic noise.
Week11	Small networks: central pattern generators. **HW4.**
Week12	Large networks: information transfer and neural coding.
Week13	Simplified models of neurons and networks. **HW5.**
Week14	Projects Presentations and **Final.**

Administrative Maters

- Mask policy: Masks and physical distancing are required when attending the class in person. Please follow the University policies: https://covid19.arizona.edu/face-coverings. If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel. Notify the instructor if you will be missing an in person or online class. Campus Health is testing for COVID-19. Please call (520) 621-9202 before you visit in person. Visit the UArizona COVID-19 page for regular updates.
- Do let the instructor know about any technological barrier or difficulty you may have in attending the course. Please see: https://student.it.arizona.edu/resources and https://it.arizona.edu/service/uawifi for available university help.
- Attendance records will not be collected but regular attendance is considered essential for satisfactory understanding of the material. Please note that the class will not be recorded due to the use of copyrighted materials. All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion. Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. Make up exams will only be allowed in cases of well-documented emergencies, with approval of instructors. Make up exams will be modified from the original and given as close to the exam date as possible.

- Students are expected to adhere to the Code of Academic Integrity. Read the full Code at: http://deanofstudents.arizona.edu/codeofacademicintegrity. Read the full Student Code of Conduct at: http://deanofstudents.arizona.edu/policiesandcodes/studentcodeofconduct.
- Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor. Any changes to the syllabus will be announced in class and posted on the class website.