EE 597 Reinforcement Learning, Spring 2022

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Lectures: TuTh 3:05PM - 4:20PM, Willard Bldg 370
Office Hour: ThTh 2:00PM - 3:00PM

Course Description

To realize the impact of AI in real-world systems requires autonomous decision making based on historical observations. Reinforcement learning is one powerful paradigm for doing so, and it is relevant to an enormous range of applications, including robotics, game playing, cyber-physical system control and optimization, etc. This class will provide a solid introduction to the field of reinforcement learning, including the basics of reinforcement learning as well as deep reinforcement learning.

Learning Outcomes

By the end of the class students should be able to:

- Understand the key differences between reinforcement learning and non-interactive machine learning.
- Given an application problem (e.g. from robotics, IoT, NLP, etc), decide whether it should be formulated as an RL problem; if yes, be able to define it formally (in terms of the state space, action space, dynamics and reward model), state what algorithm is best suited for addressing it and make it work.
- Implement common RL algorithms in code.
- Describe various performance metrics (e.g. regret, sample complexity, computational complexity, empirical performance, convergence, etc.) for RL algorithms and evaluate algorithms on these metrics.
- Understand the exploration vs exploitation dilemma and existing approaches to addressing this challenge.

Prerequisites

- Proficiency in Python. All coding assignments will be in Python. Here a tutorial for those who aren’t as familiar with Python. [https://cs231n.github.io/python-numpy-tutorial/](https://cs231n.github.io/python-numpy-tutorial/)
- College Calculus, Linear Algebra.
- Basic Probability and Statistics (EE560 or equivalent).
- Basics in Optimization and Machine Learning.

Course Webpage

- Canvas: [http://canvas.psu.edu](http://canvas.psu.edu)

References

A collection of notes, relevant papers and materials will be prepared and distributed. Textbooks recommended for further reading are:

Some other additional references that may be useful are listed below:

- Reinforcement Learning Course@Stanford, Emma Brunskill, [https://web.stanford.edu/class/cs234/CS234Win2021/](https://web.stanford.edu/class/cs234/CS234Win2021/)
- Lecture Notes on Reinforcement Learning, Amir-massoud Farahmand, [https://amfarahmand.github.io/IntroRL/lectures/LNRL.pdf](https://amfarahmand.github.io/IntroRL/lectures/LNRL.pdf)

**Course Outline**

1. Introduction to RL
2. Finite Markov Decision Processes (MDP)
3. Dynamic Programming
4. Planning and Learning with Tabular Methods
5. Temporal-Difference Learning
6. Value function Approximation
7. Policy Search Methods
8. Deep Reinforcement Learning
9. Bandit Problems
10. Fast RL

The above schedule is subject to change without prior notice.

**Course Project**

Course project is an opportunity for you to apply what you have learned in class to a problem of your interest in reinforcement learning. The project could be either original research problems in RL or the application of RL in different domains. You will complete it in groups of two.

Project deadlines:

- **Week 4 (Sunday, 02/06, 11:59 PM)** Submit a short proposal (no more than 2 page) stating the topics that you plan to work on. Describe why they are important or interesting, and provide some appropriate references.
- **Week 8 (Friday, 03/04, 11:59 PM)** Submit a progress report that explicitly refers back to your project proposal: what has been accomplished, what goals should be revised, etc.?
- **Weeks 14-16** Presentation and peer evaluation. Deliver a 20-minute presentation with slides in class.
- **Weeks 16 (Friday, 04/29, 11:59 PM)** Submit the final project report.

You are required to use LaTeX for your reports in this course, as LaTeX is a skill you should learn if you haven’t already! The official NeurIPS template will be provided to structure your reports.

**Grading**

- Homework assignments (45%), Take-home midterm (20%), Final project (35%).
- There will be three to four homework assignments. Each homework assignment may contain a written part and a programming part. All programming assignments will be in Python.
- All homework will be submitted to Canvas before the deadline. Late homework will not be accepted. You homework submission should include: 1) a PDF file containing solutions to the written part, 2) the report for the programming part, and 3) your own code. Your code should only use packages from the standard library.
- For written homework assignments, you are welcome to discuss ideas with others, but you are expected to write up your own solutions independently (without referring to another's solutions). For programming homework assignments, you may only share the input-output behavior of your programs. Please remember that if you share your solution with another student, even if you did not copy from another, you are still violating the academic integrity.

- Final project grade consists of three parts: Proposal (5%), Progress report (2%), Oral Presentation (14%), Final Report (14%).

- The final grade will be assigned according to the table below:

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**Counseling and Psychological Services Statement**

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Counseling and Psychological Services at University Park (CAPS) [http://studentaffairs.psu.edu/counseling/](http://studentaffairs.psu.edu/counseling/): 814-863-0395
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