BIOE 548 & ELEC 483/548 Syllabus - Fall 2022

This syllabus is a living document which is subject to change and serves as a guideline.

This course covers advanced statistical signal processing and machine learning approaches for modern neuroscience data (primarily many-channel spike trains). Topics include latent variable models, point processes, Bayesian inference, dimensionality reduction, dynamical systems, and spectral analysis. Neuroscience applications include modeling neural firing rates, spike sorting, decoding, characterization of neural systems, and field potential analysis.

Instructor: Shayok "Shay" Dutta

Graders/TAs: Della Luo, Kayla Volkt

Location: BRC286

Time: Tuesdays/Thursdays 10:50 AM - 12:05 PM

Prerequisites:

- Probability (ELEC 303 or equivalent),
- Linear algebra (Math 355 or equivalent),
- Python will be used for many of the homework assignments so some familiarity with scientific programming is critical.
- **New since 2021/Recommended** ELEC 478 - Intro to Machine Learning - or equivalent. (key topics: Classifiers, Clustering, Dimensionality Reduction)

Objective:

Students should learn the fundamentals of how the activity of neurons represents information within in the brain, how this activity can be monitored experi-

mentally, and how to decode underlying information from the resulting neural data.

Outcome:

Students completing the course should be able to:

- Students are comfortable with neural data in many different forms, including "spikes" measured intracellularly, extracellularly, optically, and LFP/EEG.
- Students are comfortable building generative models that describe neural activity either from first principles or using experimental data.
- Students are comfortable using generative models to optimally decode underlying information from neural activity.

Grading:

Class grade will be based on homework assignments and the final project. You are welcome and encouraged to work on homework in groups. We, the course staff, will try to operate within a self-justified grading framework with feedback and discussion to fascilitate & promote learning over instructor/grader/TA evaluation. Students enrolled in 483 may work on their final projects in groups, but students enrolled in 548 are expected to work on them independently. Details regarding grading philosophy and the final project will be provided during lectures as well as with assignments. **NOTE: The grading may be updated over the course of the semester.**

- 6-8 ~bi-weekly homework assignments (70%)
- final project (30%) (students enrolled in 483 may do final project as a team)

~Bi-Weekly Schedule

1. Introduction
2. Fundamental Neurobiology
3. Modeling spike trains
4. Point processes
5. Classification
6. Clustering / Mixture models
7. Continuous Decoding
8. Spectral Analysis

Special Requirements

If you have a documented disability that may affect academic performance, you should: 1) make sure this documentation is on file with Disability Resource Center (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) meet with the instructor(s) to discuss your accommodation needs.

Honor Code

Standard Rice Honor Code guidelines are implemented and expected to be adhered to strictly. Examples of what is permissible in terms of collaboration will be detailed in lecture.