Carnegie Mellon University
Course Syllabus
Neural Data Analysis
42-699B / 86-595 (9 units)
Tu/Th 12:00-1:20, MI 355

Instructor
Steven Chase
Mellon Institute 115N
schase@cmu.edu
(412) 268-5512
Office Hours: TBD

Teaching Assistant
Pete Lund
Hamerschlag Hall B200
pjlund@andrew.cmu.edu
Office Hours: TBD

Course Description

The vast majority of behaviorally relevant information is transmitted through the brain by neurons as trains of actions potentials. How can we understand the information being transmitted? This class will cover the basic engineering and statistical tools in common use for analyzing neural spike train data, with an emphasis on hands-on application. Topics will include neural spike train statistics, estimation theory (MLE, MAP), signal detection theory (d-prime, ROC analysis), information theory (entropy, mutual information, neural coding theories, spike-distance metrics), discrete classification (naïve Bayes), continuous decoding (PVA, OLE, Kalman), and white-noise analysis. Each topic covered will be linked back to the central ideas from undergraduate probability, and each assignment will involve actual analysis of neural data, either real or simulated, using Matlab. This class is meant for upper-level undergrads or beginning graduate students, and is geared to the engineer who wants to learn the neurophysiologist's toolbox and the neurophysiologist who wants to learn new tools.

Course Objectives

At the end of this class, you should (1) be able to explain the operation and conceptual underpinnings of a range of statistical signal processing tools, (2) derive their theoretical properties from first principles, and (3) be able to appropriately select and apply those tools to real and simulated neural data to gain insight into how the brain represents and processes information.

Course communication

We will be relying heavily on blackboard to communicate material to you (homework sets, data sets, etc.) Go to http://www.cmu.edu/blackboard to access. Pitt students: the TA will get you access.

Course requirements and evaluation

The homework will be a mix of problem set and Matlab simulation/data analysis assignment. The goal is for you to take the theory learned in class and apply it to real or simulated data. These assignments will be fairly in-depth, so start early! You may work with others, but the write-up, coding, and analysis should be your own. *If you don't have access to MATLAB, talk to the TA – we can get you access.* Assignments must be turned in **at the beginning of class on the day it is due.**

In addition to the homework, there will be a midterm, a final, and one extra in-class quiz on Probability. Grading will be determined as follows: Homeworks: 40%, Probability Quiz: 15%, Midterm: 20%, Final: 20%, and Class participation: 5%. I do not grade on a curve.

Late policy: Each student is allowed two late assignments during the semester (up to 24 hours after the deadline). Problem sets turned in outside of this grace period will receive zero credit. Note that this does not apply to quizzes, midterms, or final exams.

Readings

There is no assigned textbook for the class. Instead, the readings will be a series of handouts available through blackboard, typically a week before the date listed on the calendar. Useful texts for the materials we will cover:

Basic neuroscience:	Kendel, Schwartz, and Jessel: Principles of neural science.
Information theory:	Cover and Thomas: Elements of information theory.
	MacKay: Information theory, inference, and learning algorithms.
Probability:	Ross: A first course in probability.
Signal detection theory:	Green and Swets: Signal detection theory and psychophysics.
Matlab programming:	Wallisch et al.: MATLAB for Neuroscientists.

Calendar (Tentative!) Exams on days in red. No class on days in blue.

28-Aug *Introduction*	**30-Aug** *Anatomy of a neuron*
4-Sep *Probability I*	**6-Sep** *Probability II*
11-Sep *Probability III*	**13-Sep** *Signals to spikes*
18-Sep *Infomation Theory I*	**20-Sep** *Infomation Theory II*
25-Sep *Probability Quiz*	**27-Sep** *Infomation Theory III*
2-Oct *Information Theory IV*	**4-Oct** *Estimation/Classification I*
9-Oct *Estimation/Classification II*	**11-Oct** *Estimation/Classification III*
16-Oct *No class (SfN)*	**18-Oct** *White noise analysis*
23-Oct *Review*	**25-Oct** *Midterm*
30-Oct *Regression I*	**1-Nov** *Regression II*
6-Nov *Signal Det Theory I*	**8-Nov** *Signal Det Theory II*
13-Nov *Signal Det Theory III*	**15-Nov** *Continuous Decoding I*
20-Nov *Continuous Decoding II*	**22-Nov** *No Class (Thanksgiving)*
27-Nov *Continuous Decoding III*	**29-Nov**
4-Dec *Review*	**6-Dec** *Final*
11-Dec	**13-Dec**