PSY 471H Computations of the Mind and Brain — Fall 2021 Syllabus

Instructor Dr. Michael Mack
Office Hours: Tuesdays, 12:00-1:00pm (online link below)
Email: michael.mack@utoronto.ca

Lectures Mondays 1:00-3:00pm
Online Zoom session: https://tinyurl.com/psy471-fall2021
In person: Claude T. Bissell Building (BL) 312

Course Description

This course explores the emerging field of model-based cognitive neuroscience. By integrating mathematical models of psychology with neuroscience, this field aims to uncover the brain's computations for learning, memory, and decision making. This course will cover the key aspects of model-based cognitive neuroscience: how cognition can be described in mathematical terms, how neuroscience techniques measure information in brain activity, and how connecting cognitive models to brain function advances our understanding of the computations of the mind and brain.

Objectives: This seminar will survey current model-based fMRI methods and provide a how-to for implementing psychological models to understand brain function. Learning objectives are:

1) To become an expert *consumer* of model-based cognitive neuroscience research.
2) To gain a familiarity with computational tools of psychology theory and how these tools can be leveraged with fMRI data.

Prerequisites: PSY202H1 (or equivalent), PSY270H1/COG250Y1. It is your responsibility to ensure that you have met *all* prerequisites listed in the Psychology section of the A&S Calendar for this course. If you lack any prerequisites, you will be removed. No waivers will be granted.

Reading Material and Texts

The required reading materials for this course are scientific articles published in peer-reviewed psychology and neuroscience journals. The specific articles are listed in the course outline below and will be posted on Quercus.

Optional textbook: For students interested in learning more about computational modeling, I recommend the following textbook (*Note*: students are not responsible for knowing this book's content for assessments): Farrell, S. & Lewandowsky, S. (2018). *Computational Modeling of Cognition and Behavior*. Cambridge University Press. An eBook is available *for free* via U of T network or VPN: https://www.cambridge.org/core/books/computational-modeling-of-cognition-and-behavior/A4A90098E7CB9A58E5D030F408639D04

Quercus

Log in to Quercus (http://q.utoronto.ca/) to view the course webpage. Each week, I will post lecture slides in the current week's module. *In most cases this will be done the night before the lecture at the latest.* To facilitate critical thinking, some slides may be removed from the posted pdfs. As such, regular attendance will be helpful for scoring a good grade. **Note:** Students are responsible for all announcements and content posted to Quercus, so check regularly.

Office Hours, Email and Course Discussion Board

Use office hours! Dr. Mack's office hours will be held virtually on the course Zoom session linked above. If you cannot make office hours, please request a meeting time with Dr. Mack using the message system on Querus.

Please do not use email to contact Dr. Mack. Unfortunately, the spam filter on the UTmail+ system often confuses good emails as spam and student emails are often lost. Instead, use the Quercus message system to directly contact Dr. Mack about illness, emergencies, or any questions about course policies.

For all questions about course content, please post to a discussion on Quercus. There will be separate discussion threads each week for questions about that week's content. These discussions will be the fastest way to reach Dr. Mack and other students who might have the same question or know the answer. Don't hesitate to answer a question if you know it!

Course Assignments and Evaluation

Assignment	Grade Proportion	Due Date
In-class presentation	25%	varies by student
Weekly demos/questions	35%	each Monday, 9am
Final project draft	5%	November 29
Final project peer assessment	5%	December 5
Final project paper	30%	December 15

Assignments due at 11:59pm unless noted otherwise

Evaluation Details

In-class presentation
Students will prepare a 20 minute in-class presentation which summarizes the main ideas from a primary article related to that week's topic. Presentations are to be made using Powerpoint, Keynote, or related software. Students may team up in pairs, presenting a single article and receiving a shared grade.

Weekly Demos/Questions
Each week, a new quiz on Quercus will be posted with a combination of model demos and questions. These quizzes will cover content from the current and next week. These are due each Monday at 9am starting on Sept. 20.

Final project
The final project for this course will be an independent research paper (minimum 10 pages, APA format) that explores a cognitive neuroscience research question with a particular computational model covered in the course. Details regarding the final project are available on Quercus.

- ***Paper draft:*** Students will submit a draft of their paper that includes the background, research question, proposed experiment and modeling analysis via Quercus by Nov. 29 at 11:59pm.
- ***Peer assessment:*** Each student will submit a peer assessment of two fellow students' final project drafts via Quercus by Dec. 5 at 11:59pm.
- ***Final paper:*** The final paper will be submitted via Quercus by Dec. 15 at 11:59pm.

Provisional Course Overview

Week	Date	Topic	Assigned Readings
1	Sep 13	Course overview and intro to model-based cognitive neuroscience	
2	Sep 20	Why models? Why fMRI?	Shepard, R. N. (1987). Toward a universal law of generalization for psychological science. *Science*, *237*(4820), 1317–1323. Farrell, S., & Lewandowsky, S. (2010). Computational Models as Aids to Better Reasoning in Psychology. *Current Dir. in Psychological Science*, *19*(5), 329–335.
3	Sep 27	Decision making	White, C. N., Mumford, J. A., & Poldrack, R. A. (2012). Perceptual criteria in the human brain. *The Journal of Neuroscience*, *32*(47), 16716–24. Forstmann, B. U. et al., (2010). The neural substrate of prior information in perceptual decision making: a model-based analysis. *Frontiers in Human Neuroscience*, *4*(5), 566–570.
4	Oct 4	Categorization 1	Nosofsky, R. M., Little, D. R., & James, T. W. (2012). Activation in the neural network responsible for categorization and recognition reflects parameter changes. *PNAS*, *109*(1), 333–8. Davis, T., Love, B. C., & Preston, A. R. (2012). Learning the exception to the rule: Model-based fMRI reveals specialized representations for surprising category members. *Cerebral Cortex*, *22*(2), 260–273.
5	*Oct 11*	*Thanksgiving*	*no class*
6	Oct 18	Categorization 2	Connolly, A. C. et al. (2012). The representation of biological classes in the human brain. *Journal of Neuroscience*, *32*(8), 2608–2618. Mack, M. L., Preston, A. R., & Love, B. C. (2013). Decoding the brain's algorithm for categorization from its neural implementation. *Current Biology*, *23*(20), 2023–2027.
7	Oct 25	Linking brain and models 1	Mack, M. L., & Preston, A. R. (2016). Decisions about the past are guided by reinstatement of specific memories in the hippocampus and perirhinal cortex. *NeuroImage*, *127*, 144–157.
8	Nov 1	Linking brain and models 2	Kragel, J. E., Morton, N. W., & Polyn, S. M. (2015). Neural Activity in the Medial Temporal Lobe Reveals the Fidelity of Mental Time Travel. *Journal of Neuroscience*, *35*(7), 2914–2926. Heffernan, E. M., Adema, J. D., & Mack, M. L. (2021). Identifying the neural dynamics of category decisions with computational model-based functional magnetic resonance imaging. *Psychonomic Bulletin & Review*. https://doi.org/10.3758/s13423-021-01939-4
9	*Nov 8*	*Reading week*	*no class*
10	Nov 15	Reinforcement learning	Daw, N. D., O'Doherty, J. P., Dayan, P., Seymour, B., & Dolan, R. J. (2006). Cortical substrates for exploratory decisions in humans. *Nature*, *441*(7095), 876–879. Behrens, T. E. J., Hunt, L. T., Woolrich, M., & Rushworth, M. F. S. (2008). Associative Learning of Social Value. *Nature*, *456*, 245–249.
11	Nov 22	Perception and attention	Ling, S, Pratte, M. S., & Tong, F. (2015). Attention alters orientation processing in the human lateral geniculate nucleus. *Nature Neuroscience*, *18*(4), 496–498. Ester, E. F., Sprague, T. C., & Serences, J. T. (2015). Parietal and Frontal Cortex Encode Stimulus-Specific Mnemonic Representations during Visual Working Memory. *Neuron*, 1–13.
12	Nov 29	Modelling the brain	Serre, T., Oliva, A., & Poggio, T. (2007). A feedforward architecture accounts for rapid categorization. *PNAS*, *104*(15), 6424–6429. Schapiro, A. C., Turk-Browne, N. B., Botvinick, M. M., & Norman, K. A. (2017). Complementary learning systems within the hippocampus: A neural network modelling approach to reconciling episodic memory with statistical learning. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1711).
13	Dec 6	Project workshop and peer assessment	

Notes

- *November 8 is the last day to drop course* from academic record and GPA.
- This course does not have a final exam during the final assessment period.

Course Policies

Acceptable Documentation: If you miss a deadline due to the illness or loss of a close relative, please declare an absence using the Absence Declaration Tool on ACORN as soon as possible. Students who submit a late assignment for reasons other than medical should contact Dr. Mack directly and will likely be required to coordinate with their College Registrar to provide documentation for extenuating circumstances.

Penalties for Lateness: Please make every effort possible to turn in all course assignments on time. Late submissions of the weekly Demos/Questions, paper draft, and peer assessments will receive 0% of the available grade. Late submissions for the final paper will be subject to a 20% late penalty per day (e.g., a score of 85% on a paper that is 1 day late will be marked as 65%).

Appeals: Students who have a complaint about the marks for a course assignment or term test can write an appeal letter to Dr. Mack. All requests for a re-grade must be submitted with specific justification, in writing, within 14 days of the marks being made available for student viewing. A legitimate request will result in the entire exam or assignment being re-graded. Thus, your overall grade may be raised, be lowered, or stay the same.

Plagiarism Detection Tools: Students will be required to submit their assessments to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation web site (https://uoft.me/pdt-faq).

Academic Resources

Accessibility Needs: Students with diverse learning styles and needs are welcome in this course. If you have an ongoing disability issue or accommodation need, you should register with Accessibility Services (AS) (accessibility.utoronto.ca) at the beginning of the academic year. Without registration, you will not be able to verify your situation with your instructors, and instructors will not be advised about your accommodation needs. AS will then assess your medical situation, develop an accommodation plan with you, and support you in requesting accommodation for your course work. Remember that the process of accommodation is private: AS will not share details of your condition with any instructor, and your instructors will not reveal that you are registered with AS. Contact Accessibility Services at (416) 978-8060; http://accessibility.utoronto.ca/.

Writing: As a student here at the University of Toronto, you are expected to write well. The university provides its students with a number of resources to help them achieve this. For more information on campus writing centres and writing courses, please visit http://www.writing.utoronto.ca/. Of specific use for this course, the writing centre provides online resources for appropriately using primary sources in your writing: https://advice.writing.utoronto.ca/using-sources/. The Faculty of Arts and Sciences also provides online writing centre support: https://writing.utoronto.ca/writing-centres/arts-and-science/

Academic Integrity and Plagiarism: All students, faculty and staff are expected to follow the University's guidelines and policies on academic integrity. For students, this means following the standards of academic honesty when writing assignments, citing and using source material appropriately, collaborating with fellow students, and writing tests and exams. Ensure that the work you submit for grading represents your own honest efforts. Plagiarism representing someone else's words as your own or submitting work that you have previously submitted for marks in another class or program is a serious offence that can result in sanctions. Speak to me or your TA for advice on anything that you find unclear. To consult the Code of Behaviour on Academic Matters for a complete outline of the University's policy and expectations, please visit http://www.governingcouncil.utoronto.ca/policies/behaveac.htm.