

Neural Computation, Minor

Neural Computation Minor

Dr. Tai Sing Lee, *Director*
Melissa Stupka, *Administrative Coordinator*

<https://www.cmu.edu/ni/academics/undergrad/minor-neural-computation>

Overview

Neural computation is a scientific enterprise to understand the neural basis of intelligent behaviors from a computational perspective. Study of neural computation includes, among others, decoding neural activities using statistical and machine learning techniques, and developing computational theories and neural models of perception, cognition, motor control, decision-making and learning. The neural computation minor allows students to learn about the brain from multiple perspectives, and to acquire the necessary background for graduate study in neural computation. Students enrolled in the minor will be exposed to, and hopefully participate in, the research effort in neural computation and computational neuroscience at Carnegie Mellon University.

The minor in Neural Computation is an intercollege minor jointly sponsored by the School of Computer Science, the Mellon College of Science, and the Dietrich College of Humanities and Social Sciences, and is coordinated by the Neuroscience Institute (<https://www.cmu.edu/ni/>).

The Neural Computation minor is open to students in any major of any college at Carnegie Mellon. It seeks to attract undergraduate students from computer science, psychology, engineering, biology, statistics, physics, and mathematics from SCS, CIT, DC and MCS. The primary objective of the minor is to encourage students in biology and psychology to take computer science, engineering and mathematics courses, to encourage students in computer science, engineering, statistics and physics to take courses in neuroscience and psychology, and to bring students from different disciplines together to form a community. The curriculum and course requirements are designed to maximize the participation of students from diverse academic disciplines. The program seeks to produce students with both basic computational skills and knowledge in cognitive science and neuroscience that are central to computational neuroscience.

Application

Students must apply for admission no later than November 30 of their senior years; an admission decision will usually be made within one month. Students are encouraged to apply as early as possible in their undergraduate careers so that the director of the Neural Computation minor can provide advice on their curriculum, but should contact the program director any time even after the deadline.

To apply, send email to the director of the Neural Computation minor Dr. Tai Sing Lee (tai@cnbc.cmu.edu) and copy Melissa Stupka (mstupka@andrew.cmu.edu). Include in your email:

- Full name
- Andrew ID
- Preferred email address (if different)
- Your class and College/School at Carnegie Mellon
- Semester you intend to graduate
- All (currently) declared majors and minors
- Statement of purpose (maximum 1 page) - Describes why you want to take this minor and how it fits into your career goals
- Proposed schedule of required courses for the Minor (this is your plan, NOT a commitment)
- Research projects you might be interested in

Curriculum

The Minor in Neural Computation will require a total of five courses: four courses drawn from the four core areas (A: neural computation, B: neuroscience, C: cognitive psychology, D: intelligent system analysis), one from each area, and one additional depth elective chosen from one of the core areas that is outside the student's major. The depth elective can be replaced by a one-year research project in computational neuroscience. No more than two courses can be double counted toward the student's major or other minors. However, courses taken for general education requirements of the student's degree are not considered to be double counted. A course taken to satisfy one core area cannot be used to satisfy the course requirement for another core area. The following listing presents a set of

current possible courses in each area. Other computational neuroscience courses are being developed at Carnegie Mellon and University of Pittsburgh that will also satisfy core area A requirement and the requirements will be updated as they come on-line. Substitution is possible but requires approval.

A. Neural Computation

		Units
15-386	Neural Computation	9
15-387	Computational Perception	9
15-883	Computational Models of Neural Systems	12
85-414	Cognition in the Age of AI	9
85-419	Introduction to Parallel Distributed Processing	9
85-420	Biologically Intelligent Exploration	9
86-452	Principles of NeuroAI	9
Pitt-Mathematics-1800	Introduction to Mathematical Neuroscience	9

B. Neuroscience

03-362	Cellular Neuroscience	9
03-363	Systems Neuroscience	9
03-365	Neural Correlates of Learning and Memory	9
86-765	Foundations of the Neural Basis of Cognition	9

C. Cognitive Psychology

85-211	Cognitive Psychology	9
85-213	Human Information Processing and Artificial Intelligence	9
85-408	Visual Cognition	9
85-412	Cognitive Modeling	9
85-413	Perception	9
85-414	Cognition in the Age of AI	9
85-419	Introduction to Parallel Distributed Processing	9
85-472	Cognitive Neuropsychology	9
86-765	Foundations of the Neural Basis of Cognition	9

D. Intelligent System Analysis

10-301	Introduction to Machine Learning	12
10-423	Generative AI	12
10-733	Representation and Generation in Neuroscience and AI	12
15-281	Artificial Intelligence: Representation and Problem Solving	12
15-386	Neural Computation	9
15-387	Computational Perception	9
16-281	General Robotics	12
16-299	Introduction to Feedback Control Systems	12
16-385	Computer Vision	12
18-290	Signals and Systems	12
24-352	Dynamic Systems and Controls	12
36-401	Modern Regression	9
36-410	Introduction to Probability Modeling	9
36-759	Statistical Models of the Brain	12
42-630	Introduction to Neural Engineering	12
42/86-631	Neural Data Analysis	12
42-632	Neural Signal Processing	12
42-633	Brain-Computer Interface: Principles and Applications	12
85-270	Computational Approaches for Neuroscience Questions	9
85-432	Data Science for Psychology and Neuroscience	9

Prerequisites

The required courses in the above four core areas require a number of basic prerequisites: basic programming skills at the level of 15-110 Principles of Computing and basic mathematical skills at the level of 21-122 Integration and Approximation or their equivalents. Some courses in Area

D require additional prerequisites. Area B Biology courses require, at minimum, 03-121 Modern Biology. Students might skip the prerequisites if they have the permission of the instructor to take the required courses. Prerequisite courses are typically taken to satisfy the students' major or other requirements. In the event that these basic skill courses are not part of the prerequisite or required courses of a student's major, one of them can potentially count toward the five required courses (e.g. the depth elective), conditional on approval by the director of the minor program.

Research Requirements (Optional)

The minor itself does not require a research project. The student however may replace the depth elective with a year-long research project. In special circumstances, a research project can also be used to replace one of the five courses, as long as (1) the project is not required by the student's major or other minor, (2) the student has taken a course in each of the four core areas (not necessarily for the purpose of satisfying this minor's requirements), and (3) has taken at least three courses in this curriculum not counted toward the student's major or other minors. Students interested in participating in the research project should contact any faculty engaged in computational neuroscience or neural computation research at Carnegie Mellon or in the University of Pittsburgh. A useful webpage that provides listing of faculty in neural computation is <https://www.cmu.edu/ni/academics/pnc/pnc-training-faculty.html>. The director of the minor program will be happy to discuss with students about their research interest and direct them to the appropriate faculty.

Fellowship Opportunities

The Program in Neural Computation (PNC) administered by the Neuroscience Institute currently provides 3-4 competitive full-year fellowships (\$11,000) to Carnegie Mellon undergraduate students to carry out mentored research in neural computation. The fellowship has course requirements similar to the requirements of the minor. Students do not apply to the fellowship program directly. They have to be nominated by the faculty members who are willing to mentor them. Therefore, students interested in the full-year fellowship program should contact and discuss research opportunities with any PNC Training faculty at Carnegie Mellon or University of Pittsburgh working in the area of neural computation or computational neuroscience and ask for their nomination by sending email to Dr. Tai Sing Lee, who also administers the undergraduate fellowship program at Carnegie Mellon. See <https://www.cmu.edu/ni/academics/undergrad/research-fellowships-computational-neuroscience> for details.

The Program in Neural Computation also offers a summer training program for undergraduate students from any U.S. undergraduate college. The students will engage in a 10-week intense mentored research and attend a series of lectures in neural computation. See <https://www.cmu.edu/ni/academics/undergrad/summer-research-program-neural-computation> for application information.