CMSC389F: Reinforcement Learning

Credits: 1

Description:
This course provides an overview of the key concepts and algorithms of Reinforcement Learning, an area of artificial intelligence research responsible for recent achievements such as AlphaGo and robotic control. Students will implement learning algorithms for simple tasks such as mazes and pong games.

Hard Prerequisites:
- Minimum grade of C- or better in CMSC216
- Minimum grade of C- or better in CMSC250 or MATH310

Recommended:
- Proficiency in Python (numpy)
- Calculus and Linear Algebra (MATH141, MATH240)
- Probability & Statistics (STAT400)

This course does not assume any prior background in machine learning.

Resources:
Sutton Book
Silver Course

Topics:
Introduction to Reinforcement Learning
OpenAI Gym and Basic Techniques
Markov Decision Processes
Dynamic Programming
Value Function Approximation
Policy Gradient Methods
Monte Carlo Learning
Temporal Difference Learning
TD Lambda Learning
Q-Learning
Exploration and Expectation
Applications of Reinforcement Learning

Communication
We will interact with students in-person during office hours and online via Piazza.

Office Hours

Office hours for most of the semester will be by appointment. We will also hold scheduled office hours prior to the midterm and final project.

Schedule (assignments):

1. (8/31) -Intro to Reinforcement Learning
    a. Examples/Demos of RL agents
    b. Concepts of RL
    c. Overview of class schedule
2. (9/7) - OpenAI Gym
    a. Setup environment
    b. Run demo
3. (9/14) - Markov Decision Processes
4. (9/21) - Value Function Approximation
5. (9/28) - Implementing RL methods
    a. Representing MDP with Numpy
    b. Visualizations with Matplotlib
6. (10/5) - Policy Gradient Methods
7. (10/12) - Monte Carlo method, assign take-home midterm
8. (10/19) - Temporal Difference Learning
9. (10/26) - Implementing model-free algorithms
10. (11/2) - Q Learning I
11. (11/9) - Q Learning II
12. (11/16) - Introduce final project
13. (11/23) - **Thanksgiving Break**
14. (11/30) - Applications of Reinforcement Learning
    a. Robotics
    b. Game Theory
    c. Finance
15. (12/7) - Final demonstrations

Grading:

50% - Problem Sets
20% - Take-home Midterm
20% - Final Project
10% - Participation

Problem Sets

Students will complete weekly problem sets and small coding assignments. By implementing the learning algorithms, students will have increased interaction with the material.

Midterm

To ensure that students are following along with course material, a midterm will be assigned on week 7 of the class. The midterm will be take-home and open-note. Students must work on the midterm individually, but they will be able to receive help from office hours and questions on Piazza.

Project
Through the semester, students will be implementing learning algorithms in OpenAI environments. For the the final project, they will apply an algorithm to a new environment of their choice. The students will be responsible for submitting the code for their algorithm and a short writeup on the results of their algorithm. In addition, they will give a short 2 minute demonstration of their project on the final day of class. Students may work in pairs or individually. We will be holding additional office hours for the final 2 weeks of the class to assist students with this project.

Academic Integrity
Note that academic dishonesty includes not only cheating, fabrication, and plagiarism, but also includes helping other students commit acts of academic dishonesty by allowing them to obtain copies of your work. In short, all submitted work must be your own. Cases of academic dishonesty will be pursued to the fullest extent possible as stipulated by the Office of Student Conduct.

It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu.

TAs:
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Excused Absence and Academic Accommodations
See the section titled "Attendance, Absences, or Missed Assignments" available at http://www.ugst.umd.edu/courserelatedpolicies.html

Disability Support Accommodations
See the section titled "Accessibility" available at http://www.ugst.umd.edu/courserelatedpolicies.html

Course Evaluations
If you have a suggestion for improving this class, don't hesitate to tell the instructor or TAs during the semester. At the end of the semester, please don't forget to provide your feedback using the campus-wide CourseEvalUM system. Your comments will help make this class better.