NEU 466M – Quantitative Methods in Neuroscience
The University of Texas at Austin
#54892

Spring 2018

Instructor: Thibaud Taillefumier
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Office hours: Tu 12:30p.m.-1:30p.m. and Wed 12:00p.m.-12.30p.m. @ NHB 3.128
Lecture: Tu/Th 11:00 a.m. 12:30 p.m. GDC 6.202
MATLAB lab session: Th 3.30 a.m.-5:00p.m., WEL 2.128

Course content and aims
This course will provide a broad introduction to basic mathematical and computational tools for a quantitative analysis of neural systems. Integrated lectures, MATLAB sessions, and homework sets will introduce techniques and help us learn to apply them. We will cover a range of topics, including neural encoding and decoding, population codes, filtering, correlation, convolution, spike-triggered averaging (reverse correlation), deconvolution, and dimensionality reduction, clustering, and spike-sorting through principal components analysis, as well as some probability and Bayesian inference, as used in neuroscience. The goal is to help develop a level of intuitive and practical comfort with quantitative methods and visualization of complex data.

Prerequisites
Calculus (credit in Mathematics 408D or 408M), and Neuroscience 325 or 325H; or permission of Instructor.

Textbook
None required.

Good reference texts
Dayan, P., and Abbott, L.F. Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems. 1st edition. (MIT Press, 2005).
The book is available on Amazon.com and at the UT Coop bookstore. An electronic version of the book is available @UT Library.

Software
We will use the mathematical programming language MATLAB for in-class demonstrations, computer lab, and homework assignments. MATLAB is commonly used for scientific analysis of data across the physical and biological sciences, including for neuroscience research and laboratory work. The College of Natural Sciences at UT Austin has purchased a campus-wide site license for MATLAB, and in principle it can be installed and run on any UT Austin-owned computer. In addition, you can obtain a free MATLAB license for your own personal computer or laptop using the university-wide MATLAB license. Go to https://www.utexas.edu/its/products/matlab/. Finally, you can access computers with MATLAB pre-installed in the following computer labs. You will need to logon to the computers with your UT EID and password.

PCL (Perry Castaneda Library): 150 seats at entry level, first-come, first- served. Hours can be found here: http://www.lib.utexas.edu/about/hours/pcl.

WEL 2.128: Reserved for our class at the following times: T/Th: 3.30-5pm

Non-MATLAB alternatives: A freeware program called Octave has much (but not all) of the functionality of MATLAB, and uses the same commands and programming environment. An important scientific programming alternative is Python. Python is very versatile and free, but can perhaps be somewhat less easy to use at the beginning, so we will focus on MATLAB. You are encouraged to try various alternatives for exposure and future use, but for uniformity and grading purposes, homework should be submitted in MATLAB (note that code written for Octave and Python can typically be easily ported into Matlab).

Labs/Tutorials

We will have a weekly MATLAB session/tutorial in WEL 2.128 at 3.30-5pm on Thursdays. Attendance is required, but if you already know the material, you are free to bring and work on your class homework.

Grading

There are three components to your grade: problem sets, one midterm exam, and a final project or exam. The breakdown will be as follows: Problem sets 60%, Midterm Exam 20%, Final 20%.
This course will use +/- grading, and grades will be assigned on a curve as needed.

Course-related materials

Course-related materials, such as a copy of this syllabus, handouts, readings, homework assignments, slides, etc., will be posted on the course website: https://mathneuro.cns.utexas.edu/teaching

Homework problem sets

There will be regular (weekly) problem sets, for a total of about 10 (give or take a couple) over the semester. Homework will be distributed Thursdays during class and will be due at the beginning of class the following Thursday. Allow enough time to do the problem sets and begin well in advance: the homework will take about 10 hours each. You are allowed and encouraged to discuss and collaborate on the homework with other students in the class. On every submitted homework, you are required to note the names of those you collaborated/discussed with. After collaborative discussions and derivations, the actual programming and writing out of solutions must be done entirely by yourself. Copying of code will result in a loss of credit for all involved individuals. There will be a 25% deduction if you hand in the assignment one day late and a 50% deduction for two days late. Assignments will not be accepted for grading if they are more than two days late.

Final Project or exam

The final will involve either a project (like a larger, more in-depth homework set), or a sit-down in the final exam period.

Office hours
The TA and I are available during posted office hours or at other times by appointment. The most effective way to request an appointment outside of normal office hours is to suggest several times that work for you. Please get in touch with a message like the one below:

Dear Professor Taillefumier,
I'd like to request a meeting with you outside of regular office hours this week. I'm available anytime Thursday, or on Friday between 9 a.m. – 11 a.m. and 2 p.m. – 4 p.m..
Thank you, Jane Doe

Email policy
Please address all questions related to course material to me or the TA, in class, during one of our office hours, or by arranging a meeting with either of us outside office hours. Such questions are best answered in person, and we will not answer such questions over email. Please reserve email for questions with yes/no answers only, to alert us of any error or ambiguity you encounter on the problem sets, or to request a meeting time if you cannot make the regular office hours. Neither the TA nor I will discuss grading issues over email. According to state law and UT regulations, all grading information must be kept confidential, and email is not a confidential communication medium. If you have concerns about your grade, talk to me or the TA in person.

Religious holidays
A student who misses classes or other required activities, including examinations, for the observance of a religious holiday should inform the instructor as far in advance of the absence as possible, so that arrangements can be made to complete an assignment within a reasonable time after the absence.

Academic honesty
I expect students to behave with integrity. Students found cheating on an exam or assignment will receive a score of zero for that exam or assignment, and may be subject to additional disciplinary action. For more information on the University of Texas scholastic dishonesty policy, see the General Information Catalog.

Students with Disabilities
The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641.

How to succeed in this class
You will succeed in this class if you follow these recommendations:
1. Attend all lectures and computer tutorials/labs. Participate in in-class activities.
2. Don't give up too quickly. This is a problem-solving class, not a memorization class. The only way to successfully solve problems is to keep trying, even if you are not sure anything you do makes sense. Until you have tried ten different approaches, you haven't tried very hard.
3. Don't do your homework at the last minute. It is very common that we cannot solve a problem on one day, but on the next day everything becomes clear. Our brain has worked on the problem in the background and has found a solution. This mechanism will only work if you start early and give your brain time to process the material. Programming problems will involve debugging and testing, which can also take several iterations and time.
4. Come prepared to class. Read up on the covered material in reference books or papers, when relevant.

Lecture Schedule

Week 1: Classes begin. Preliminaries, introduction to Matlab.
Week 2: 1/22-1/26 Homework 1 assigned.
Week 3: 1/29-2/2 Homework 2 assigned.
Week 4: 2/5-2/9 Homework 3 assigned.
Week 5: 2/12-2/16 Homework 4 assigned.
Week 6: 2/19-2/23 Homework 5 assigned.
Week 7: 2/26-3/2 No homework in preparation for midterm
Week 8: 3/5-3/9 Midterm (in-class) and Homework 6 assigned. 3/12-3/17
Spring Break: 3/12-3/16
Week 9: 3/19-3/23 Homework 7 assigned.
Week 10: 3/26-3/30 Homework 8 assigned.
Week 11: 4/2-4/6 Homework 9 assigned.
Week 12: 4/9-4/13 Homework 10 assigned.
Week 13: 4/16-4/20 Homework 11 assigned.
Week 14: 4/23-4/27 No homework in preparation for final
Final: 5-9/12, 14-15/12