CSIP5403

Research Methods and Applications  
Lab Sheet – 5

Aims:

* In this lab, you will understand OpenAI Gym and do examples
* OpenAI Gym: <https://github.com/openai/gym>
* Understand Q-learning and how it is implemented.
  + Based on:
    - <https://github.com/dennybritz/reinforcement-learning/blob/master/TD/Q-Learning%20Solution.ipynb>
    - [CSC421/2516 Lecture 21: Q-Learning (toronto.edu)](https://www.cs.toronto.edu/~rgrosse/courses/csc421_2019/slides/lec21.pdf)

# Part 1 – Understanding and experimenting OpenAI Gym

1. Understand what OpenAI Gym is.
2. Create an environment instance and interact with it, for example, create "CartPole-v1" environment and with it. Try other environment instances such as “Acrobot-v1”, “MountainCarContinuous-v0”, “MountainCar-v0”, “Pendulum-v1”, etc. Where do you find this information on the Gym GitHub code? Explore the other environments.
3. Learn more about notable related libraries such as CleanRL,
4. Delve into reinforcement learning (RL) world to learn more about it. Compare and contrast different RL algorithms such as
   1. Q-learning
   2. Temporal Difference (TD)
   3. SARSA (State–action–reward–state–action)
   4. REINFORCE
   5. Asynchronous Advantage Actor-Critic (A3C), etc.

# Part 2 – Understanding and experimenting Q-Learning

1. Download and execute the code. You may need to upload the code to the Google Colab to successfully run it.
2. Understand the code:
   1. How is the policy function implemented?
   2. Does changing hyperparameters such as number of episodes improve the performance?
   3. What about the other hyperparameters such as discount factor, epsilon and alpha?
   4. Compare Q table **before** and **after** it is learned.
3. Can you relate the code to the Q-learning given in the lecture slides?
4. Describe or list the application areas of Q-learning, and it how it can be applied. Discuss among groups.

# Part 3 – Continue Working on your Mini-Project

Identify one or two group members to work with (this could be your lab group if you have already been working on lab exercises within a group).

After you identify the topic of your **mini-project**, you should continue working on it. Please keep in mind the **deadline** of the project.