

PSYCH 60: Introduction to fMRI data analysis

Spring 2019

INSTRUCTOR

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Office Hours:

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TEACHING ASSISTANT

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SPACE AND TIME

Moore 110

2A Tue/Thurs: 2:25-4:15

X-Hour Wed: 4:35-5:25

COURSE DESCRIPTION AND OBJECTIVES

How can we understand how the brain works? This course provides an introduction to in vivo neuroimaging in humans using functional magnetic resonance imaging (fMRI). The goal of the class is to introduce: (1) how the scanner generates data, (2) how psychological states can be probed in the scanner, and (3) how this data can be processed and analyzed. Students will be expected to collect and analyze brain imaging data using the opensource Python programming language. We will be using several packages such as numpy, matplotlib, nibabel, nilearn, fmripred, and nlttools. This course will be useful for students working in neuroimaging labs, completing a neuroimaging thesis, or interested in pursuing graduate training in fields related to cognitive neuroscience.

GOALS

- 1) Learn the basics of fMRI signals
- 2) Introduce standard data preprocessing techniques
- 3) Introduce the general linear model
- 4) Introduce advanced analysis techniques

TEXTBOOK

Poldrack, R. A., Mumford, J. A., & Nichols, T. E. (2011). *Handbook of functional MRI data analysis*. Cambridge University Press.

ONLINE VIDEOS

Students are encouraged to watch assigned videos freely available online to supplement the classroom experience. Most videos will be available on youtube from the Principles of fMRI Course

ASSIGNMENTS

READINGS Most of the readings will be from the Poldrack (2011) book. We will be supplementing these readings with additional articles and chapters and occasionally online videos. The reading list and electronic PDFs (or links) will be posted on Canvas.

CLASS PARTICIPATION (10% of grade) You will be expected to participate in class discussions each day of class. This might include asking clarifying questions or helping another student.

HOMEWORK (20% of grade) We will have occasional homework assignments based on lab assignments. You will be required to upload your jupyter notebook to the canvas site by midnight the day the homework is due.

ANATOMY FLASH (10% of grade) In each class, a student will present a very brief presentation on one region of the brain. Flash presentations will include how to identify the region anatomically, a quick overview of its function, and a brief example of an interesting imaging study that identified a functional property of the region. Presentations should be developed on google slides and should be between 2-5 minutes.

EXAM (20% of grade) To ensure that students learn key concepts about the principles of fMRI data analysis, we will have one exam with short answer and essay questions.

DATA COLLECTION (10% of grade) We will spend approximately one week of the course collecting data on the 3T Siemens Prisma scanner at the Dartmouth Brain Imaging Center located in the basement of Moore Hall. Students are expected to operate the scanner and participate in the experiment (assuming it is safe for them to be scanned).

ANALYSIS PROJECT (30% of grade) A key component of this course is learning how to process and analyze imaging data. Students will be introduced to key concepts during the laboratory assignments. Students will be expected to apply what they learn to analyzing an fMRI dataset. Most students will likely analyze the data collected in class, but are free to analyze any publicly available dataset (e.g., <https://openfmri.org/>, <https://www.datalad.org/datasets.html>). Students may work in small groups (~2-3 people), but each will independently write a final report of the research. The final written paper should be in journal format using APA style with an abstract, intro, methods, results, discussion, and references. Format 12-20 typed double-space pages, 11pt Ariel or Times font. (bibliography not included in the page limit). Each person is expected to write their own intro and conclusion, but the group can collaborate on the methods and results sections if they want. At the end of the class each group will give a ~10 minute presentation on their project (background, hypothesis, experimental design, results, analyses, conclusions). Paper Due at Midnight on the last day of class.

- Paper: 15%
- Presentation: 10%
- Group participation: 5%

CLASSROOM POLICIES

HONOR CODE Students are expected to strictly adhere to the Dartmouth Academic Honor Principle. As described in the Student Handbook, fundamental to the principle of independent learning is the requirement of honesty and integrity in the performance of academic assignments, both in the classroom and outside. Dartmouth operates on the principle of academic honor. Students who submit work that is not their own or who commit other acts of academic dishonesty will forfeit the opportunity to continue at Dartmouth. If you have questions or concerns regarding this policy during the course, please contact Professor Chang.

PLAGIARISM Writing about scientific publications without just rephrasing is difficult, particularly when not everything is fully understood. Doing this properly takes time and practice, and one goal of the course is to move us in that direction. I don't expect to see a perfect scientific treatment at this stage. But I do want to see evidence of independent thought when considering the material and implications (rather than just regurgitating it), and some degree of creativity. When quoting, be sure appropriate citations are made.

MISSED ASSIGNMENTS A student will only be excused from an assignment by permission of the Instructor and on the basis of a written note from a dean, doctor, or supervisor of official college- sponsored events being held off-campus and requiring a students' absence. If excused, a make-up must be taken as soon as possible (usually within 1 day of the originally-scheduled exam/assignment date).

LATE ASSIGNMENTS All papers and presentations are due at the date and time specified. Scores for late papers will be reduced by 10% for every 24-hour period a paper is late. No extensions will be granted due to computer failure, roommate difficulties, printing problems, etc. According to College policy, there are no excused absences from class for participation in College-sponsored extracurricular activities.

TECHNOLOGY Computers and tablets may be used in class, but use of cell phones will not be permitted (no phone calls, ringers, or texting).

DISABILITIES Any student with a documented disability needing academic adjustments or accommodations is requested to speak with me by the end of the second week of the term. All discussions will remain confidential, although the Academic Skills Center may be consulted to verify the documentation of the disability.

RELIGIOUS OBSERVANCES Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance which conflicts with your participation in the course, please meet with me by the end of the second week of the term to discuss appropriate accommodations.

SCHEDULE (<https://tinyurl.com/dartpsych60>)

Measurement and Signal

Readings: Huettel, ch 7

Homework:

Videos: Principles of fMRI Modules 5-8

MRI Safety

Readings:

Homework:

Videos

Image Processing

Readings: Poldrack ch 1,2

Homework:

Videos: Principles of fMRI Modules 9

Data Preprocessing

Readings: Poldrack ch 3,4

Homework:

Videos: Principles of fMRI Modules 13-14

General Linear Model

Readings: Poldrack ch 5

Homework:

Videos: Principles of fMRI Modules 15-22

Group Analysis

Readings: Poldrack ch 6

Homework:

Videos: Principles of fMRI Modules 23-25

Multiple Comparisons

Readings: Poldrack ch 7

Homework:

Videos: Principles of fMRI Modules 26-29

Connectivity

Readings: Poldrack ch 8

Homework:

Videos:

Prediction/Classification

Readings: Poldrack ch 9

Homework:

Videos:

Representational Similarity Analysis

Readings: Haxby et al., 2014; Kriegeskorte et al., 2008

Homework:

Videos:

Intersubject Synchrony

Readings: Hasson et al., 2011; Nummenmaa et al, 2018

Homework:

Videos: