Reinforcement Learning: An Introduction

Reinforcement learning (RL) is a computation approach to learning whereby an agent tries to maximize the total amount of reward it receives when interacting with a complex, uncertain environment. This course will introduce the mathematical theory of reinforcement learning and its applications to the design of human-level artificial intelligence. The objective of this course is to provide students with required knowledge to conduct research in reinforcement learning and basic skills to apply reinforcement learning techniques to real-world applications.

Topics:

1. Introduction to reinforcement learning and its framework.
2. Bandit problems and on-line learning.
3. Markov decision processes, returns, and value functions.
4. RL solutions: dynamic programming methods.
5. RL solutions: Monte-Carlo methods
6. RL solutions: temporal difference methods
7. Eligibility traces.
8. Value function approximation.
9. Models and planning.
10. Case studies: applications in artificial intelligence
11. Advanced topics: deep reinforcement learning with applications in Alpha Go, self-driving cars, etc.

Grading Policy (tentative): homework (50%), mid-term (20%), final exam (30%)

Pre-Requisites: basic knowledge in probability, programming ability in some language (e.g. Python, C++).

References:

1. (Textbook) *Reinforcement Learning: An Introduction,* by Richard S. Sutton and Andrew G. Barto. MIT Press, Cambridge MA, 1998. (Second edition in progress, pdf available on-line)
2. Reinforcement Learning for Cyber-physical Systems with Cybersecurity Case Study, by C. Li and M. Qiu, CRC Press, 2019
3. *Dynamic Programming and Optimal Control*, by D.P. Bertsekas, 2 Vols., Athena Scientific Press, 2005
4. *Algorithms for Reinforcement learning*, by Csaba Szepesvari, Morgan & Claypool Publishers, 2010