



CSCI4XXX/NESC4XXX – Introduction to MRI analysis

Course Syllabus

Instructor Information:

Instructor: Dr. Carlos Hernandez Castillo

Course Homepage: <https://dal.brightspace.com>

Office hours: Tuesday 11 am - 12 pm

Important Dates

May 06 - Classes begin.

May 20 - Victoria Day - University closed.

June 04 - Last day to drop without a "W"

June 17 to 21 - Summer Break - No class.

July 01 - Canada Day - University closed.

July 04 - Last day to drop with a "W"

Aug 05 - Natal Day – University Closed.

Course Description

This course offers a comprehensive exploration of neuroimaging analysis applied to structural and functional MRI data. Students will engage deeply with methodologies including Voxel-based morphometry, functional connectivity analysis, independent component analysis, graph analysis and other sophisticated approaches in neuroimaging, investigating their utility for understanding the impact of disease on brain structure and function.

Learning Outcomes

- Understanding foundational concepts of MRI.
- Identify the advantages of using MRI as a tool for clinical research.
- Familiarize with the current software tools for neuroimaging.
- Recognize the appropriate neuroimaging analysis for different research questions.
- Gain the ability to develop custom code for neuroimaging analysis.
- Compare different applications of motion detection.
- Implement computational techniques for neuroimage analysis.
- Select and apply standardized analysis pipelines.

Course Rationale

Neuroimaging is a multidisciplinary field that requires highly qualified personnel with broad knowledge, including both the biology of the brain and methodological/computational expertise. Therefore, this course is designed for computer science students who are interested in neuroimaging, as well as neuroscience students who want to improve their computational skills.

Besides providing the fundamental knowledge about neuroimaging, this course will allow students working on research questions using clinical data, providing an opportunity to pair students from both disciplines.

Class format and course communication

Content will be delivered each Tuesday in Goldberg building and will consist of lectures for each topic on the syllabus. The lecture will be also available online as a short video. With each lecture, a quiz covering the material on the video lecture will be released. Students will have until Wednesday at midnight pm (ADT) to submit their answers using Brightspace. A tutorial on each Thursday will be held to further talk about the weekly topics, practice implementation, and answers questions. Assignments and Practicums will be scheduled each week on interleaved order during the course. Final examination will be scheduled based on the official period set by the University.

Course announcements will be posted in the main page of the course (Brightspace) and via the mailing list. Avoid sending emails to TAs and the professor regarding the course content, assignments, and practicums. All questions must be posted in the corresponding chat in Brightspace, in this way other students can benefit from the answers.

Evaluation Criteria

Quizzes 10% - Quizzes will review the lecture material. There will be one quiz per week, starting in week 1, making a total of 10. Quizzes can be written by the student any time after the quiz is released and before Wednesday at 23:50 hours ADT.

Assignments 20% - Assignments will consist of either theoretical questions or practical exercises related to the lecture content with the objective of reinforce the topic. In total, there will be 4 assignments in the course, Assignments will be released on Tuesdays and the results should be submitted on Friday before 23:50 ADT.

Practicums 40% - Students will implement software solutions to some problems discussed on the previous lectures. The focus of the practicums is both the result and the original code used to solve the problem. There will be 4 practicums released on Tuesdays and the results should be submitted on Friday before 23:50 hours ADT. The code used to process the image will be reviewed and it must follow the best practices for style and clarity. Any case of plagiarism will be reported.

Final project 30% - There will be a final project scheduled for the last week of classes. During that week, there will be no lecture, quizzes, or assignments. The students will submit a written report and perform a 4-minute presentation. After the presentation there will be 2 minutes for questions. The evaluation will be performed during the exam period at the end of the semester. The presentation will be evaluated by the instructor and the students. Each student will evaluate their peers in terms of presentation style and understanding of the topic.

Student Declaration of Absence

The Student Declaration of Absence policy shall apply. https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/academic-policies/student-absence.html The student has a maximum of two (2) SDAs per course per semester. The student must notify the instructor

of their inability to meet a deadline before the deadline by contacting the instructor or submitting the completed SDA. Upon notification the student has 2 days after the deadline to submit the SDA.

Academic Standards

Failure to properly attribute sources in your work will be treated as an academic standards issue and points may be deducted for not following citation requirements. For example, forgetting to quote text taken from other sources, failure to include in-text citations, or a failure to include required information in the citations or references. Please see the resources on proper citation provided by the Dalhousie Writing Center

(<https://dal.ca.libguides.com/c.php?g=257176&p=5001261>).

Please note that if it appears that the error was made with intent to claim other people's work as your own such as a lack of both citations and references, an allegation of plagiarism will be submitted to the Faculty Academic Integrity Officer, which could result in consequences such as a course failure.

Resources

Further information about the topics of this course can be found in these books. However, the students are encouraged to search for other sources of information including the original papers reporting the methods and applications covered in this course.

- Jenkinson, M., & Chappell, M. (2018). Introduction to neuroimaging analysis. Oxford University Press.
- Poldrack, R. A., Mumford, J. A., & Nichols, T. E. (2011). Handbook of Functional MRI Data Analysis.

Prerequisites

- CSCI 1300 or MATH1000, MATH1030, and CSCI2360 or STAT 2060 are requirement to take this course.
- Basic knowledge of algorithms, artificial Intelligence/machine learning is expected but not mandatory, examples are CSCI2110, CSCI2203, CSCI3151.

Tentative Course schedule

Week 01 – Welcome session, introduction to MRI physics.

Week 02 – Image processing basics and MRI modalities.

Week 03 – Anatomical analysis.

Week 04 – Diffusion Tensor Imaging.

Week 05 – Preprocessing of functional data.

Week 06 – Functional analysis (subject level).

Week 07 – High level analysis (group level).

Week 08 – Functional connectivity.

Week 09 – Multi-Voxel Pattern Analysis.

Week 10 – Visualization and reporting data.

Assignments and Practicums

May 09 – Assignment 1: Basics of MRI, due May 12
May 16 – Practicum 1: Tissue segmentation, due May 19
May 23 – Assignment 2: Tractography, due to May 26
May 30 – Practicum 2: Motion correction, due June 2
June 06 – Assignment 3: General linear model, due June 9
June 20 – Assignment 4: Group comparison, due June 23
June 27 – Practicum 3: Connectivity maps, due June 30
July 04 – Practicum 4: Classification, due July 7
July 11 – Final project: TBD, due July 28

Responsible Computing Policy

Usage of all computing resources in the Faculty of Computer Science must be within the Dalhousie Acceptable Use Policies (https://www.dal.ca/dept/university_secretariat/policies/information-management-and-technology/acceptable-use-policy-.html) and the Faculty of Computer Science Responsible Computing Policy. For more information please see https://www.dal.ca/content/dam/dalhousie/pdf/faculty/computerscience/policies-procedures/fcs_policy_local.pdf

Use of Plagiarism Detection Software

All submitted code may be passed through a plagiarism detection software, such as the plagiarism detector embedded in Codio, the Moss (<https://theory.stanford.edu/~aiken/moss/>) Software Similarity Detection System, or similar systems. If a student does not wish to have their assignments passed through plagiarism detection software, they should contact the instructor for an alternative. Please note, that code not passed through plagiarism detection software will necessarily receive closer scrutiny. https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/policy-repository/OriginalitySoftwarePolicy.pdf

Use of Artificial Intelligence Tools

You may use AI-driven tools to assist you in learning but remember that your objective is to understand, achieve, and apply the course competencies and outcomes. While you may use tools for learning, specific assessments in this course will disallow the use of AI-driven tools to assert that you have attained course learning outcomes. This is because a graduate must be able to analyze, assess and produce work unassisted by AI technology. Where tools are allowed: you must acknowledge all tools used to assist you. If applicable, you must provide links to chat logs. Using AI-driven tools where prohibited constitutes an academic offense.

Student Health and Wellness

Taking care of your health is important. As a Dalhousie student, you have access to a wide range of resources to support your health and wellbeing. Students looking to access physical or mental health & wellness services at Dalhousie can go to the Student Health & Wellness Centre in the LeMarchant Building. The team includes: registered nurses, doctors, counsellors and a social worker. Visit dal.ca/studenthealth to learn more and book an appointment today.

Students also have access to a variety of online mental health resources, including telephone/texting counselling and workshops/training programs. Learn more and access these resources at dal.ca/mentalhealth.

Culture of Respect¹

Every person has a right to respect and safety. We believe inclusiveness is fundamental to education and learning. Misogyny and other disrespectful behaviour in our classrooms, on our campus, on social media, and in our community is unacceptable. As a community, we must stand for equality and hold ourselves to a higher standard.

What we all need to do:

1. **Be Ready to Act:** This starts with promising yourself to speak up to help prevent it from happening again. Whatever it takes, summon your courage to address the issue. Try to approach the issue with open-ended questions like “Why did you say that?” or “How did you develop that belief?”
2. **Identify the Behaviour:** Use reflective listening and avoid labeling, name-calling, or assigning blame to the person. Focus the conversation on the behaviour, not on the person. For example, “The comment you just made sounded racist, is that what you intended?” is a better approach than “You’re a racist if you make comments like that.”
3. **Appeal to Principles:** This can work well if the person is known to you, like a friend, sibling, or co-worker. For example, “I have always thought of you as a fair-minded person, so it shocks me when I hear you say something like that.”
4. **Set Limits:** You cannot control another person’s actions, but you can control what happens in your space. Do not be afraid to ask someone “Please do not tell racist jokes in my presence anymore” or state “This classroom is not a place where I allow homophobia to occur.” After you have set that expectation, make sure you consistently maintain it.
5. **Find or be an Ally:** Seek out like-minded people that support your views, and help support others in their challenges. Leading by example can be a powerful way to inspire others to do the same.
6. **Be Vigilant:** Change can happen slowly, but do not let this deter you. Stay prepared, keep speaking up, and do not let yourself be silenced.

¹ Source: Speak Up! © 2005 Southern Poverty Law Center. First Printing. This publication was produced by Teaching Tolerance, a project of the Southern Poverty Law Center. Full “Speak Up” document found at: <http://www.dal.ca/dept/dalrespect.html>. Revised by Susan Holmes from a document provided April 2015 by Lyndsay Anderson, Manager, Student

Dispute Resolution, Dalhousie University, 902.494.4140, lyndsay.anderson@dal.ca
www.dal.ca/think.

University Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate.

<https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=117&loadusercredits=False>

Territorial Acknowledgement

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

Dalhousie acknowledges the histories, contributions, and legacies of the African Nova Scotia people and communities who have been here for over 400 years.

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." <https://www.dal.ca/about-dal/internationalization.html>

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect. As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. (read more: http://www.dal.ca/dept/university_secretariat/academic-integrity.html)

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion please contact: https://www.dal.ca/campus_life/academic-support/accessibility.html for all courses offered by Dalhousie with the exception of Truro.

Conduct in the Classroom — Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion — Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). (read more: <http://www.dal.ca/cultureofrespect.html>)

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. (read

more: https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/policy-repository/Code%20of%20Student%20Conduct%20rev%20Sept%202021.pdf)

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. (read more:

https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html)

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work, and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. (read more:

https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/policy-repository/OriginalitySoftwarePolicy.pdf)

Student Use of Course Materials

These course materials are designed for use as part of the CSCI courses at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading material to a commercial third party website) may lead to a violation of Copyright law.

Learning and Support Resources

Please see https://www.dal.ca/campus_life/academic-support.html