Introduction to Neural data analysis
NEURL-UA 302-003

Spring 2018
Prof. Wei Ji Ma

This syllabus is subject to change. Changes will be announced in class and by email.

Description
This course will provide an introduction to data, data visualization, summary statistics, model fitting, hypothesis testing, and neuroscience-specific methods for data analysis. We will pay special attention to the assumptions behind and relations between different techniques. You will also learn the basics of the programming language Python. This course is strongly recommended if you are interested in doing research in neuroscience.

Prerequisites: Introduction to Neural Science and Calculus 1

Instructors
Lecturer: Prof. Wei Ji Ma, wm44@nyu.edu, Meyer 754, 212 992 6530
Teaching assistant: Ella Podvalny, ella.podvalny@nyumc.org

Weekly schedule (exceptions will be announced)

Tue	2 PM	Homework due. No extensions.
Tue	2 – 4 PM	Lecture, Meyer 760
Wed	2 – 4 PM	Recitation, Meyer 760
Fri	4 – 6 PM	Ella's office hours, Health Sciences Library, Medical Science Building, Ground Floor, 550 First Ave

Meet with Wei Ji by appointment

Questions
Wei Ji and Ella will not answer content-related questions by email. Please ask your questions at an office hour or by appointment. Skype/Google Hangout meetings can be arranged.

Materials
- Lecture notes will be provided, but no lecture recordings.
- We will use Wallisch and Nylen, *Neural data science* (Elsevier, 2017) as a reference.
- We will use Python as a programming language.

Grading
The total grade will be calculated as follows:

Best 9 of 12 homework sets	50%
Midterm	20%
Final	20%
Participation	10%

Letter grade
Your numerical grade will be turned into a letter grade according to the following scale: 90-100 A; 87-89 A-; 84-86 B+; 80-83 B; 77-79 B-; 74-76 C+; 70-73 C; 67-69 C-; 64-66 D+; 60-63 D; 57-59 D-; 0-56 F.

Homework

- There will be twelve homework sets. The lowest three homework grades will not be counted. You can drop homework for any reason, but no more than three drops will be allowed.
- Homework is due at 2 PM every Tuesday starting Week 2, through NYU Classes → Assignments. Late homework will not be accepted by the system and will count as 0. No extensions for any reason.
- Submit all homework as a Jupyter notebook, both as the original (.ipynb) and as PDF. The notebook should contain everything: text answers, equations (as LaTeX), and plots. Make sure that all code runs without errors. Name both files with the homework number and your last name, e.g. "HW1_lastname.ipnyb" and "HW1_lastname.pdf".
- If you think your homework has been graded incorrectly, please first talk to Ella. If no resolution is reached, talk to Wei Ji.
- We will not provide answer keys. However, we will discuss any homework problem in recitation upon request.

Policies on collaboration and cheating

- You are expected to work on these homework assignments independently. If you are stuck on a problem: Try your best first – this could mean struggling for hours, but that is often the best way to learn. If you are still stuck, the preferred method is to contact Ella or Wei Ji for help.
- If you ask a classmate for help **after trying hard yourself**, then you must indicate on your homework whom you worked with on what. You will not be penalized for learning with your peers. We ask that you say who you worked with for two reasons: 1) Honesty. 2) We want to know what material is difficult so we can spend more time helping you learn. If you relied on a peer for a challenging question then we want to make sure that you understand the material before test time.
- Under no circumstances should you copy a classmate's answer or code, even if you modify it slightly. **Copying someone else's work is cheating, is easy to detect, and will result in a grade of 0 and potentially further disciplinary measures.**
- If someone asks you for help on the homework: do not give them your answer or code – this is cheating and will yield a grade of 0. First, make sure that the person you are helping has tried their best on the homework. You will only hurt them come exam time if you just handed them the answers all semester. Second, explain how you got started and how you thought about the problem. If you can help someone learn that way, that is impressive.

Participation

- Attendance is mandatory. Your participation grade will be based on attendance, as well as on participation during lecture and recitation.
- To request an excused absence, please email Ella and Wei Ji in advance.

Midterm and final

- Both exams will be take-home. You may use any written and electronic materials (including your own code from before), but of course not consult anyone or communicate with anyone about the exam.
- No early or late exams.

Schedule

Day	What	Due	Topic
Tue Jan 23	Lecture 1		Introductions. Data in neuroscience research. Types of variables: dependent, independent, categorical, discrete, continuous. Univariate, bivariate, multivariate data. Installing Python.
Wed Jan 24	Recitation 1		Basics of Python. Plotting practices.
Part 1: Summarizing data			
Tue Jan 30	Lecture 2	HW 1	Summarizing univariate data: histograms, mode, median, interquartile range, mean, variance, standard deviation, higher moments.
Wed Jan 31	Recitation 2		
Tue Feb 6	Lecture 3	HW 2	Summarizing bivariate data: binning, covariance, correlation, spurious correlations, cross-correlogram.
Wed Feb 7	Recitation 3		
Part 2: Estimators and models			
Tue Feb 13	Lecture 4	HW 3	Populations. Univariate population parameters: proportion, mean, and variance. Bias in estimation. Standard error of the mean.
Wed Feb 14	Recitation 4		
Tue Feb 20	Lecture 5	HW 4	Modeling univariate data: Models. Probability distributions. The Poisson distribution. The Gaussian distribution. Maximum-likelihood estimation.
Wed Feb 21	Recitation 5		
Tue Feb 27	Lecture 6	HW 5	Modeling bivariate data: Linear regression and logistic regression.
Wed Feb 28	Recitation 6		
Tue Mar 6	Lecture 7	HW 6	Modeling bivariate data: Process models and how to fit them. Psychometric curve in perception. Softmax decision model. Tuning curves.
Wed Mar 7	Recitation 7		
Tue Mar 13	**Spring break**	**Midterm**	
Wed Mar 14	**Spring break**		
Part 3: Hypothesis testing			
Tue Mar 20	Lecture 8		Univariate data. One-sample t-test. Significance.
Wed Mar 21	Recitation 8		
Tue Mar 27	Lecture 9	HW 7	Non-parametric tests. Sign test and randomization test. Statistical power.
Wed Mar 28	Recitation 9		
Tue Apr 3	Lecture 10	HW 8	Two-sample tests. Two-sample t-test, two-sample paired t-test, rank-sum test, signed-rank test, and permutation tests.
Wed Apr 4	Recitation 10		
Tue Apr 10	Lecture 11	HW 9	More than two samples: Analysis of variance, Kruskal-Wallis test, permutation F-test
Wed Apr 11	Recitation 11		
Tue Apr 17	Lecture 12	HW 10	Repeated-measures data, multivariate data, two-way ANOVA, significance of a correlation.

Wed Apr 18	Recitation 12		
Tue Apr 24	Lecture 13	HW 11	Cautionary tales: multiple comparisons, false discovery rate, p-hacking, replication crisis.
Wed Apr 25	Recitation 13		
Part 4: Wrapping up			
Tue May 1	Lecture 14	HW 12	Kaleidoscope of advanced methods: time series analysis, power spectrum, clustering, dimensionality reduction.
Wed May 2	Recitation 14		Final review and general discussion
Tue May 8		**Final**	