CIVE 7397 – Fall 2020 Assignment 5

Due date: 12/02/2020 (23:59:59 PM)

Number of points: 13

In this assignment, you will implement the famous Deep Q-Network (DQN) on the game of Breakout using the OpenAI Gym. The goal of this assignment to understand how Reinforcement Learning works using deep neural networks when interacting with the pixel-level information of an environment.

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1. Deep reinforcement learning

Download the starting package Startpkg_A5 from blackboard. The top-level notebook mp5.ipynb will guide you through all the steps of the DQN. You will mainly implement the training of the Agent in the agent.py file. We provide you with the neural network. Please do not change the architecture of the neural network (for consistency of grading). We are consistent with the high-level concepts of the paper, but due to the computational constraints, we expect you to reach a mean reward score of 5 after training for 5000 episodes.

Note, as you look in the notebook, in our terminology, a single episode is a game played by the agent till it loses all its lives (in this case, your agent has 5 lives). In the paper, however, an episode refers to almost 30 minutes of training on the GPU and such training is not feasible for us. Here is a table of expected rewards vs. number of episodes provided to help with your debugging. The reward comes in a range, and the training time is roughly equal for Colab and uHPC.

Episode	Reward	Accumulated training time (hours)
1000	1.0-1.5	1
2000	1.2-2.0	2
3000	2.0-3.0	3.5
4000	2.5-3.5	5
5000	3.5-5.0	10

Some reference for DQN:
- Official DQN Pytorch Tutorial (highly recommended)
- Official DQN paper
- DQN Tutorial on Medium

This is a computationally expensive assignment. It is expected that your code should run for 10 hours to complete 5000 episodes. You can stop training early if you reach a mean score of 5 in the game. This assignment requires a GPU, and we recommend you to use Colab or uHPC.

Task: Training a DQN, and report your results using the given template.
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2. Render the gaming frame while your training (optional)

You can actually render the game Breakout while you training the DQN. However, this requires some setup and not available on Colab or uHPC. There are two things you can try here.

First, you may initialize the game of Breakout to see how the environment looks like by enabling the code *env.render()* in mp5.ipynb (or mp5.py). This will provide you a frame of the game.

Second, you may render the game frame while the training is going by enabling the render function under config.py (render_breakout = True). This will enable a window showing the real-time training results.

Please be aware that both trials mentioned here are not available on Colab or uHPC. Unless you are using your own GPU, we don't recommend rendering while training for your final results. However, if you just want a peek of the process, both trails can be done on your local PC without a GPU. So, we recommend you try to render for a few episodes for fun on your own PC, then disable the rendering functions and run full scale on Colab or uHPC for meaningful results for your report.

Some hints for rendering on your PC using CPU:
- Do not expect this to give you any reasonable result as the training will be extremely slow.
- You might need to install cmake and gym for this on your local machine, simply run the code under the terminal:

  pip install cmake
  pip install gym[atari]
- Scikit-image package is also required and can be installed via anaconda.
- For things to run on your CPU, you will have to replace the *.cuda()* code under the agent.py file. Simply replace *.cuda()* by *.to(device)* for things to run on your CPU.

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3. Submission instructions

Submit files to blackboard including:
- All of your code (python files and ipynb file) in a single ZIP file.
  File name as Assignment5_code_CougarNetID.zip
- Results of notebooks mp5.ipynb converted to PDF format (only a couple of final episode results when you reach ideal reward score are good enough). You may take a screenshot of result cells then convert them to a PDF, or you may print your notebook with results as a PDF. If using uHPC, save those results in a text file for submission.
  File name as Assignment5_output_CougarNetID.pdf

- Report using Assignment5_report_template.docx from blackboard. Convert and submit your report as a single PDF.

  File name as Assignment5_report_ CougarNetID.pdf.

Please be aware that this assignment is set to allow **only one submission on blackboard**. However, you can always save your assignment as a draft without submitting and continue working on it later. Save as draft stores comments and the files on the page, but does not submit them. You may return later to modify or finish the assignment. Submit must be selected to send your final results.