PSY 4219 / PSY 6219
Scientific Computing for Psychological and Brain Sciences
Mon/Wed 2:30-3:45pm
Kissam Center C216
Fall 2022

Instructor
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Office Hours
Mon 11-12pm or by appointment

Teaching Assistant
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Office Hours
by appointment

Help Session (Group Office Hours)
Mon 3:50-5:00pm, KC C216 or WH 113

Course Overview

This course is an introduction to scientific computing for psychological and brain sciences. The goal of the course is for students to develop some proficiency in designing, writing, and debugging computer programs to control experiments, perform data analyses, and simulate simple neural and psychological mechanisms. Topics include computer programming methods, algorithms and data structures, graphing and visualization techniques, computational and numerical methods, data science methods, image and signal processing, optimization, simulation methods, and high performance computing.

Prerequisites

For graduate students, although no previous formal coursework in computer programming is required, I will assume that students have familiarity with computer programming and understand basic programming concepts common to many programming language. For undergraduates, an introductory course in programming is required as a prerequisite (CS/DS 1100, CS 1101, 1103, or 1104). I will try to adjust the pace of the course depending on the amount of computer programming and mathematics background students have had. I encourage everyone to let me know if the material is going by too quickly or too slowly. Whether graduate student or undergraduate, no prior experience with Python is required, but it is recommended.

Brightspace

All class materials will be posted on Brightspace (readings, class slides, example code, homework assignments). You will turn homework assignments in on Brightspace. Grades will be posted on Brightspace.

Course Logistics

Students are encouraged to bring laptops to class. But they must only be used for class-related work to avoid distracting others sitting nearby. I will often share example code before class on Brightspace that will be used during class, so I recommend checking Brightspace shortly before class and downloading any code for class onto your laptop.

Weekly Help Session

Jason Chow (course Teaching Assistant) will hold weekly help sessions immediately after class on Mondays. He will try whenever possible to simply stay in our classroom (Kissam Center C216) for that session, but if it is booked he will need to move it to Wilson Hall 113 (which we have reserved). These are group help sessions where people can ask questions and get answers that might benefit others in the course with similar questions. If you need to talk with the instructor or TA individually, you should do so during office hours or by making an appointment.

Course Requirements and Grading

Homework assignments each week will be used throughout the course to allow students the opportunity to put the scientific computing tools into practice. There will be no exams. Final letter grades will based on percentages as follows:

		A	92.5 – 100%	A-	90.0 – 92.5%
B+	87.5 – 90.0%	B	82.5 – 87.5%	B-	80.0 – 82.5%
C+	77.5 – 80.0%	C	72.5 – 77.5%	C-	70.0 – 72.5%
D+	67.5 – 70.0%	D	62.5 – 67.5%	D-	60.0 – 62.5%
		F	0.0 – 60.0%		

While I encourage students to help each other out with conceptual confusions, individually or via Piazza, all homework assignments must be completed individually. Unexcused late assignments will be penalized 10% for every 24 hours late, starting from the time class ends, for a maximum of two days, after which they will earn a 0.

You will turn in homework assignments using Brightspace (see below). I ask two things: First, that you submit a ***single ZIP file*** rather than multiple files. Second, that you make sure that you send me ***everything*** that's needed for the program to run successfully, which includes not only files you created but copies of any files I might have given you as part of the assignment (unless stated otherwise).

Any student officially auditing the course is expected to attend class and can participate in a way commensurate with the amount of work they do on class assignments.

Graduate Student Requirements

From time-to-time, there will be additional questions required of graduate students (as required by the university for "mezzanine courses" such as this).

Recommended Free Python Textbooks

A Whirlwind Tour of Python by Jake VanderPlas, available as a free ebook at
https://jakevdp.github.io/WhirlwindTourOfPython/

Python Data Science Handbook, also by Jake VanderPlas, available as a free ebook at
https://jakevdp.github.io/PythonDataScienceHandbook/

See class slides for how to access (interactive) Jupyter Notebook versions of both textbooks and run on Google Colab (or locally).

Introduction to Computation and Programming in Python, by John V. Guttag

Python

The Python programming language will be used for all assignments in this course. Python is a high-level computer programming language particularly well suited to scientific computing in psychology and neuroscience. It is free, open software that runs on multiple platforms (Windows, Mac, and Linux). It is highly extensible with thousands of libraries and modules written and shared by scientists from around the world; it also allows easy interface with programs written in languages like C, Fortran, Java, or Matlab.

Details on what version of Python and what Python packages we will be using in this course with details on how to download and install Python and set up environments will be given on slides uploaded to Brightspace and will be discussed in class.

Piazza

We use Piazza to facilitate discussions about assignments, Python coding, Jupyter notebooks, PyCharm, PsychoPy, and Python setup. Rather than emailing questions to the teaching staff, we encourage you to post questions on Piazza. Answers we give on Piazza might help other students with similar questions. We also encourage students to help other students on Piazza – doing so will not only help you learn the material more deeply, but may earn you a bit of extra credit at the end of the semester if you're at the borderline between two final grades. The course site on Piazza is:
piazza.com/vanderbilt/fall2022/psy42196219

Possible Course Topics

Python and Jupyter Notebooks
Numeric and Non-numeric Types
Array, Vector, and Matrix Operations
Matrix Algebra
Python Language Fundamentals
Programming Techniques
Graphing, Plotting, and Visualization
Random Numbers and Monte Carlo Methods
Scientific Computing
Optimization Methods
Simulation Methods
Images and Image Processing
Signals and Signal Processing
Experimental Control Programming
Pandas and Data Science Methods
Web-Based Experiments
High-Performance Computing
Debugging Techniques