CPT_S 580 – Reinforcement Learning

Homework 3

Due: 11:59 PM on Mar. 7

1. Problem from Week 4-2 [10pt]

Given two functions $f(x)$ and $g(x)$, prove that

$$\left|\max_x f(x) - \max_x g(x)\right| \leq \max_x |f(x) - g(x)|.$$

We assume $\max$ are well-defined in the inequality above.

2. Contraction Mapping [20pt]

Consider an infinite horizon discounted RL problem with finite state space and finite action space. Consider a model-based Q-learning algorithm with the following value iteration:

$$Q_{k+1}(i,u) = \mathbb{E}\left[r(i,u)\right] + \alpha \sum_j p_{ij}(u) \max_v Q_k(j,v),$$

or written as

$$Q_{k+1} = \mathbb{T}_Q(Q_k).$$

Prove that $\mathbb{T}_Q$ is a contraction mapping.

3. Maze Game (Q-learning) [20pt]

Please download the files `hw_3_1.ipynb` and `gridworld_maze.py` from Canvas and complete the codes in `hw_3_1.ipynb` following the instructions in the file. You can run and debug your codes using Google Colab. After completing the tasks, save `hw_3_1.ipynb` as `hw_3_1.py` by clicking "File $\rightarrow$ Download $\rightarrow$ Download .py". Then upload `hw_3_1.py` to Gradescope. The autograder on Gradescope will automatically grade your coding homework.

If you cannot pass the sample test but want to get partial credits, you need to remove the line with "assert" in the sample test code before you submit to Gradescope.

4. Tetris Game (SARSA with Linear Function Approximation)[20pt]

Please download the files `hw_3_2.ipynb` and `tetris_env.py` from Canvas and complete the codes in `hw_3_2.ipynb` following the instructions in the file. You can run and debug your codes using Google Colab. After completing the tasks, save `hw_3_2.ipynb` as `hw_3_2.py` by clicking "File $\rightarrow$ Download $\rightarrow$ Download .py". Then upload `hw_3_2.py` to Gradescope. The autograder on Gradescope will automatically grade your coding homework.

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