NeuroAI: Models of the Human Brain and Mind

PSYC 4690 | PSYC 6690

This course introduces the foundational principles of NeuroAI, exploring how biological brains and AI systems process information across modalities such as vision, audition, and language, and how their representation spaces can be interconnected. No prior programming experience is required.

Instructors	Dr. N Apurva Ratan Murty (ratan@gatech.edu)
Teaching Assistant(s)	Mainak Deb (mainak@gatech.edu)
Meeting times	Tue/Thu 12:30-1:45 pm
Classroom	JS Coon TBD
Credits	3
Office hours	Dr. Murty – Tue 3-4 PM JS Coon 131 or with an appointment

Course Description: What can AI teach us about the brain? And how can neuroscience shape the next generation of AI algorithms? This course explores these twin questions by connecting insights from human neuroscience to the design and evaluation of artificial intelligence. We will examine how the brain processes vision, audition, and language, and how these same computations are implemented in modern AI systems.

Students will learn the structure and function of the brain, methods for measuring neural activity and behavior, and computational approaches including deep neural networks, linear encoding models, probabilistic models, and topographic brain models. Hands-on tutorials will build practical skills in Python for model construction and data analysis. We will cover core techniques for mapping between human and machine representations, and for exploring computational models of perception, learning, and cognition. Group projects will provide opportunities to apply these methods in a research-oriented setting, focusing on formulating hypotheses and testing models of neural computation.

Prerequisites: Introductory courses in neuroscience and computational neuroscience are recommended. Tutorials and projects require some coding experience.

Textbook: No NeuroAI textbook really exists yet, so there is no required book for the course. All required materials will be provided on the class Canvas page. You might find the following open-source textbooks helpful:

> *Computational Cognitive Neuroscience (5th edition)*
> https://github.com/CompCogNeuro/book/releases/download/v5.0.1/ccnbook_ed5.pdf
> *Neuromatch NeuroAI course*
> https://neuroai.neuromatch.io/tutorials/intro.html

Evaluation Methods and Gradings:
Assignments (N = 2): 10% Weekly quiz: 20% Presentation: 20% Project Report: 20%
Final exam: 30% CIOS: 2%

Note: Students will be allowed to drop their lowest-scoring weekly quiz

A = 90-100% **B = 80-89%** **C = 70-79%** **D = 60-69%** **F = 0-59%**

Learning Objectives:

- Develop a strong understanding of the history and progress in NeuroAI
- Understand the goals of NeuroAI models. What questions do they enable and how Understand the different ways of comparing neural network models and human brain and behavior
- Apply fundamental python programming and scientific computing tools to analyze cognitive neuroscience data
- Design and carry out a small-scale research project that formulates a clear scientific hypothesis, analyse data, and interprets results
- Submit a 2-page CCN-style conference paper summarizing your project, the project template can be found here: https://2026.ccneuro.org/paper-submissions/

Additional expectations of Masters and Grad students

- Submit a 8-page CCN-style conference paper summarizing your project, Find project template here: https://2026.ccneuro.org/paper-submissions/
- Masters and grad students need to critically evaluate and integrate appropriate related literature into the paper's framing and discussion.
- Masters and grad students will also be evaluated on their ability to apply appropriate statistical tests and visualizations to support their core arguments.

Expectations for Tutorials

- Two tutorials will be posted on Canvas over the course of the semester.
- Students are expected to work through both tutorials carefully and on time.
- Tutorials are designed to build practical skills, so you should actively engage with the material rather than passively reading or skimming.
- Masters and graduate students are expected to go a step further by connecting the tutorial content to course concepts and their project where appropriate.
- Completion and quality of engagement with the tutorials will contribute to your overall evaluation.

Weekly Quizzes

Weekly quizzes will consist of short multiple-choice questions designed to help you stay on track with the material. These will take place after the regular lecture on Thursdays. Quizzes are intended to reinforce key concepts rather than trick you. Keeping up with the lectures and assigned materials should be sufficient preparation.

Class Schedule:

1. August 25 , 2026 (Tuesday)	**The goals of cognitive modeling (Introduction)**
2. August 27, 2026 (Thursday)	**The human brain**
3. September 1, 2026 (Tuesday)	**Measuring the brain and behavior**
4. September 3, 2026, 2026 (Thursday)	Tutorial #1: Basics on How to Python (numpy, matplotlib)
5. September 8, 2026 (Tuesday)	**AI models** Basic algorithms that power our new world
6. September 15, 2026 (Thursday)	**Mapping between human and machine representations 1** From point neurons to anatomically realistic ones
7. September 17, 2026 (Tuesday)	**Mapping between human and machine representations 2**
8. September 22, 2026 (Thursday)	**Group project time** *Meet with your group members and decide on your research topic -- Submit your research to your TA by the end of today!*
10. September 24, 2026 (Tuesday)	**The computational challenge of vision** How photons are transformed to perception
11. September 29, 2026 (Thursday)	**DNN models of vision 1** Early feedforward DNN models
12. October 1, 2026, 2026 (Tuesday)	**Group project time** *Develop a hypothesis and a plan of approach -- Submit them to the GTA by the end of today!*
13. October 6, 2026 (Tuesday)	**no class (fall break)**
14. October 8, 2026 (Thursday)	Tutorial #2: On mapping representations (RDMs, encoding models, feature extraction, testing)
15. October 13, 2026 (Tuesday)	**DNN models of vision 2** DNN models of vision now. Successes and limitations
16. October 15, 2026 (Thursday)	**Group project time** *Hands-on data analysis and computational modeling*
17. October 20, 2026 (Thursday)	**Group project time** *Hands-on data analysis and computational modeling*
18. October 22, 2026 (Tuesday)	Tutorial #3: Building linear encoding models
19. October 27, 2026 (Thursday)	**Learning and recurrence**

	Making models more human-like. Unsupervised learning, semi-supervised learning, feedback, recurrence
20. October 29, 2026 (Tuesday)	**The computational challenge of audition** Transforming pressure patterns into sound
21. November 3, 2026 (Thursday)	**Group project time** *Hands-on data analysis and computational modeling*
22. November 5, 2026, 2026 (Tuesday)	**DNN models of audition** CochDNN models of auditory cortex and auditory metamers
23. November 10, 2026, 2026 (Thursday)	**Language models** LLMs as models of language and cognition
24. November 12, 2026 (Tuesday)	**Group project time** *Hands-on data analysis and computational modeling*
25. November 17, 2026, 2026 (Thursday)	**Topographic models of the brain** ANNs as tools to study neural network function
26. November 19, 2026 (Tuesday)	Tutorial #4: Training neural network models
27. November 24, 2026 (Thursday)	**Group project time** *Summarize results and prepare presentations*
28. November 26 (Thursday)	Thanksgiving Break
29. December 1, 2026 (Thursday)	**Recap Class**
30. December 3, 2026 (Tuesday)	**Final project finalization time**
31. December 8, 2026 (Tuesday)	**Paper submissions**

Academic Integrity:
All students are assumed to have read the Code of Student Conduct and consented to be bound by it: https://policylibrary.gatech.edu/student-life/student-code-conduct. Violations of these rules of conduct are taken extremely seriously and will result in a failing grade for the course. Specific violations include (but are not limited to):

- Use or provision of prohibited assistance during quizzes or exams
- Sharing of outside assignments such as research reports or papers
- Plagiarism- This includes both the use of the words and ideas without attribution (e.g., by presenting online materials as if they were your own work)

Policy on Use of Generative AI (Artificial Intelligence) for class work:
In this class, we treat AI-based assistance, such as ChatGPT, the same way we treat collaboration with other people: for both individual and team-based assignments, you are welcome to discuss your ideas and work with other people, both inside and outside the class, as well as with AI-based assistants.

However, all work you submit must be your own. You should never include in your assignment anything that was not written directly by you without proper citation (including quotation marks and in-line citation for direct quotes).

Including anything you did not write in your assignment without proper citation will be treated as an academic misconduct case. If you are unsure where the line is between collaborating with AI and copying AI, we recommend the following heuristics:

Heuristic 1: Never hit "Copy" within your conversation with an AI assistant. You can copy your own work into your own conversation but do not copy anything from the conversation back into your assignment.

Instead, use your interaction with the AI assistant as a learning experience, then let your assignment reflect your improved understanding.

Heuristic 2: Do not have your assignment and the AI agent open at the same time. Similar to the above, use your conversation with the AI as a learning experience, then close the interaction down, open your assignment, and let your assignment reflect your revised knowledge.

This heuristic includes avoiding using AI directly integrated into your composition environment: just as you should not let a classmate write content or code directly into your submission, so you should also avoid using tools that directly add content to your submission.

Deviating from these heuristics does not automatically qualify as academic misconduct; however, following these heuristics essentially guarantees your collaboration will not cross the line into misconduct.

Disability Services Accommodations Procedures for Students:
Georgia Tech complies with the regulations of the Americans with Disabilities Act of 1990 and offers accommodations to students with disabilities. If you need classroom accommodation, please make an appointment with the Office of Disability Services to discuss the appropriate procedures. Their website is www.disabilityservices.gatech.edu

Technology:
Cell phones should be kept on vibrate or silent. If you anticipate a phone call, let us know before class. There may be various times we use cell phones for class participation (in-class quizzes, texting polls, etc.). We welcome new technology and look forward to incorporating it into our classroom environment, but not at the cost of your learning.

Student Well-Being
It is important for us to promote health/wellness and belonging in this course, as well as remove barriers to well-being. We are aware that you may experience stressors that impact your academic experience. We do not want hunger or thirst to affect your ability to stay focused and engaged in this course, therefore, you are welcome to bring snacks/meals into this classroom. We encourage you to stay hydrated, so you are welcome to bring a water bottle and fill/refill it. If you need to take a break that requires you to leave the classroom briefly, that is fine but please try to limit the break to 4-5 minutes maximum. Otherwise, a break of 5 minutes is integrated into the class schedule for every 45 min of class time.

Campus Resources for Students

There is a myriad of resources at Georgia Tech to support you. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. Below you will find some resources to support you both as a student and as a person.

Academic support

Center for Academic Success http://success.gatech.edu

Tutoring & Academic Support https://tutoring.gatech.edu/

Peer-Led Undergraduate Study (PLUS) http://success.gatech.edu/tutoring/plus

Academic coaching http://success.gatech.edu/coaching

Residence Life's Learning Assistance Program https://housing.gatech.edu/learning-assistance-program

Academic advisors for your major http://advising.gatech.edu/

Personal Support

Georgia Tech Resources

The Office of the Dean of Students: https://studentlife.gatech.edu/ **404-894-6367**; Smithgall Student Services Building 2nd floor. You also may request assistance at https://gatech-advocate.symplicity.com/care_report/index.php/pid423974?

Center for Mental Health Care & Resources provides crisis intervention, testing and assessment, short-term individual counseling, group counseling, couples counseling, and referrals to on and off campus resources. To schedule an appointment, you can call the Center at **404-894-2575** or walk into the office, Suite 238, Smithgall Student Services "Flag" Building to schedule an appointment. Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. *Students in crisis during the day can walk into the assessment suite (8am-4pm, Monday through Friday). To reach the on call after hours (after 5:00 pm on weekends and during the weekends) call 404-894-2575 and follow the prompts.*

Students' Temporary Assistance and Resources (STAR): https://star.studentlife.gatech.edu/. STAR services include Campus Closet, Financial Assistance, Housing, and Klemis Kitchen

Stamps Health Services: https://health.gatech.edu; 404-894-1420. Primary care, pharmacy, women's health, psychiatry (referrals to psychiatry start in the Center for Mental Health Care & Resources), immunization and allergy, health promotion, and nutrition

Wellness Empowerment Center: wellnesscenter.gatech.edu/ 404-894-9980.WE Center provides upstream, innovative, and relevant programs, services, and initiatives to help students and employees thrive.

VOICE Victim-Survivor Support: https://healthinitiatives.gatech.edu/support-services/advocacy

Women's Resource Center: http://www.womenscenter.gatech.edu; 404-385-0230

LGBTQIA Resource Center: http://lgbtqia.gatech.edu/; 404-385-2679

Veteran's Resource Center: http://veterans.gatech.edu/; 404-385-2067

OMED: Educational Services: http://www.omed.gatech.edu; 404-894-3959

Georgia Tech Police: https://police.gatech.edu/ 404-894-2500

Statement of Intent for Inclusivity: As a member of the Georgia Tech community, we are committed to creating a learning environment in which all our students feel safe and included. Because we all are individuals with varying needs, we are reliant on your feedback to achieve this goal. To that end, we invite you to enter into dialogue with us about the things we can stop, start, and continue doing to make my classroom an environment in which every student feels valued and can engage actively in our learning community.