Biology 4/510: Analysis of Neural Data

Spring, 2021
University of Oregon, Dept. of Biology

Summary
This course will focus on developing basic tools and techniques from probability and statistics that are useful in data analysis, applying these techniques to the analysis of data from publicly available neuroscience datasets.

Instructor
James Murray
Office hours: 3:30-4:30pm, Tue and Wed
Email: jmurray9@uoregon.edu

Time: 2:15-3:35pm, Tue and Thu

Place: Due to the pandemic, this course will be taught remotely and synchronously. See the course’s Canvas page for a Zoom link.

Prerequisites
• Coding. The homework assignments for this course will be done in Python. While previous experience with coding in Python will make this course easier, it is not strictly necessary. Students who are new to coding in Python should plan to invest some extra hours of work during the early weeks of this course. Links to introductory tutorials online will be provided.
• Math. No prior background in probability or statistics is assumed. Though we will try to keep the amount of assumed background as minimal as possible, the course will make some use of calculus and vector algebra, so students should have at least some familiarity with these.
• Neuroscience. It will be assumed that students have taken a course in neuroscience previously and are familiar with basic facts about neural circuits, e.g. what spikes and firing rates are. It is recommended that students who don’t have any neuroscience background but are eager to learn about it should discuss their situation and possible additional reading materials with the instructor during the first week of class.

Textbook
Analysis of Neural Data by R. Kass, U. Eden, and E. Brown. The UO library provides free access to a PDF version of the book. There are also a limited number of copies available at the campus bookstore.

In addition to the main textbook, additional tutorials and resources on Python, mathematical background, and neuroscience background will be posted on the course’s Canvas page.

Evaluation
• Homework (60%). Homework assignments are the most important component of this course and will consist primarily of writing code in the form of Python notebooks to analyze publicly available neuroscience data. Homework assignments will also feature some short
mathematical exercises on topics that are covered during the lectures and in the reading. Grading may be based on a randomly selected subset of the assigned exercises.

- **Final project (40%).** Small groups of students will perform a novel analysis on a publicly available dataset, write a short report (3-5 pages) on the results, and prepare a 10-minute presentation on their findings to present to the class. As part of this project, students will also read and summarize the research paper in which the data originally appeared.

**Material**
This course will cover the following topics, with each topic taking 1-3 weeks:

- **Numerical computing with Python.** Interactive coding sessions will introduce students to the basics of Python
- **Probability and random variables.** Basic concepts in probability for random variables and random vectors, important probability distributions
- **Estimation and uncertainty.** Maximum likelihood estimation, confidence intervals
- **Models, hypotheses, and statistical significance.** Testing null hypotheses, assessing statistical significance, likelihood ratio tests
- **Linear regression and logistic regression.** Single- and multivariable regression and classification, correlation and causation
- **Dimensionality reduction.** Principal components analysis, factor analysis, nonlinear methods

**Policies**
- I am happy to refer to students by their preferred names and pronouns if these differ from those listed in the UO records. Please let me know in person or by email if you have a request that you would like me to accommodate.
- Students who may need accommodation for a disability are encouraged to speak to me about it early in the term.
- Students are welcome and encouraged to discuss the homework assignments and final projects with one another, but the submitted solutions should be the work of the individual student. Under no circumstances should a student directly copy the work of another student into his/her own homework solution. Any violations of the University’s guidelines on academic integrity will be taken very seriously and may result in a failing grade for the course. These guidelines may be found here: [https://policies.uoregon.edu/vol-3-administration-student-affairs/ch-1-conduct/student-conduct-code](https://policies.uoregon.edu/vol-3-administration-student-affairs/ch-1-conduct/student-conduct-code)