PSY629
fMRI design and analysis
Lectures: Wednesday, 8:30–11:20, PRCE 255 / PRCE 282

Instructor

Prof. Sébastien Hélie
Email: shelie@purdue.edu
Phone: (765) 496–2692
Office: PRCE 359
Hours: Email for appointment

Course objectives

The goal of this course is to teach students how to design fMRI experiments and perform fMRI data analyzes using both lectures and hands-on exercises. Covered topics include MR physics, block designs, rapid–event related designs, data preprocessing, and standard analyses using the general linear model. Advanced analysis techniques (e.g., functional connectivity analysis, multivariate pattern analysis, etc.) and common pitfalls in design and analysis will also be covered.

Course format

This course includes a mixture of lectures and hands–on exercises. Courses will be held weekly in PRCE 255 until the end of October. In November and December, discussion seminars will be held in PRCE 282.

Recommended pre–requisites

Basic knowledge of inferential statistics is required. Familiarity with the general linear model (GLM) and signal processing is helpful.

Required text

Most chapters will be coming from the required text. Additional reading material will be posted in Brightspace.

- Ashby, F. G. (2019). *Statistical Analysis of fMRI Data. 2nd Edition.* Cambridge, MA: MIT Press. (≈ $40,) [**A19**]

Additional references and software

- Ashby, F. G. (2011). *Statistical Analysis of fMRI Data.* Cambridge, MA: MIT Press. (Online Purdue library access)

- Duda, R. O., Hart, P. E., & Stork, D. G. (2001). *Pattern Classification. 2nd Edition.* New York: John Wiley & Sons.
- FMRIB Software Library v6.0: http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/
- Huettel, S., Song, A., & McCarthy, G. (2014). *Functional Magnetic Resonance Imaging. 3rd Edition.* Sunderland, MA: Sinauer Associates.
- Poldrack, R. A., Mumford, J. A., & Nichols, T. E. (2011). *Handbook of Functional MRI Data Analysis.* New York: Cambridge University Press. **[PMN11]**
- The R Project for Statistical Computing: https://www.r-project.org/
- van Drongelen, W. (2007). *Signal Processing for Neuroscientists: An Introduction to the Analysis of Physiological Signals.* Academic Press. (Online Purdue library access)

Evaluation

- Class participation (attendance, in class exercises, etc.) 15%
- 2 × Homework @ 20% each 40%
- Class presentation 20%
- Critical essay 25%

Class participation includes attendance, actively participating in class discussions, asking questions, and in–class exercises. The homeworks are expected to be done individually and may contain a mixture of theoretical questions to be answered at home and hands–on exercises to be done during class time. You will have about one week to complete each homework. The tentative due dates are 09/29 and 11/03 at 8:30 AM.

For your class presentation and final essay, you will need to find an article related to your research topic that uses fMRI. You will present and lead a class discussion (seminar style) during one of the last four weeks of lectures. Your presentation (and discussions related to your article) should last about 1 hour. You will then have to write a critical essay on your selected article where you summarize the article and criticize the methodology. The essay should take into consideration discussions from the presentation. In the critical essay, you are expected to discuss implications of the findings, how the research could be improved, and possible follow–up research. The length of the critical essay is expected to be about 10 pages (double space), and the deadline is 12/12.

Grading scheme

Grade	Letter	Grade	Letter
$\geq 90\%$	A	$65\% - 69\%$	C+
$85\% - 89\%$	A-	$60\% - 64\%$	C
$80\% - 84\%$	B+	$55\% - 59\%$	C-
$75\% - 79\%$	B	$< 55\%$	F
$70\% - 74\%$	B-		

Class computers

The class computers will be used for exercises requiring mostly R and FSL. The computers are connected to the Purdue network and you can login using your Purdue credentials. R can be run directly from the Windows environment. However, FSL runs on a Linux platform, which also works on Apple computers, but on Windows computer you need to access FSL through a virtual machine. When running the virtual machine (VMware), you will be prompted for a username and password to access the Linux machine. Select 'psy629' as the username and type 'fsluser' (no quotes) as the password. You will now be running a Linux virtual machine and be able to access FSL. Some of the exercises will include big data sets and the 'results' folder might be large. It is your responsibility to make sure that you can either transfer your results on a cloud space at the end of each lecture or bring a USB memory stick to class.

Class etiquette

I expect you to be respectful and polite to me and the other students in the class. Here are some of my specific expectations:

- **Arrive On Time.** Class starts at 8:30. Late arrivals are disruptive.
- **Turn Off Technology.** Turn off all phones, tablets, and all other noise–making things before the beginning of class. Do not use the computer unless we are involved in a class exercise.
- **Don't Chitchat.** Talking distracts me and other students. Of course, if you have a question or comment during a lecture, please raise your hand and ask. But other chitchat is disruptive to me and everyone else.
- **Purdue Honors Pledge.** Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breeches of this value by either emailing integrity@purdue.edu or by calling 765–494–8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern. As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together – we are Purdue.

Attendance policy

Classroom attendance is required. There will be no make–up work or opportunity for extra credits. Due dates for homework are strict and delays will result in grading penalties.

CAPS Information

Purdue University is committed to advancing the mental health and well–being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS)

at (765) 494–6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

Tentative schedule – may change as we go...

Date	Topic	Reading
08/25	Introduction to MRI and fMRI	[A19] Chap. 1
09/01	Modeling the BOLD response / R	[A19] Chap. 3
09/08	Matrix algebra / R	[A19] Appendix A
09/15	fMRI design / Linux Shell	[A19] Chap. 4.1, 6.1 – 6.7
09/22	Preprocessing / FSL	[A19] Chap. 5
09/29	General Linear Model (GLM)	[A19] Chap. 6.8 – 6.10, 6.14
10/06	Multiple comparison problem	[A19] Chap. 7
10/13	Group analyses	[A19] Chap. 8.1 – 8.6, [PMN11] Appendix A4
10/20	Functional connectivity	[A19] Chap. 9.1, 11.1 – 11.3
10/27	Multivariate pattern classification	[PMN11] Chap. 9
11/03	**Conference (NO CLASS)**	–
11/10	Student presentations	Articles TBD
11/17	Student presentations	Articles TBD
11/24	**Thanksgiving (TURKEY)**	–
12/01	Student presentations	Articles TBD
12/08	Student presentations	Articles TBD