Introduction to Quantified Cognition

Psychology 5332 — Spring 2021

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Quick Reference

Credit: 3 units
Time: Thursday, 14:00 – 16:30
Place: Online
Text: Assigned readings
Course Web Page: Slack / GitHub
Course assistants: None
Instructor: Dr. Per Sederberg
Office: Online
E-mail: pbs5u@virginia.edu
Lab Website: Computational Memory Lab
Office hours: TBD
Final: Project-based

Overview and Course Objectives

Much of science, and especially psychology and neuroscience, involves testing and updating verbal theories, which are often imprecise and under-specified. Only by quantitative modeling of our experimental results can we hope to make significant progress in understanding the mechanisms that underlie cognition. Furthermore, only by quantifying and defining knowledge via mathematical principles can we achieve the effective interdisciplinary communication necessary for combining approaches to make useful progress towards understanding a system as complex as the brain. This course aims to equip students with the skills to a) think more deeply about the mechanisms underlying observed neural and behavioral phenomena, improving scientific thinking, and b) develop computational models that enable more precise, quantifiably testable hypotheses, improving the scientific process.

Topics covered in the course will include: computer programming, probability theory, Bayesian statistics, computational modeling, model comparison, neuroscience methods, neural networks, and open science. Taught at a high level, yet with practical hands-on examples for every topic, this course will provide the foundation necessary to understand, develop, and compare mechanistic models of cognitive processes.

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.

There are some online tools that provide free hosting and execution for Jupyter notebooks (e.g., Google Collaboratory). These hosting services limit the computational resources, so you may want to run 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 either via Google Collaboratory or locally.

Online Course Expectations

This course will be taking place entirely online with "synchronous" classes on Zoom. As much as possible, I hope we can make this feel like we are all in this together, meeting in the same room. As such, these are the primary guidelines and expectations for our Zoom meetings:

- You should keep your video on unless a transient issue arises (e.g., there is something seriously distracting going on in the room.)
- You can, however, keep your microphone muted when not talking.
- Feel free to ask questions anytime! It's often hard for me to see everyone, so interjecting by voice is perfectly fine (i.e., you don't need to use the hand-raising feature in the Zoom chat.)
- We will be recording the lessons, which will be made available *only* to those in the class via UVACollab.

If you have any concerns about any of these policies, please set up a meeting with me and I will do my best to accommodate your needs.

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. If you'd prefer to have a one-on-one discussion it is possible to send direct messages in Slack. 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 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. Overview
1. Programming and Principles of Open Science
2. Probability
3. Data as a Random Variable
4. Quantifying Uncertainty
5. Bayesian Regression
6. Bayesian Data Analysis
7. Cognitive Process Models of Decision-making
8. Interactive Model Exploration
9. Bayesian Fits of Process Models
10. Inference with Process Models
11. Models of Memory
12. Models of Reinforcement Learning
13. Bring Your Own Data (BYOD) Project

Readings

There is no textbook for this course, however, there will often be relevant readings that accompany each lesson. PDF versions of these will be shared along with the Jupyter notebooks and lectures for each class.

Evaluation

This is a graduate-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)
- Two mini-projects (15 pts + 15 pts)
- Final project (40 pts)

for a total of 100 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.