Sums 707– Basic Reinforcement Learning
Elementary Theory and Applications — Winter 2021

Instructor Information

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Class Information

TA: Shereen Elaidi
Class Dates and Times: TBD – TBD
Classroom: Zoom

Course Description

Reinforcement learning (RL) tackles the general problem of how an agent predicts and behaves in a stochastic environment, given its past experiences. This course will NOT provide you with a broad background in reinforcement learning. This course goes over enough domain knowledge and mathematical background so that you can semi-autonomously study and understand recent research in the field. Topics we may cover are: markov decision processes (MDP), dynamic programming, prediction and control, function approximation methods, policy gradient methods, actor critic, temporal abstraction, exploration.

Prerequisites (subject to change)

Ideally, you know probstats, linear algebra and calculus, machine learning, and category theory. Other (probably approximately) useful tools would be stochastic processes, martingale theory, concentration inequalities, and higher topos theory. Please contact the instructors if you have doubts regarding your background. Otherwise, an exceptional curiosity and self-drive may (hopefully) compensate for the missing background.

Course Objectives

We hope that by the end of the course, you will:

- Understand the basics: problem formulation, methods, drawbacks
- Acquire mathematical background geared towards research in reinforcement learning
- Be able to read and understand academic papers in the field, interpret and discuss results
- Meme at an academic level

Class Attendance and Participation

We strongly suggest you attend all lectures, or have a really good friend that is willing to latex the course notes for you. In our experience, this occurrence is rare, you may be better off just attending the lectures. Recall that this course is a commitment, unlike your other commitments (as it doesn't give you a grade and credits on your transcript) but nonetheless a commitment. We believe the time you spend on participating (during lectures and beyond) is proportional to what you get out of the course.

Textbooks, References

There are no official textbooks for this course. You may choose to use the following as references to complement your learning.

- *Reinforcement Learning: An Introduction* by Andrew Barto and Richard S. Sutton
- *Reinforcement Learning: Theory and Algorithms* by Alekh Agarwal, Nan Jiang, Sham M. Kakade
- *Algorithms for Reinforcement Learning* by Csaba Szepesvári
- *Labelled Markov Processes* by Prakash Panangaden
- *Éléments de Géométrie Algébrique* by Alexander Grothendieck, assisted by Jean Dieudonné

Homework

There will be suggested homework as the semester progresses. We emphasize here an age-old proverb that mathematicians tend to overuse in their course syllabi: "The only way to learn math is to do the exercises". Course TAs as well as course instructors will be able to help you with these.

Final Project

As an enrolled student, you are expected to deliver a written report near the end of the semester. You may attempt to reproduce a paper's experiments, or reproduce as well as explain a proof in a paper of your choice. This will be your opportunity to demonstrate your understanding of a particular topic of interest.

Academic Integrity

Please don't cheat.

Instructors' remarks

This course is really about you and your growth as a curious individual who likes challenges and is ready to spend time and effort on studying something really cool and exciting. We believe reinforcement learning to be a progressively growing field with a multitude of potential in many settings such as healthcare, autonomous vehicles, robotics, and many more. We will present to you the general framework, a variety of approaches, and formally introduce each of our respective researches. What you choose to focus your attention on is entirely up to you, as long as you're still curious, excited, and learning! We really hope that you enjoy the experience and make the most out of it! :')