CS4287 Neural Computing

Assignment 2: Sem1 AY 25/26 – Deep Reinforcement Learning

10/Nov/25 (Week 10) – v1.

1. Objectives

To implement a Reinforcement Learning (RL) agent using a Deep Q Network (DQN).

OPTION 1: Classic Control - implement DQN for one of the Gym environments for Classic Control other than the pole balancing problem.

OR

OPTION 2: Atari with extra credit 6% - implement DQN for one of the environments in OpenAI Gym for an Atari game.

2. Submission

OPTION 1 (24 marks) – Classic Control.

Submit a Jupyter notebook with text boxes and/or code cell output action discussing/describing:

1. Why Reinforcement Learning is the machine learning paradigm of choice for this task (2 marks)
2. The Gym Environment (3 marks):
3. Implementation:
    a. Capture and sampling of the data (2 marks).
    b. The network structure (2 marks).
    c. A very clear and extremely detailed discussion on the code where the Q learning update is applied to the weights (4 marks). For example: what is the update, and how is the error calculated?

4. Results – plots with short accompanying explanations of the information conveyed (3 marks).
5. Evaluation of the results (4 marks).

1. Independently researched concepts to improve performance such as random seed initialisation, the impact of regularisers on scores, techniques to counter catastrophic forgetting and maximisation bias (4 marks). An attempt must be made to code and evaluate the efficacy of one of these concepts.
6. References (P/F).

OPTION 2 (30 marks) – Atari.

Submit a submit a Jupyter notebook with extensively commented code. Code cell output action and/or text boxes should be used to describe/discuss

2. Why Reinforcement Learning is the machine learning paradigm of choice for this task (3 marks)
3. The Gym Environment (3 marks):
4. Implementation:
    a. Capture and pre-processing of the data (3 marks).
    b. The network structure (4 marks).
    c. A very clear and extremely detailed discussion on the code where the Q learning update applied to the weights (3 marks). For example: what is the update, how is the error calculated?

    Coding fragments and/or diagrams should be included to illustrate the concepts under discussion.
5. Plots (3 marks)
6. Videos and plots with short accompanying explanations of the information conveyed (1 marks).
7. Evaluation of the results (5 marks):
    a. How does one evaluate the performance of the RL agent?
    b. Are the metrics that we have seen to date relevant?
8. Independently researched concepts such as random seed initialisation, the impact of regularisers on scores, and techniques to counter catastrophic forgetting and maximisation bias (5 marks). An attempt must be made to code and evaluate the efficacy of one of these concepts.
9. References (P/F).

NOTE: you are allowed to use Keras or Tensorflow DQNAgent library for option 2.

The Jupyter notebook must (a) include output i.e. code cell action outputs, and (b) be extensively commented. Failure to comply with one or both of these requests will result in the award of 0 marks for the submission.

3. Notes and Guidelines

- You may complete the project in teams of 2 or 3.
- **Submission deadline is** 23:59 Sat 6th Dec. (Week 13). Happy to negotiate this deadline via the class rep if majority in favour of change.
- The Jupyter notebook is named CS4287-Prj2-ID1_ID2_ID3
    - Where ID1, ID2, and ID3 are the student id numbers of the team members
- The first three lines of the **Jupyter notebook** should be comments with:
    1. The first line is the **names and ID numbers** of the team members.
    2. The second line **states if the code executes to the end** without an error.
    3. The third line is **one or more links to any third-party implementations used for the submission**.
- Submission is via the Brightspace Assignment tool.
- Programming language is Python.