

PSY 51300 Introduction to Computational Cognitive Neuroscience

Spring 2025

Last updated: January 31, 2025

Instructor

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Class Meeting Time and Location

Tuesdays and Thursdays 9:30 am - 10:45 am at PRCE 255 (the Computer Room)

Office Hours

We are going to hold office hours together on Fridays 1:00 pm - 3:00 pm at PRCE 365E

Alternative meeting times can be arranged if the regular office hours are not convenient.

Anyone is welcome to join us during office hours to discuss anything about computational modeling, neuroscience, psychology, physics, math, etc.

Course Description

This 3-credit course will provide an introduction to computational cognitive neuroscience. The course will focus on using deep learning models and other mathematical and computational methods to build models that can help us understand the cognitive functions of the brain. The course will introduce some important computational models in lectures and will allow students to get hands-on programming experience in discussion sessions and homework assignments.

Recommended Prerequisites

Programming: The course will primarily use Python for programming. Some programming experience with Python or any other programming language is highly recommended. Stu-

dents who do not have any programming experience may still take the course if they are willing to learn and complete some preparatory tutorials at the beginning of the course.

Math: Basic knowledge about Probability and Statistics, Calculus, and Linear Algebra is highly recommended. Students who do not have sufficient math background may still take the course if they are willing to learn and complete some preparatory tutorials at the beginning of the course.

Psychology and Neuroscience: Knowledge about Psychology and Neuroscience is recommended but not required.

List of prerequisites for undergraduate students:

(MA 26500 or MA 35100 or equivalent) and (STAT 35000 or STAT/MA 41600 or STAT 41700 or equivalent)

Tentative Outline

Week 1: Model Types

Week 2: Model Fitting

Week 3: Introduction to Reinforcement Learning

Week 4: Different Kinds of Reinforcement Learning Models

Week 5: Introduction to Artificial Neural Networks

Week 6: Convolutional Neural Network

Week 7: Hopfield Network and Boltzmann Machine

Week 8: Hidden Markov Model and Variational Autoencoder

Week 9: Generative Models, Active Inference, and the Free Energy Principle Theory in Neuroscience

Week 10: Spring Break (No Class)

Week 11: Transformer

Week 12: Computational Theories About Consciousness

Week 13: Cognitive Neuroscience Theories About Art

Week 14: NeuroAI (Deep Reinforcement Learning, Monte Carlo Tree Search, etc.)

Week 15: Project Presentations

Week 16: Office Hours (No Class)

Course Format and Student Expectations

The class will meet twice a week, and students are expected to attend every class.

On Tuesday, the instructor will give a lecture to the class introducing the topic. The Thursday class meeting will be a discussion session in which students will discuss materials in the tutorials provided by the instructor. All tutorials are Jupyter Notebooks in Python, designed to be run on Google Colab.

Starting from the second week, each student needs to post **at least 3 discussion questions or comments** online on Piazza based on the tutorial for the current week by **5:00 pm** on Wednesday. Students are encouraged to review each other's questions and comments and to discuss them with one another on Piazza, both before and after class.

One student will lead each discussion session, and all students are expected to ask and answer questions. The instructor will provide guidance during the discussion. There will also be some simple programming exercises for the students to complete in the tutorials. Students can discuss and complete the programming exercises during the class.

If any programming exercises are not finished during the class, students can complete them at home. **Students need to submit their completed tutorials by the end of next Monday.**

There will be a take-home midterm assignment and a course project. The take-home tutorial will be an assignment with exercises that the students need to complete at home.

For the course project, students can build a simple model that is related to any psychology or neuroscience topics based on their interests. Students may work independently or complete the course project in groups of two or three. The expected effort and output will be proportional to the group size.

Educational Platforms

Google Colab:

We will primarily use Google Colab to run the code in the tutorials. The tutorials are Jupyter Notebooks in Python, so it is also possible to run the code in other environments if using Colab is not convenient for the student.

Brightspace:

The course materials, including lecture notes, tutorials, assignment announcements, and grades will be posted on Brightspace. The weekly assignments (completed tutorials) should be submitted on Brightspace.

Piazza:

We will use Piazza for class discussion.

(sign up link: <https://piazza.com/purdue/spring2025/psy51300>)

Starting from the second week, each student is required to post at least 3 discussion questions or comments online on Piazza based on the tutorial for the current week by 5:00 pm on Wednesday. We also encourage you to post them on Piazza if you have any other questions about the course content, assignments, or project. It is a shared discussion forum, where you can get help quickly and efficiently from your classmates, the TA, and the instructor while benefiting other students with similar questions.

Assessment and Grading

Final Grades will be calculated as follows:

Attendance/Participation: 30%

Leading Discussion Sessions: 10%

Completing Weekly Tutorials: 30%

Midterm Assignment: 10%

Final Project: 20%

Final Grade Cutoffs:

85%: A

75%: B

65%: C

55%: D

less than 55%: F

+ and - Grades will be assigned to the scores close to the above cutoffs.

Academic Honesty

You are encouraged to discuss the exercises in tutorials and other course materials with other people. However, you are expected to complete all tutorial assignments by yourself after you have understood the materials.

For the course project, you are expected to develop models, implement the models with code, and write a project report by yourselves. You may get help from outside resources when necessary, but you must be the primary individuals conducting the project, understand every part of it, and ensure that your course project reflects your own ideas.

Nondiscrimination Statement

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. More details are available on our course Brightspace table of contents, under University Policies.

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the

Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. More details are available on our course Brightspace under Accessibility Information.

Mental Health Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack. Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am - 5 pm. If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: 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 mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Disclaimer

This syllabus is tentative and subject to change. Any substantive change will be communicated to the students.