Deep Learning in Robotics
CS4910 — Spring 2022

Instructor Information

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Office Hours: TBD

Class Information

Time: TF 3:25 - 5:05 PM
Classroom: Room 204, Behrakis Health Sciences Center
Website

Course Description

This course explores topics in deep learning with applications to robotic grasping. During the first portion of the course, students will learn how to implement several learning algorithms using PyTorch and understand basic concepts in robotic manipulation. The rest of the course will be project-based, with students working in groups to develop a learning algorithm to perform an interesting manipulation task with a low-cost robotic arm.

Course Objectives

After this course, you should be able to...

- Design neural network architectures with PyTorch
- Understand the core differences between and use-cases for supervised, unsupervised and reinforcement learning
- Determine metrics and generate plots to debug and improve the training of neural networks
- Publish open-source Python packages that can be downloaded with pip, are well-documented, and have a proper license

Computer

Any computer that that can write and execute Python code is suitable for this course. For additional compute power when training neural networks, you may use Google Colab or potentially Northeastern's HPC. To send commands to the robot, you will need a USB-A port (adapters can be rented from ITS).

Robot

All students will have access to a small robotic arm for testing learning algorithms. The robots will

be available for use during class or can be taken home. For logistic purposes, please fill out this form to use a robot outside of class.

Class Attendance and Participation

Students are expected to attend class and follow along with any coding examples. Classes will not be recorded but all materials will be available afterwards on the website. Participation will make up 30% of your grade; to receive a good grade you should come prepared for discussions about your final project when applicable (see discussion days marked on the schedule; these will occur weekly for the second half of the course).

Surveys

There will be short surveys each week to allow students to provide feedback on the course. They should only take a few minutes to fill out and the responses will be anonymous.

Assignments

In the first few weeks of the class, there will be short (4-6 hour) programming assignments to provide a basic introduction to PyTorch, neural network architectures, deep learning methods, and robotic manipulation concepts. The purpose of the assignments is to give you a strong foundation so you can be creative and productive with your project. Solutions will be provided for all assignments after they are due.

Final Project

The final project is to apply a deep learning method to solve an interesting manipulation problem on a low-cost robotic arm. Students will work in groups of 2-4 on their projects. Students are encouraged to refine and test methods in the simulator but should work toward deploying their code on the real robot arm. For more details on the project and what is expected, look for the project description on the course website.

Grading

The course grade is determined by the following components:

Assignments	20%
Participation	30%
Final Project	50%

You will not be graded on a curve. Any student who works earnestly, regardless of their background experience with deep learning, can do well in this class.

Late Policy

For every day that an assignment is late, the grade will drop by 20%. For instance, if you turn in a

perfect assignment two days late, then you will get a 60%. You have three late-days that you can use on the assignments.

Academic Integrity

Be honest about citing other people's work. If you want to use code that you found online, add a comment that indicates where it came from.

Use of Student Work

In compliance with the federal Family Educational Rights and Privacy Act, registration in this class is understood as permission for assignments prepared for this class to be used anonymously in the future for educational purposes.

Email Policy

Email is the most effective way to reach out to the Instructor outside of class hours. To increase the likelihood of a quick response, please add [CS4910] to the beginning of email subject lines. For instance, an acceptable subject line would be "[CS4910] Help! My robot has become sentient".

Schedule

The schedule may change, so the most up-to-date version can be found on the course website. The first part of the course is designed to give you a strong foundation of skills to excel on the project. The second part of the course is less structured: one day per week will be a lecture on a topic related to the final project, while the other day will be reserved for meeting with your project groups and getting feedback on your progress from the instructor. Possible lecture topics include the following:

- Policy Learning Methods
- Grasp Mechanics and Planning
- Exploiting Symmetry in Neural Networks
- Transfer Learning
- Proto Manipulation
- Goal-Conditioned Reinforcement Learning
- Real-world Data Collection for Robotics