

# NEURAL PROCESSING IN ARTIFICIAL MINDS

Spring 2016

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<b>Instructor:</b>	Emre Neftci & Jeff Krichmar	<b>Time:</b>	Tu Th 9:30 – 10:50
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**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).

There is no required book. The course is based on material from the following books, and may provide useful complementary information.

## Key References:

- [1] M. A. Nielsen. *Neural Networks and Deep Learning*. 2015.
- [2] Peter Sterling and Simon Laughlin. *Principles of neural design*. MIT Press, 2015.
- [3] Mark F Bear, Barry W Connors, and Michael A Paradiso. *Neuroscience*. Vol. 2. Lippincott Williams & Wilkins, 2007.
- [4] P. Dayan and L.F. Abbott. *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems*. MIT Press, 2001.
- [5] 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>

**Teaching Assistant:** Ryan Stokes [stokesr@uci.edu](mailto:stokesr@uci.edu)

**Office Hours:**

- **Neftci:** Tu 11:00 - 12:30 or by appointment at SBSG 2308
- **Krichmar:** Tu Th 1:30 - 3:00 SBSG 2328
- **Stokes (TA):** Tu 1:00 - 3:00 SBSG 2246

**Tentative Course Schedule:**

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

**Grading:** Assignments (20%), Midterm (30%), Final (50%). No written make-up examinations. Reports and assignments must be submitted before the deadline posted with each assignment sheet. There will be 5 individually graded assignments. The overall grade for the assignments will be calculated using the best 4 grades.

**Important Dates:**

Midterm .....	May 3, 2016
Final Exam .....	Jun 9, 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>.