New course, Fall 2023

Models of the mind: A laboratory course in computational neuroscience

This class is a hands-on introduction to several kinds of computational models used in the cognitive and neural sciences. In science, computational models are tools we use to test and refine theories. No programming background is required. Students will learn programming basics so that they can work with already-implemented models (and students can choose to do more advanced challenges). The modeling and programming we cover could help prepare students for advanced studies in various disciplines, and/or a foundation for delving more deeply into machine learning or data science. Students should bring a laptop to class each week.

This course is open to **graduate** and **undergraduate** students. Grad students and honors students will be expected to do slightly more intensive exercises. For modeling sections, we'll start with a programming 'notebook' that is already set up to do a basic simulation. The basic homework will require exploring the simulation and writing a lab report. Grad students and honors students will do "challenge" extensions of the homeworks.

Modeling topics:

- **Computational thinking**: *the utility of modeling to guide theory development*
- **Verbal & Mathematical models:** *quantifying theoretical predictions*
- **Network science / graph theory:** *quantifying connected systems*
- **Agent-based models:** *exploring how complexity emerges from interactions among simple elements following simple rules*
- **Neural network models:** *from fundamentals to demystifying current advances in deep learning*

Course Objectives:

By the end of the course, students will be able to:

- Describe the role of theories in the scientific method generally, via deeper understanding of how theories are developed in the cognitive and neural sciences
- Describe how computational models can be used as theory- refining tools
- Distinguish between theoretical models and application models
- Link biological data (behavior in particular) to models
- Determine whether the relation between a model and biological data suggests whether the model is falsified, the model needs to be refined, or the model is consistent with available data
- Use Jupyter notebooks to conduct and analyze simulations with a variety of computational models (note that you will not be graded directly on programming, but you will have the opportunity to develop basic programming skills if you choose to do so)

No programming background is assumed, but students without background will need to do additional readings.

Currently scheduled for Fridays, 9-12, but could possibly be shifted to fit students' schedules.