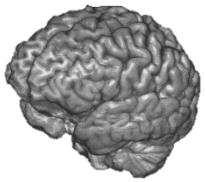
Bio 123L: Human Neuroimaging Lab

Instructor

Dr. Craig Stark
cestark@uci.edu

TA

Jessica Lingad
nochej@uci.edu



Course Overview

Modern neuroimaging tools give us a host of ways that we can peer inside our heads to see what our brains look like, how they change over the course of our lives, and how they function. We can watch as different brain regions engage and form different patterns of activity as we perceive the world, learn information, or solve problems. We can do this all without harm. How? How do these neuroimaging techniques work? How is it that we can use huge magnets to get a 3D picture of your brain or of patterns of neural activity?

Requirements

- Bio Sci 93 and either BioSci 100 or 108
- Satisfactory completion of the Lower-Division Writing requirement
- Access to computer (Mac, Windows, Chromebook, or Linux) and internet connection with the ability to run x2go
- Ability to log into Zoom for class discussion either via computer or phone / tablet app.
- Ability to access the Canvas course page (see Canvas student support for assistance). UCI students are given a UCI gmail account, but it may not be accessible in certain counties. Thus, it is very important you update the Canvas settings and notifications to ensure you receive the important messages and announcements from your professor. Click on "setting" to add another email address and/or a cell phone number to receive notifications. Click on "notification" to configure how you receive Canvas notifications.

Purpose

The goal of this laboratory course is to introduce you to the incredible field of human neuroimaging, with particular emphasis on magnetic resonance imaging (MRI). Through lecture, class discussion, and hands-on data analysis, you will be introduced to how neuroscientists go about using imaging to answer these questions and you will gain skills by conducting hands-on lab exercises with imaging data.

Course Objectives and Goals

By the end of the course, you should have a solid understanding of:

1. What different human imaging techniques are being used in modern neuroscience along with how they can be used to understand brain function and changes in brain function.
2. The fundamentals of how MRI scanning works
3. What different types of MRI scans can tell us about the brain
4. How to perform basic analysis of structural, functional, and diffusion-weighted MRI scans

5. How to design a functional MRI experiment

By the end, you should be able to

1. Use the Linux command line to navigate directories, launch software, etc.
2. Use software like fsleyes to view MRI images, overlay multiple datasets, and make measurements on the images
3. Analyze structural MRI images to extract the brain, segment it into different tissue types, and measure regional volume
4. Register different brain images on top of each other to bring them into alignment using both simple linear and complex non-linear techniques
5. Analyze functional MRI data to measure differences in activity during different cognitive processes
6. Evaluate the effectiveness of different MRI image processing tools or approaches
7. Communicate your results clearly and effectively.

Textbook

Introduction to Neuroimaging Analysis by Mark Jenkinson and Michael Chappell, (Oxford: Oxford University Press), 2018, ISBN: 978-0198816300. Available via the UCI Bookstore on Canvas

COVID Health Guidelines

The university has developed a set of specific health guidelines for instruction during COVID-19. Although we are working remotely on the course, please refer to those guidelines for any questions you may have pertaining to COVID.

Meetings

Given our remote nature this year, we will not be using the full class time for live instruction. Rather than a typical Mon/Wed 9-10:50 class, pre-recorded lectures will be posted up on Canvas ahead of time and you will be able to watch them on your own. During a portion of what would be class time (10-10:50 Pacific), we will have a Zoom meeting. You are expected to attend in this time as we will use it to go over lecture material, address questions from it and go over assignments.

Offline discussions will happen both in Zoom-based office hours and on Piazza (see below), where you are encouraged to not only ask questions, but see if you can help others in answering them too! That's one of the best ways of learning.

Course Format

The course is a mixture of lecture, discussion, and hands-on image analysis. In particular, there are ~~i~~ activities throughout the course that give you hands-on experience in aspects of image analysis. These activities are to be completed during class and have comprehension assessments (in the form of quiz questions) throughout the activity. These are suitable for working either alone or in small groups. In addition, there are larger-scale projects that will have you performing analyses in class and writing up

your findings in the form of 500-750 word lab reports. This writing may extend to work outside of class, but keep in mind these lab projects are to be done on your own and not in a group.

Grading

There are a total of 100 possible points in the class. Each of the 4 full lab reports counts for 20% of your grade. These are to be completed on your own. The activities, including the MR safety exam count are individually graded as pass/fail and then averaged to make up the remaining 20% (each pass counts as 100%, each fail as 50%, each missing activity as 0%). Late assignments will have scores reduced by 20%. Note, that if you're trying to follow your grade in Canvas, it will only be approximate as it can't quite give us this scheme, but it's close. Labs are 20 points, quizzes are typically each 2 points, etc. Contact the TA if you have any questions about your current grade.

Writing

This course serves as partial fulfillment of your writing requirement at UCI. UCI requires that you have 4,000 words worth of writing-intensive coursework and this class will count for half of this requirement with your other required lab work fulfilling the rest. You will receive written feedback in the form of electronic comments on your lab reports and you will have up to 2 weeks to revise the assignment based on the comments to improve your grade (up to a maximum of 80% credit). Prior to your first lab report, we will go over the provided sample lab report and what expectations are for your work. We will also, as a group, go over common issues students encountered on the reports during our meetings. In addition, students are encouraged to make use of UCI's Writing Center for help in improving their writing.

Communication and Netiquette guidelines

We are going to be using Piazza for class discussions (course link). The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to us directly, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com. One of the great things about Piazza is that it can be anonymous. So *ask questions even if you think they're stupid*. Now, keep in mind also that the questions should be related to the course and not about random topics like the airspeed velocity of an unladen sparrow. In all communications, treat other students, the TA and the professor of the course with respect. For guidance, please refer to the UCI Remote Learning Netiquette policy.

Finally, know that other students can be a great resource in answering questions (and you can be a great resource to them). We try to check in on it every day during the quarter, but please don't expect that if you put up a question in the middle of the night on Sunday when an assignment is due on Monday morning that we'll respond (other students have a far higher chance of being online to answer questions then). Think in terms of traditional work / business hours and know that we'll make every effort to respond within one business day. If you have any issues that are not suitable for the public discussion board, use the Canvas message system to email us and we will respond directly to you.

Academic Honor Code

Students are expected to uphold the Academic Honor Code of the University of California, Irvine. The Academic Honor System is based on the premise that each student has the responsibility (1) to uphold the highest standards of academic honesty and integrity in the student's own work, (2) to refuse to tolerate violations of academic integrity in the University community by reporting to the proper personnel, and (3) to foster a high sense of integrity and social responsibility on the part of the University community. Violations of academic integrity are unacceptable and will not be tolerated, because they devalue the teaching and learning experience for the entire community. Observing basic honesty in one's work, words, ideas, and actions is a principle to which all members of the community are required to subscribe. Note, to help enforce this, we will employ software to check the originality of assignments. Further information can be found on the University's website on academic integrity.

Copyright

This course is provided by the University of California, which has policies regarding copyright. Materials used in connection with this course may be subject to copyright protection. Refer to the information provided in each video/file/module/unit for copyright information for each work. The course content related video/file/module/unit was created to be used in compliance with the TEACH Act. 17 U.S.C. §110(2). In particular, Section 102.23 of Policies Applying to Campus Activities, Organizations, and Students states that the following activities constitute grounds for discipline:

Selling, preparing, or distributing for any commercial purpose course lecture notes or video or audio recordings of any course unless authorized by the University in advance and explicitly permitted by the course instructor in writing. The unauthorized sale or commercial distribution of course notes or recordings by a student is a violation of these Policies whether or not it was the student or someone else who prepared the notes or recordings.

Accessibility

The University of California, Irvine, is committed to providing a barrier-free environment for learning and an electronic environment that is accessible to everyone, including individuals with disabilities. If you have a disability and feel you need accommodations in this program or a course, please contact the Disability Services Center (DSC). DSC approved accommodations will be provided for students who present a Faculty Notification Letter from the DSC.

Course Schedule

A: In-class activity
L: Lecture / discussion

Date	Subject	What's due soon
10/5	Have watched the course overview lecture (video) Zoom- Discussion of course structure and content Zoom- Will go over *Imaging techniques, how they work, and what can they tell us?* (also see: slides, video)	10/6: Google Doc test 10/7: Get your x2go working (part 1, part 2, video)

10/7	Have read: Ch 1 and Appendix Have watched: *Basics of brain anatomy* (slides, video) Zoom- Discussion of brain anatomy, help on x2go and Linux	10/9: Brain basics (Canvas quiz) 10/9: Basics of Linux (video, activity, Canvas quiz)
10/12	Have read Ch 2.1-2.2 Have watched *Making images with magnets* (slides, video) Zoom- Discussion on how MRI works, demo of fsleyes	10/14: Viewing images in fsleyes
10/14	Have read 3.1-3.2 Zoom- Go over *Viewing images* activity Zoom- Go over sample artifacts from textbook	10/16: Spot and classify the artifacts (Canvas quiz)
10/19	Have read Ch. 4 Have watched: *Structural MRI – what do we measure?* (slides, video) Zoom- Go over *Structural MRI* lecture Zoom- Setup for *Lab 1: Where's the brain*	10/21: **Lab 1**: Where's the brain? – Evaluating different brain extraction tools
10/21	Zoom- Go over Lab 1 Zoom- Setup for tissue segmentation	10/23: Tissue type segmentation
10/26	Have watched *Shapes, Jacobians, and more advanced structural measures* (slides, video) Zoom- Go over Tissue type segmentation activity Zoom- Go over *Advanced structural* lecture Zoom- Setup for Shape analysis activity	10/28: Shape analysis using FIRST
10/28	Zoom- Go over Shape analysis activity Zoom- Setup for Lab 2 (note: due 11/2)	11/2: **Lab 2**: Subcortical shape changes in aging using FIRST
11/2	Have read Ch 5.1-5.3 Have watched *Image registration and normalization – why and how do we do it?* (slides, video) Zoom- Go over Lab 2 Zoom- Go over *Image registration* and setup Registration activity	11/4: Registration Part 1
11/4	Have read Ch 5.4-5.7 Zoom- Go over Registration 1 and setup Registration 2	11/6: Registration Part 2
11/9	Have watched MRI Safety videos and read manual (Canvas) Zoom- Go over Registration 2 Zoom- MRI safety discussion	11/13: *MRI Safety exam* on Canvas
11/11	**No class** (but look at next Monday and get a start on these)	Get a start on the videos and chapter readings for the next week
11/16	Have read Ch 2.4	Start working on the Single-subject fMRI fluency analysis activity

	Have watched *Basics of fMRI* lecture (vid, slides) and *fMRI: Experimental design lecture* (vid, slides) Zoom- Go over MRI safety exam and both the lectures	
11/18	Have read Ch 3.4 Have watched *Pre-processing* (vid, slides) and *single-subject analysis* (vid, slides) lectures Zoom- Go over those lectures Zoom- Setup the single-subject analysis	11/20: Single-subject fMRI fluency analysis
11/23	Zoom- Go over *Single-subject fMRI fluency* activity Zoom- Setup *Lab 3: Case study in word generation* (formal write-up of activity's results)	
11/25	**No class**	
11/30	Have watched *Group Level Analysis in fMRI* (vid, slides) lecture Zoom- Go over Lab 3 Zoom- Go over *Group Level Analysis in fMRI* lecture and setup activity	11/30: **Lab 3**: Case study in word generation
12/2	Zoom- Help on group analysis activity and lab	12/4: *Group analysis of fMRI* activity
12/7	Have watched *Other Methods* lecture Zoom- Help on Group analysis activity and lab 4. Go over *Other MRI methods and techniques* Zoom- General Q&A	12/11: **Lab 4**: Group Analysis Pyramids and Palm Trees Lab
12/9	Live lecture - *Using MRI to Explore Pattern Separation and the Aging Hippocampus*	