

Computational Neuroscience

This multidisciplinary concentration spans many fields, including computer science, neuroscience, cognitive science, applied math, and data science. Students studying Computational Neuroscience will learn to use computational models of the brain and nervous system to study complex biological processes and overcome the limitations of human experimentation. They will also learn to use the brain and nervous system as a model to improve the power and efficiency of artificial systems. Concentrators will think critically about the impact of their work on society and understand how biases can negatively influence computational models.

Standard program for the Sc.B. Degree

Background Courses (must take one of each):

Calculus		
MATH 0100	Single Variable Calculus, Part II	
Differential Equations		
APMA 0350	Applied Ordinary Differential Equations	
Linear Algebra		
MATH 0520	Linear Algebra	
or MATH 0540	Linear Algebra With Theory	
Statistics		
APMA 1650	Statistical Inference I	
or APMA 1655	Honors Statistical Inference I	
or CLPS 0900	Statistical Methods	
or BIOL 0495	Statistical Analysis of Biological Data	
or CSCI 1450	Advanced Introduction to Probability for Computing and Data Science	

Core Concentration Courses:

NEUR 0010	The Brain: An Introduction to Neuroscience	1
NEUR 1020	Principles of Neurobiology	1
or NEUR 1030	Neural Systems	
CSCI 0111	Computing Foundations: Data	1
or CSCI 0112	Computing Foundations: Program Organization	
or CSCI 0150	Introduction to Object-Oriented Programming and Computer Science	
or CSCI 0170	Computer Science: An Integrated Introduction	
or CSCI 0190	Accelerated Introduction to Computer Science	
CSCI 0200	Program Design with Data Structures and Algorithms	1
or CSCI 0190	Accelerated Introduction to Computer Science	
NEUR 0680	Introduction to Computational Neuroscience	1

Two Computational Neuroscience Electives From The Below List: 2

CLPS 1492	Computational Cognitive Neuroscience	
NEUR 1440	Mechanisms and Meaning of Neural Dynamics	
NEUR 1660	Neural Computation in Learning and Decision-Making	
CLPS 1291	Computational Methods for Mind, Brain and Behavior	
CSCI 1810	Computational Molecular Biology	
NEUR 1940B	Deep Learning in Neuroethology	
NEUR 1630	Big Data Neuroscience Ideas Lab	
CLPS 1950	Deep Learning in Brains, Minds and Machines	

CLPS 1850	Language Processing in Humans and Machines	
HIST 1956S	History of Artificial Intelligence	
NEUR 2110	Statistical Neuroscience	

One Course in Artificial Intelligence: 1

CSCI 1410	Artificial Intelligence	
CSCI 1420	Machine Learning	
CSCI 1430	Computer Vision	
CSCI 1460	Computational Linguistics	
CSCI 1470	Deep Learning	
DATA 2060	Machine Learning: from Theory to Algorithms	

Two Upper-Level Neuroscience Electives 2

Two courses that will enhance your understanding of the field of neuroscience. While electives need not be from the neuroscience department, the following list are common courses taught by Neuroscience and other departments that are often used as electives. We encourage students to explore the broader course catalog and consult with their concentration advisor to explore the full range of electives, rather than limiting themselves to this list. These electives must be of 1000-level or above.

CLPS 1400	The Neural Bases of Cognition	
ENGL 1900Z	Neuroaesthetics and Reading	
ENGN 1220	Neuroengineering	
NEUR 1540	Neurobiology of Learning and Memory	
NEUR 1650	Structure of the Nervous System	
NEUR 1740	The Diseased Brain: Mechanisms of Neurological and Psychiatric Disorders	

One Elective in Ethics: 1

CSCI 1805	Computers, Freedom and Privacy	
CSCI 1951Z	Fairness in Automated Decision Making	
DATA 0080	Data, Ethics and Society	
ENGN 1800	Social Impact of Emerging Technologies: The Role of Scientists and Engineers	
PHIL 0401	Ethics of Digital Technology	
PHIL 0403	Ethics and Politics of Data	
APMA 1910	Race and Gender in the Scientific Community	
STS 1700T	Race, Gender, and Technology in Everyday Life	

Two Additional Electives: 2

Two courses that will enhance your understanding of the field of computational neuroscience. These electives are not limited to a specific department, and are able to be any of the courses already listed for this concentration (though, you cannot cross-count an elective with a named requirement). The following list are courses that we recommend be used as electives, however, we encourage students to explore the broader course catalog and consult with their concentration advisor to explore the full range of electives, rather than limiting themselves to this list. Students can substitute TWO semesters of independent study (NEUR1970 or equivalent course from another department) for one elective course

APMA 0160	Introduction to Scientific Computing	
APMA 0200	Introduction to Modeling	
APMA 0360	Applied Partial Differential Equations I	
APMA 1070	Quantitative Models of Biological Systems	
APMA 1170	Introduction to Computational Linear Algebra	
APMA 1360	Applied Dynamical Systems	
APMA 1660	Statistical Inference II	
APMA 1690	Computational Probability and Statistics	
APMA 1710	Information Theory	

APMA 1740	Recent Applications of Probability and Statistics	
APMA 1860	Graphs and Networks	
APMA 1941D	Pattern Theory	
BIOL 1435	Computational Methods for Studying Demographic History with Molecular Data	
BIOL 1555	Methods in Informatics and Data Science for Health	
CLPS 0450	Brain Damage and the Mind	
CLPS 0800	Language and the Mind	
CSCI 0535	Linear Algebra for Machine Learning	
CSCI 1010	Theory of Computation	
CSCI 1570	Design and Analysis of Algorithms	
CSCI 1951A	Data Science	
ENGN 2912P	Topics in Optimization	
MATH 1210	Probability	
PHYS 1610	Biological Physics	
NEUR 1900	Capstone	1
Total Credits		14