Neural Processing in Artificial Minds

Spring 2016

Instructor:	Emre Neftci & Jeff Krichmar	**Time:**	Tu Th 9:30 – 10:50
Email:	eneftci@uci.edu jkrichma@uci.edu	**Place:**	SBSG 240.

Course Overview: This course focuses on brain-inspired models to create artificial minds. These models have the potential to create artificial intelligence and could lead to a better understanding of brain processing for artificial intelligence. This course will explore in the algorithmic bases of intelligence, by bridging machine learning and biological processes of learning in the brain, and understanding the outstanding challenges in evoking intelligence in artificial minds.

After a description of simple models of biological neurons, the course will approach artificial minds from the standpoint of neural networks. We will explore how models of artificial neural networks can recognize patterns, and learn to do so. This will be followed by basic concepts of deep learning and how inspiration from the anatomy of the visual cortex constrains deep networks and vastly improves their performance at recognizing images. Next, we will look into neural networks that can maintain working memory for evaluating sequences and use associative memory to recall patterns from partial information. We will examine how neural models can learn to make decisions and put together behavioral sequences.

This course is ideal for students interested in machine learning and reinforcement learning techniques but that do not have the mathematical background to access advanced courses on these topics. The course is intended to be accessible to students from a broad range of disciplines, with varying background knowledge in the field. However, quantitative reasoning skills are required for the assignments and to understand the core concepts of neural processing and artificial minds.

Assignments in this course will be programming-based. The programming language used throughout the course is Python. The instructors will introduce the necessary programming concepts for this course during the first weeks. Prior programming skills are not necessary, but you may want to use these resources as references: `http://www.scipy-lectures.org/intro/index.html` (sections 1.1 through 1.4).

No single textbook that covers all the material, but the following books provide useful complementary information on some of the covered topics.

Key References:

[1] M. A. Nielsen. *Neural Networks and Deep Learning*. 2015.

[2] Mark F Bear, Barry W Connors, and Michael A Paradiso. *Neuroscience*. Vol. 2. Lippincott Williams & Wilkins, 2007.

[3] P. Dayan and L.F. Abbott. *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems*. MIT Press, 2001.

[4] J. von Neumann. *The Computer and the Brain*. New Haven, CT, USA: Yale University Press, 1958, pp. xiv + 82.

Course Pages: `http://nmi-lab.org/teaching`

Office Hours: Tu 11:00 - 12:30 or by appointment at SBSG 2308 .

Tentative Course Schedule:

Introduction to Neural Processing and Artificial Minds	Mar 29
Introduction to Python Programming	Mar 31
From biological neurons to artificial neurons	Apr 5, 7
Pattern Recognition	Apr 12
Deep Neural Networks	Apr 14, 19
Visual Cortex-inspired Pattern Recognition	Apr 21, 26
Neural models of Associative memory	Apr 28
Mid-Term	May 3
Population coding and Brain Machine Interfaces	May 5
Action Selection and Decision Making	May 10, 12
Behavioral sequence learning	May 17, 19
TBD	May 24, 26, 31
Final Exam Q&A	Jun 2

Grading: Assignments (30%), Midterm (20%), Final (50%). No make-up examinations. Reports and assignments must be submitted before the deadline posted with each assignment sheet.

Important Dates:

Midterm	May 3, 2016
Final Exam	Jun 7, 2016

Academic Misconduct: Students found to be guilty of plagiarism or cheating as defined by official university policy will automatically receive an "F" in the course. Other actions consistent with university policy may also be taken where deemed appropriate. Important information on how the university responds to instances of academic dishonesty can be found at http://honesty.uci.edu/students.html.