COGS 205D: Neural Networks and Machine Learning

Winter 2019

Instructor:	Emre Neftci	**Time:**	Fri 9:00AM – 11:50PM
Email:	eneftci@uci.edu	**Place:**	SBSG 2200.

Teaching Assistant: None

Office Hours:

- **Neftci:** Wednesdays 1:00PM - 5:00 by appointment at SBSG 2308. Appointements can be booked through Google Calendar Appointments

Course goals and description: Machine learning and artificial intelligence repeatedly broke new grounds in solving pattern recognition, signal processing, and complex cognitive tasks. The relevance of such feats to neural and cognitive sciences is twofold: (1) Provide state-of-the-art methods for large-scale data analysis and prediction, and (2) Guide our understanding how the building blocks of the brain support cognition.

This course will introduce the basics of machine learning and neural networks, teach the usage of established software tools, explore commonly used models and neural networks architectures, and construct bridges between machine learning and neuroscience. Each class will include a lecture component, and will be followed by hands-on experimentation using software.

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, including basic calculus and computer programming are necessary to understand and implement the core concepts of machine learning and neural dynamics. In case of doubt, interested students are encouraged to e-mail the instructor.

The programs distributed for the hands-on exercises and assignments will be written in Python and Pytorch. The instructor will introduce Pytorch Python package for simulating large-scale models. Students are expected to have basic scientific programming skills in Python, and be familiar with the concepts in sections 1.1 through 1.4 here: `http://www.scipy-lectures.org/intro/index.html`.

Students will be evaluated on assignments and a project of their choice and present it orally on the last week. Ideally, this project should related to the students' research.

Prerequisites: None.

Reading list/texts: The course is based on material from the following books, and may provide useful complementary information. Specific reading will be assigned weekly.

[1] Ian Goodfellow, Yoshua Bengio, and Aaron Courville. *Deep learning*. MIT press, 2016.

[2] Wulfram Gerstner, Werner M Kistler, Richard Naud, and Liam Paninski. *Neuronal dynamics: From single neurons to networks and models of cognition*. Cambridge University Press, 2014.

[3] C.M. Bishop. *Pattern recognition and machine learning*. Springer-Verlag New York, Inc. Secaucus, NJ, USA, 2006.

Assessment:

- Assignments (50%): Assignments will be due every other weed and must be submitted before the deadline posted with each assignment sheet.
- Project (50%): Students will be evaluated on an individual project of their choice and present it orally on week 10 to the class. Ideally, this project should related to the students' research and, if applicable, using pre-collected data.

Reports and assignments must be submitted before the deadline posted with each assignment sheet. There will no more than 3 individually graded assignments.

Participation guidelines:

- Participation is essential for success in this class. Regular attendance are mandatory.
- Please review the assigned readings before each class and be ready to ask questions and participate in the discussion.
- Lectures will reinforce and supplement the readings. The material covered in lectures will be included in the exams.

Topical outline for lectures:

Introduction, Historical perspective, Course logistics .....
Pattern Classification, k Nearest Neighbor, Perceptrons, Linear Classification .....
Introduction to deep learning, Python software and computer setup .....
Machines learning, loss functions, optimization and learning .....
Neural Networks, Multilayer Networks, Gradient Backpropagation .....
Models and Architectures for Visual Pattern Classification: ConvNet variants .....
Models and Achitectures for pattern generation: Autoencoders, VAE, GAN .....
Sequence Modeling: Recurrent Neural Networks, LSTM, WaveNet .....
Language Modeling: Embeddings, Transformer Networks .....
From Artificial Neural Nets to Biological Neural Nets: Surrogate Gradient Learning .....
Final Projects Presentation .....

Important Dates:

Project Presentation ..... Dec. 6 2019
Project Report Due ..... Dec. 13 2019

Academic integrity: Please familiarize yourself with UCI policies on academic integrity: https://aisc.uci.edu/students/academic-integrity/definitions.php

Campus support services:

- Learning and Academic Resource Center (LARC) http://www.larc.uci.edu/students/
- Disability Services Center (DSC) UCI is committed to supporting and accommodating students with disabilities. Students with disabilities are invited to meet with me privately to discuss their needs. If you have questions, please visit the DSC website (https://www.dsc.uci.edu/index.php) or contact them via phone (949-824-7494) or email: dsc@uci.edu.
- Counseling and Emergency Services http://www.counseling.uci.edu/emergency/