RM: Computational Methods in Psychology and Neuroscience

Psychology 4215/7215 — Fall 2021

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Quick Reference

Credit: 3 units
Time: Thursday, 14:00 – 16:30
Place: Dell 2, rm. 101
Text: Assigned readings
Course Web Page: GitHub (https://github.com/compmem/compsy)
Course assistants: Adam Fenton (and CompMem lab members)
Instructor: Dr. Per Sederberg
Office: Online
E-mail: pbs5u@virginia.edu
Lab Website: Computational Memory Lab (https://compmem.org)
Office hours: TBA (Online)
Final: Project-based

Overview and Course Objectives

In the late 1800s, Hermann Ebbinghaus and Georg Elias Müller were busy launching the systematic study of human memory. They painstakingly wrote out study lists and and kept track of their own and their participants' memory performance by hand after studying the items. Müller even built a "memory drum" that had stimuli wrapped around a rotating drum that revealed them one at a time at a fixed rate. All analysis and visualization of their results involved tabulating data by hand in notebooks. Nonetheless, through years of dedicated work they were able to lay the foundation for the next century of memory research. Today, we have the help of computers, which have become an indispensable tool in Psychology and Neuroscience. Yet, in these same fields, computers are rarely employed to their full potential, limiting the productivity, reproducibility, and quality of our work.

Science is hard. We need as many tools as possible at our disposal to make our job easier. These days computers play an integral role in our scientific workflow and psychologists typically rely on a limited number of large-scale software packages to assist at each stage of this process (e.g., EPrime, Microsoft Excel, SPSS and, if we're willing to branch out into the land of programming, Matlab or R). This course is designed to break the fetters of commercial, and often inflexible, applications with the power of computer programming. With no assumptions of prior programming experience, we focus on the Python language and specifically on how it can help with *every* stage of our scientific workflow in Psychology and Neuroscience. The goal is that you will gain a better understanding of how a computer works (and can work for you), improve how you solve problems, and optimize and speed up your workflow, but, most importantly, that you will lessen the need to tailor your research questions based on the status quo.

Resources

The main sources for lesson materials at the start of the course are:

- Downey, Allen (2016). Think Python: How to think like a computer scientist (2nd Edition). Needham, MA: Green Tea Press.
  - Free downloadable copy at https://greenteapress.com/wp/think-python-2e/
- Gael Varoquaux, Valentin Haenel, Pierre de Buyl, Gert-Ludwig Ingold, Emmanuelle Gouillart, Michael Hartmann, … João Felipe Santos. (2020, March). scipy-lectures/scipy-lecture-notes: Release 2020.1 (Version 2020.1)
  - https://scipy-lectures.org/index.html

In addition, we will make use of a number of other online resources, including documentation and user manuals for the various Python libraries and packages that you will be learning to use.

Computing Requirements

This is a computational class and all work will be performed on a computer, and almost entirely with the Python programming language within Jupyter notebooks. You will need to bring a laptop running Windows, OSX, or Linux to every class.

You will run the Jupyter notebooks directly on your computer. This will also allow you to incorporate these approaches into your own research more easily. Thus, my recommendation is that you install and use the Anaconda Python distribution for your OS.

We will spend time on the first day of class to ensure everyone has a functioning computer that will be able to run everything necessary for the course.

Assistance

I am eager for you to get as much as possible from this course, so please feel free to come to me with any questions you have. That said, science is a team effort and in order to reduce duplication of questions and discussions, we will be using Slack for all class communication and discussions. Please do not email me unless there is an issue with Slack. We will set up channels for general discussion. If you'd prefer to have a one-on-one discussion it is possible to send direct messages in Slack to either me or the TAs. We will spend some time on the first day ensuring everyone is set up to use Slack. I will also have weekly office hours to which you are always welcome to come and have virtual in-person discussions.

Schedule

The following is the general order of the topics covered in the course. Please note that sometimes we may cover multiple topics in a single lecture, or spend more than one lecture on a single topic, and this list is subject to modification at any time. That said, all major changes will also include an update to the syllabus, so it will remain a point of reference.

0. Intro and Ecosystem setup
1. Python programming
2. Experiment design and implementation
3. Data collection and processing
4. Data visualization
5. Data analysis and statistics
6. Repeat 2 through 5 for various topics: Attention, Perception, Working Memory, Long-term memory, Decision-making
7. Neural data analysis
8. Advanced topics (e.g., machine learning, computational modeling, etc…)

Lectures, in the form of Jupyter Notebooks, will typically be posted the day of class, so you can follow along. Assignments, from smaller exercises to larger projects (see below), will be assigned in class with clear due dates spread throughout the semester.

Evaluation

This is a upper-level course, which means that much of the burden of staying motivated to learn is transferred to the student. As such, there will not be any in-class exams. Students will be evaluated on the basis of:

- Lesson exercises / class participation (30 pts)
- List generation project (10 pts)
- Experiment project (10 pts)
- Experiment labs (30 pts)
- Final project (20 pts)

for a total of 100 points.

Graduate students will have the following additional course requirements:

- Experiment motivation and design document (10 pts)
- Final write-up with results and discussion (20 pts)

for a total of 30 additional points.

The course will be graded using the standard grading scale with your percentage of points earned out of the total possible points rounding to the nearest whole percentage point.