Queen's University
Department of Psychology

Psychology 917:
Introduction to Cognitive Neuroimaging
Functional MRI Design and Analysis
Winter 2024

Course Instructor: Jason Gallivan

Office: Botterell Hall 239

E-mail: gallivan@queensu.ca
Office Hours: By appointment

Course Description:
Functional magnetic resonance imaging (fMRI) has become a dominant tool in the study of human brain function and organization. The aim of this course will be for students to learn, in a hands-on fashion, how to process and analyze fMRI data. Specifically, the goal is that students not only understand how to analyze fMRI data using available software, but also understand why they should be analyzing it in a certain fashion, as well as the strengths/limitations of different approaches. In this course, students will be given several real fMRI data sets in which to process, analyze and, later, write-up results.

Course Learning Outcomes:
Upon completion of this course, a successful student should be able to:

1. Pull 'raw' data off of the fMRI scanner and be able to preprocess and analyze it.
2. Understand the rationale behind, and how to implement, both basic and more advanced fMRI analyses and how the corresponding results should be interpreted.
3. Understand some basic human functional neuroanatomy and topography
4. Apply active learning, critical thinking and problem-solving to the study of human functional brain data

Course Overview:
Each week will have a seminar/lecture component led by instructor/students, and an implementation/tutorial component. I will provide pre-filled Jupyter notebooks to students each week, with everything required to perform an analysis. For analysis, we will be using Python. The class data will be a previously collected dataset from my group, formatted in BIDS format (https://bids.neuroimaging.io/). Throughout the term, we will work on preprocessing and analyzing this data set. Near the end of the course, you will also be provided a 'mystery' data set, which you need to 'reverse inference' (more on that below).

Relevance of Course: Information taught in this course is highly relevant for students interested in the human brain and behaviour, cognitive and systems neuroscience, neurobiology, computer science, medicine, clinical psychology, research and teaching. My goal is that, even if you do not use fMRI as a research tool in your own work, you will learn analyses and new approaches that can be implemented in your own work and on a wide variety of neuroimaging data sets (e.g., EEG, MEG, etc.)

Course Content: Tentative lecture schedule (*Subject to modification*)

Date	Lecture/Tutorial Topic
Week 1: January 9	• Introduction to Course and Instructor • Go over course syllabus • **Introductory Lecture to fMRI**
Week 2: January 16	• **Lecture on Principles of fMRI Design and Analysis** • *Introduction to Python for neuroscience* • *Tutorial: Loading and viewing images with nibabel and nilearn*
Week 3: January 23	**Temporal Preprocessing** • Motion correction, slice-scan time correction, and temporal filtering • *Tutorial: Temporally filtering functional images with nilearn*
Week 4: January 30	**Spatial Preprocessing** • Coregistration, normalization, brain segmentation and spatial smoothing • *Tutorial: Overview of fmriprep; image processing with nilearn*
Week 5: February 6	**Single-run and single-subject GLMs** • First-level analysis: HRF, First-level design matrix, first-level contrasts • *Tutorial: Running a first-level analysis with nistats*
Week 6: February 13	**Group-level GLMs** • Second-level analysis: Second-level design matrix, multiple comparisons • *Tutorial: Running a second-level analysis with nistats*
Week 7: February 20	READING WEEK: NO CLASSES
Week 8: February 27	**ROI-based analyses** • *Tutorial: Masks, data extraction, ROI analysis*
Week 9: March 6	**MVPA 1: Pattern Classification** • *Tutorial: Machine learning and pattern analysis with scikit-learn and nilearn*
Week 10: March 13	**MVPA 2: Representational similarity analysis** • *Tutorial: Machine learning and pattern analysis with scikit-learn and nilearn*
Week 11: March 20	**Research Project week: Mystery dataset release and work time**
Week 12: March 27	**Functional connectivity 1:** Brain parcellation, functional connectivity *Tutorial: Functional connectivity analysis with nilearn*
Week 13: April 3	**Functional connectivity 2:** Network analysis *Tutorial: Connectome analysis with brain connectivity toolbox*

Textbook &/or Courseware Package: There is no required textbook for this course. Any required readings will be made available for download through OnQ/Dropbox or email.

Evaluation Scheme

Description	Value	Date
Class Participation	25%	Just show up every week…
Topic Overviews	20%	Starts week 3…
Weekly assignments	15%	Start week 3…
Research Project	40%	Due in April (date TBD)

Class Participation (25% of final mark):
This is a major component of your final mark and only requires that you show up weekly, get involved and do the work. As with all grad courses, you will only get out of this course what you put into it—and this old adage is probably truer for this course than most. This course will have weekly exercises and learning opportunities that reinforce core themes and concepts, and once going, this course moves along at a fairly quick pace. This requires that you be present to know what is going on and to fully capitalize on the material covered. You will learn some cool stuff in this course.

Weekly assignments (15% of final mark):
Once the tutorials start humming along, after each class we will require you submit brief assignments based on the content/material covered.

Topic Overviews (20% of final mark):
These topic overviews are designed to be introductory summaries, presented at the beginning of each class, on the key concepts/topics to be covered in that day's tutorial. Each topic overview should not exceed 10 minutes each. One of these topic overviews will be required by each student in the course, and the student's grade for this component will be based on their ability to provide context, clarity and content for the tutorial topic.

In each topic overview, students will be expected to provide the following:
- Define the topic and what it accomplishes
- Why it is used/performed
- When it should be used/performed
- How it is implemented (at a theoretical level).

The topic overviews TBD (based on class enrollment numbers)
- Some examples include: Motion-correction, slice scan time correction, co-registration, spatial smoothing, 1st level analyses, Pattern classification, RSA, etc.

Research Proposal (40% of final mark):
You will be given raw data corresponding to several subject data sets and given only timing information of when stimuli/events occurred in the data (e.g., when condition A, B, appeared, etc.). Your job is to fully analyze the data from scratch and employ whatever analyses you deem appropriate in an attempt to reverse-inference the project; i.e., determine what the experimental conditions are. This will involve you creating statistical maps of the different experimental conditions, interpreting their activations and relating them, and using the existing literature and tools like Neurosynth (https://neurosynth.org/) to assess the likely stimuli/events that created those activations.

This project is meant to be fun – it is a key opportunity to employ everything you have learnt in the course and do some sleuthing through the literature. The deliverable will be a brief write-up of the Methods, Results and a Discussion section wherein you interpret the results and attempt to identify the experimental conditions. More information on that is to be provided.

Grading system – Numbers In, Letters Out: All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale as shown below:

Grade	Numerical Course Average (Range)	Descriptor
A+	90-100	Truly Exceptional
A	85-89	Outstanding
A-	80-84	Excellent
B+	77-79	Very Good
B	73-76	Good

Late Policy: Unless otherwise stated, late submissions will be penalized by 5% per day it is late (e.g., a submission earning a grade of 85% will receive an 80% if submitted one day late).

Students are responsible for keeping back-up copies of all written work and assignments. Invalid or corrupt files submitted electronically will be subject to the course late penalty and computer, disk, and/or other hardware related problems will not be accepted as an excuse to hand in late hard-copy assignments.

REGULATIONS AND POLICIES

Important University Dates

Please visit the Faculty of Arts and Sciences Sessional Dates website for all academic deadlines.

Inclusion

Land Acknowledgement

The territory that Queen's University occupies is included in the Dish with One Spoon Wampum Belt Covenant, an agreement between the Iroquois Confederacy and the Confederacy of the Ojibwe and Allied Nations to peaceably share and care for the resources around the Great Lakes. The Kingston Indigenous community continues to reflect the area's Anishinaabek and Haudenosaunee roots. There is also a significant Métis community as well as First Peoples from other Nations across Turtle Island present here today.

Equity, Diversity, and Inclusivity Statement

Queen's University recognizes that the values of equity and diversity are vital to and in harmony with its educational mission and standards of excellence. It acknowledges that direct, indirect, and systemic discrimination exists within our institutional structures, policies, and practices and in our community. These take many forms and work to differentially advantage and disadvantage persons across social identities such as race, ethnicity, disability, gender identity, sexual orientation, faith, and socioeconomic status, among other examples. In this class I will work to promote an anti-discriminatory, anti-racist and accountable environment where everyone feels welcome. Every member of this class is asked to show respect for every other member.

Building a Classroom Community

University is a place to share, question, and challenge ideas. Each student brings a different set of lived experiences. You can help to create a safer, more respectful classroom community for learners by following these guidelines:

- Make a personal commitment to learn about, understand, and support your peers.
- Assume the best of others and expect the best of them.
- Recognize and value the experiences, abilities, and knowledge each person brings to the course.
- Acknowledge the impact of oppression on other people's lives and make sure your words and tone are respectful and inclusive.
- Encourage others to develop and share their ideas.
- Pay close attention to what your peers say/write before you respond. Think through and re-read what you have written before you post online or send your comments to others.
- Be open to having your ideas challenged and challenge others with the intent of facilitating growth.
- Look for opportunities to agree with one another, building on and intentionally referencing peers' thoughts and ideas; disagree with ideas without making personal attacks, demeaning, or embarrassing others.

Fostering Accessibility

All of us have a shared responsibility for fostering accessibility and promoting meaningful inclusion of those with disabilities. The Accessibility Hub at Queen's University's Human Rights & Equity Office offer a host of tutorials that provide us all with practical tips for:

- creating accessible documents, e.g., to submit to your teaching team or share with peers in peer feedback activities/in a presentation,
- emails, e.g., while communicating with group members or your teaching team, and
- meeting practices (e.g., in tutorials/labs/seminars or virtual meetings.

Name/Pronoun

If, for whatever reason, you wish to change how your name appears in onQ and/or on class lists, please follow these steps. You may also use this process to add your pronouns to the appearance of your name.

1. Log into SOLUS.
2. Click on Personal Information tab.
3. Click on the Names tab
4. Click on the Add New Name tab
5. Choose Preferred from the Name Type drop down menu
6. Enter the name you would like to appear in onQ and/or on class lists.
7. Click Save.

Please allow 24 to 48 hours for your name to be registered within the system. If you have further questions or concerns, please contact ITS at Queen's University.

Copyright of Course Material

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course

materials or to provide an instructor's course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

Communication

Questions about the Course and Contacting the Teaching Team

Students requiring assistance are encouraged to speak with me either before or after lectures/tutorials. Should you wish to meet with me outside of this time, please email me to make an appointment. Email, while commonly used, does limit the effectiveness of communications and may not be the best way for me to answer your question(s). In such instances, I may suggest a personal meeting at a mutually agreed upon time. I will do my very best to answer emails as soon as possible; however, emails can be expected to be replied to within 2 working days (i.e., a reply to a 1 am Saturday night email may not arrive before Tuesday). To facilitate my responses, please include the course ID (i.e., "PSYC 917") in the subject line of the email. Thanks.

Queen's Email

The university communicates with students via Queen's email. Please check your email regularly to ensure you do not miss important information related to your course.

Course Feedback

At various points during the course, you may be asked to take part in a variety of feedback activities, such as surveys and questionnaires. This feedback enables the teaching team to improve the course. All surveys are anonymous and are directly related to activities, assessments, and other course material.

Assignment Late Policy

5% shall be deducted from an assignment for each day, or portion thereof, if it is late (including weekends). **The absolute last day to submit a late assignment in this course is April 3rd.** Anything that arrives after this will not be accepted without permission of the instructor.

Students with letters of accommodation should, if possible, confirm the implementation of their accommodations prior to the listed due date. Please see the "Accommodations for Disabilities" section of this syllabus for more information.

Students experiencing short-term extenuating circumstances that are beyond their control and may affect their academic work should submit a request to their faculty office for academic consideration. Please see the "Academic Considerations for Students in Extenuating Circumstances" section of this syllabus for more details.

Policy Review of Graded Work

Requests for assignment regrading may be made to your TA 48 hours after you have received the marked copy of your assignment, but no more than 10 days later. Be sure to read your TA's feedback carefully before you submit a review of graded work. To request that your assignment be reviewed, please include the following in your email:

- Your name, student number, and TA's name.
- The original copy of your marked assignment, attached.

- Your reason for the request:
    - The specific aspects of your assignment that you believe were not sufficiently awarded, referring to the categories of the rubric.
    - Why you believe that your assignment meets the criteria for a higher mark for each of the categories of the rubric that you indicated above. Please make explicit reference to the detailed descriptions of each category provided in the rubric.

If a review of graded work results in only a slightly different final grade, the original grade will stand. Should we find an error where marks were not assigned when they should have been or were missed in adding up the total score or were added up incorrectly resulting in a higher score than earned, the grade will be changed so that it is accurate. Grades would only increase or decrease if there was evidence of an error in marking, not simply because the regrader interprets or applies the rubric slightly differently than the original grader.

Policies

Class Attendance

Your presence and participation in class contributes to the knowledge and skills that you will develop throughout this course. I expect that you attend class regularly, participate in class conversations and learning activities. These types of activities provide active engagement, promote a deeper understanding of the course content, and contribute to your success in this course.

Academic Support

All undergraduate students face new learning and writing challenges as they progress through university: essays and reports become more complex; effectively incorporating research into writing becomes more important; the types of assignments become more diverse; managing your time and developing the skills you need to read and think critically gets more challenging. I encourage students to contact Student Academic Success Services (SASS). SASS offers many different ways to receive support:

- Free online or in-person appointments to get personalized support on writing and academic skills from expert staff and trained peers.
- Workshops and drop-in programs. SASS' Events Calendar lists events coming soon.
- Online resources that provide strategies for academic skills and writing development at university.
- If English is not your first language, SASS has specific resources for English as Additional Language students, including weekly programs and EAL academic skills appointments. You can meet on an ongoing basis with an EAL consultant to work on your academic writing, speaking, listening, and reading skills.

Accommodations for Disabilities

Queen's University is committed to working with students with disabilities to remove barriers to their academic goals. Queen's Student Accessibility Services (QSAS), students with disabilities, instructors, and faculty staff work together to provide and implement academic accommodations designed to allow students with disabilities equitable access to all course material (including in-class as well as exams). If you are a student currently experiencing barriers to your academics due to disability related reasons, and you would like to understand whether academic accommodations could support the removal of those barriers, please visit the QSAS website to learn more about academic accommodations or start the registration process with QSAS by clicking ***Access Ventus*** button at **Ventus | Accessibility Services | Queen's (queensu.ca)**

VENTUS is an online portal that connects students, instructors, Queen's Student Accessibility Services, the Exam's Office and other support services in the process to request, assess, and implement academic accommodations.

To learn more go to: https://www.queensu.ca/ventus-support/students/visual-guide-ventus-students

Academic Consideration for Students in Extenuating Circumstances
Academic Consideration is a process for the University community to provide a compassionate response to assist students experiencing unforeseen, short-term extenuating circumstances that may impact or impede a student's ability to complete their academics. This may include but is not limited to,

- Short term Physical or Mental Illness or Injury (stomach flu, anxiety/depression, mononucleosis, concussion, broken bones, surgery, medical treatments, etc.)
- Traumatic Event/Confidential (Bereavement, serious injury, illness or required treatment for a significant other/family member or a traumatic event such as divorce, sexual assault, social injustice, etc.)
- Requirements by Law or Public Health Authorities (court dates, jury duty, requirements to isolate, etc.)
- Significant Event (varsity athletic event, distinguished event, serving in the Reserve Forces, etc.)

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances. For more information, please see the Senate Policy on Academic Consideration for Students in Extenuating Circumstances.

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. For more information, undergraduate students in the Faculty of Arts and Sciences should consult the Faculty's webpage on Academic Consideration in Extenuating Circumstances and submit a request via the Academic Consideration Request Portal. Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

Students are encouraged to submit requests as soon as the need becomes apparent and to contact their instructor and/or course coordinator as soon as possible once academic consideration has been granted. Any delay in contact may limit the options available for academic consideration.

For more information on the Academic Consideration process, what is and is not an extenuating circumstance, and to submit an Academic Consideration request, please see the Faculty of Arts and Science's Academic Consideration website. ASO courses include links to information on **Academic Consideration** on your **Course Homepage** in onQ.

Please see the Teaching Team page for contact information for your instructor and TA(s), where relevant.

Queen's Policy Statement on Academic Integrity

Queen's University is dedicated to creating a scholarly community free to explore a range of ideas, to build and advance knowledge, and to share the ideas and knowledge that emerge from a range of intellectual pursuits. Queen's students, faculty, administrators and staff therefore all have responsibilities for supporting and upholding the fundamental values of academic integrity. Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility and by the quality of courage. These values and qualities are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University.

The following statements from "The Fundamental Values of Academic Integrity" (2nd edition), developed by the International Center for Academic Integrity (ICAI), contextualize these values and qualities:

1. **Honesty** Academic communities of integrity advance the quest for truth and knowledge through intellectual and personal honesty in learning, teaching, research, and service.
2. **Trust** Academic communities of integrity both foster and rely upon climates of mutual trust. Climates of trust encourage and support the free exchange of ideas which in turn allows scholarly inquiry to reach its fullest potential.
3. **Fairness** Academic communities of integrity establish clear and transparent expectations, standards, and practices to support fairness in the interactions of students, faculty, and administrators.
4. **Respect** Academic communities of integrity value the interactive, cooperative, participatory nature of learning. They honor, value, and consider diverse opinions and ideas.
5. **Responsibility** Academic communities of integrity rest upon foundations of personal accountability coupled with the willingness of individuals and groups to lead by example, uphold mutually agreed-upon standards, and take action when they encounter wrongdoing.
6. **Courage** To develop and sustain communities of integrity, it takes more than simply believing in the fundamental values. Translating the values from talking points into action -- standing up for them in the face of pressure and adversity — requires determination, commitment, and courage.

Students are responsible for familiarizing themselves with and adhering to the Senate regulations concerning academic integrity, along with Faculty or School specific information. Departures from academic integrity include, but are not limited to, plagiarism, use of unauthorized materials, facilitation, forgery and falsification. Actions which contravene the regulation on academic integrity carry sanctions that can range from a warning, to loss of grades on an assignment, to failure of a course, to requirement to withdraw from the university.

Syllabus statements for Generative Artificial Intelligence (AI) Tools

Students must submit their own work and cite the work that is not theirs. Generative AI writing tools such as ChatGPT/Gemini/Claude are very welcome (and frankly, expected) in this class. I recognize that some of you will have never coded before, and using AI tools will be critical for your learning process. Any other use constitutes a Departure from Academic Integrity.

Queen's Student Academic Success Services (SASS) offers a self-directed, online academic integrity module which we encourage all students to take which will help with:

- Understanding the nature of the academic integrity departure
- Understanding the expectations of and role of sources in scholarly writing
- Integrating sources into your writing (paraphrasing, quoting, summarizing)
- Understanding when and how to cite your sources
- Managing your time effectively to avoid the need for shortcuts
- Taking effective notes to ensure accuracy of source material and correct attribution

Turnitin Statement

This course makes use of Turnitin, a third-party application that helps maintain standards of excellence in academic integrity. Normally, students will be required to submit their course assignments through onQ to Turnitin. In doing so, students' work will be included as source documents in the Turnitin reference database, where they will be used solely for the purpose of detecting plagiarized text in this course. Data from submissions is also collected and analyzed by Turnitin for detecting Artificial

Intelligence (AI)-generated text. These results are not reported to your instructor at this time but could be in the future.

Turnitin is a suite of tools that provide instructors with information about the authenticity of submitted work and facilitates the process of grading. The similarity report generated after an assignment file is submitted produces a similarity score for each assignment. A similarity score is the percentage of writing that is similar to content found on the internet or the Turnitin extensive database of content. Turnitin does not determine if an instance of plagiarism has occurred. Instead, it gives instructors the information they need to determine the authenticity of work as a part of a larger process.

Please read Turnitin's Privacy Policy, Acceptable Use Policy and End-User License Agreement, which govern users' relationship with Turnitin. Also, please note that Turnitin uses cookies and other tracking technologies; however, in its service contract with Queen's Turnitin has agreed that neither Turnitin nor its third-party partners will use data collected through cookies or other tracking technologies for marketing or advertising purposes.

For further information about how you can exercise control over cookies, see Turnitin's Privacy Policy.

Turnitin may provide other services that are not connected to the purpose for which Queen's University has engaged Turnitin. Your independent use of Turnitin's other services is subject solely to Turnitin's Terms of Service and Privacy Policy, and Queen's University has no liability for any independent interaction you choose to have with Turnitin.

Portions of this document have been adapted, with permission, from the University of Toronto Centre for Teaching Support and Innovation tip sheet "Turnitin: An Electronic Resource to Deter Plagiarism".