

CMPSCI 390A Homework 7

YOUR NAME HERE

Assigned: April 22 2021; Due: April 29 2021 @ 11:00 am ET

Abstract

This assignment will cover implementing an Actor-Critic algorithm and bias and ethical issues in machine learning. To submit this assignment, upload a .pdf to Gradescope containing your responses to the written response questions below. You are required to use L^AT_EX for your write-up. When submitting your answers, use the template L^AT_EX code provided and put your answers below the question they are answering. Do not forget to put your name on the top of the .pdf. To submit the assignment's coding portion, upload a single python file called `my_hw7.py`, to the Gradescope programming assignment for Homework 7. An auto-grader will check your code for the correct output. As such, your program must meet the requirements specified below. We will also be using cheating detection software, so, as a reminder, you are allowed to discuss the homework with other students, but you must write the code on your own.

1 Implementing Actor-Critic (30 points)

In this part of the assignment, you are asked to implement the Actor-Critic algorithm (Algorithm 16.2 in the course notes and shown below) to solve the stopped car problem using the code provided in the template file `my_hw7.py`.

Algorithm 1: An Actor-Critic Algorithm

```
for each episode do
    // Run one episode (play one game).
    for each time  $t$  in the episode do
        // Execute one time step of agent-environment interaction
        Agent observes state  $S_t$ ;
        Agent selects action  $A_t$  according to the current policy,  $\pi_\theta$ ;
        Environment responds by transitioning from state  $S_t$  to state  $S_{t+1}$  and emitting reward  $R_t$ ;
        // You are implementing these updates.
        // Learn from the outcome of this one time step.
         $\delta_t \leftarrow R_t + \gamma v_w(S_{t+1}) - v_w(S_t)$ ;
         $\forall i, \theta_i \leftarrow \theta_i + \alpha \delta_t \frac{\partial \pi_\theta(S_t, A_t)}{\partial \theta_i}$  // Actor update
         $\forall j, w_j \leftarrow w_j + \beta \delta_t \frac{\partial v_w(S_t)}{\partial w_j}$  // Critic update
    end
end
```

Implement the following functions:

- `LinearValueFunction.get_value(self, state)`. This function computes output of the value function $v_w(s) = \sum_{j=1}^m w_j \phi_j(s)$, where s is the variable `state` and ϕ_j is the j^{th} output of the basis function.
- `LinearValueFunction.get_value_grad(self, state)`. This function computes and returns two quantities: $v_w(s)$, and $\frac{\partial}{\partial w_j} v_w(s)$.
- `ActorCritic.update(self, state, action, reward, next_state, terminal)`. This function updates the value function and policy as specified by the algorithm. The variables: `state`, `action`, `reward`, and `next_state` corresponds to S_t , A_t , R_t , and S_{t+1} . The variable `terminal` is a boolean that indicates if the episode has ended. When `terminal` is true $v_w(S_{t+1}) = 0$.

2 Solving the Stopped Car Problem (10 points)

With the above functions correctly implemented, the next step is to tune the algorithm's hyperparameters. This algorithm has four hyperparameters: the critic step size β , the policy step size α , the discount factor γ , and the Fourier basis order. These hyperparameters need to be tuned to find a setting that makes the algorithm reliably achieve good performance.

The performance will be measured by the sum of rewards without discounting (i.e., $\gamma = 1$). The algorithm will be run for 100 trials (lifetimes), each containing 400 episodes. The algorithm's average performance will be represented by the same learning curve plot in the previous homework. This plot is automatically generated and saved when the function `main` is run. Your written response should contain the learning curve plot and the hyperparameters you found.

3 Machine Learning Beyond the Algorithms (60 points)

As we have discussed so far in the course, machine learning algorithms can take data about our world and produce models that can make useful predictions or decisions. However, machine learning algorithms also inherit society's biases and may not always be used to improve the lives of everyone. To gain exposure to some of these issues, you will read a paper from the list below write a reflection on how machine learning affects society.

Pick an article from this list:

1. [The Grey Hoodie Project: Big Tobacco, Big Tech, and the threat on academic integrity](#)
2. [Decolonial AI: Decolonial Theory as Sociotechnical Foresight in Artificial Intelligence](#)
3. [Oxford Handbook on AI Ethics Book Chapter on Race and Gender](#)
4. [Closing the AI accountability gap: defining an end-to-end framework for internal algorithmic auditing](#)
5. [Delayed Impact of Fair Machine Learning](#)
6. [Lessons from Archives: Strategies for Collecting Sociocultural Data in Machine Learning](#)
7. [Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification](#)
8. [Machine Bias](#)
9. [Your Résumé vs. Oblivion](#)

After reading the article, write a summary of the article followed by a one-page response reflecting on several aspects of the paper. In writing the summary, you must answer the following questions.

1. Title of the article
2. Give a one-sentence summary of the paper that is specific about the paper's contribution.
3. What is the high-level problem setting, and what is the specific problem(s) being examined in the work?
4. What are the main questions the article is trying to answer, or what is the main point the article is trying to make?
For an academic paper, what are the hypotheses being tested?
5. Do you think the article provides enough supporting evidence? Why or why not?

The one-page reflection should discuss: What you already knew about the topic, your perspective on the topic was before reading, what you learned from the article, and how your viewpoint changed (or why it did not). Also, discuss any new questions you might have and look for resources to answer those questions. To formulate your reflection, you may want to consider some of these questions below.

- What was your point of view and knowledge on the topic before reading?
- What biases might have influenced how the authors presented the main argument?
- What biases might you have in accepting or not the authors' central argument?
- Does the paper omit specific topics that would change the relevance or accuracy of their arguments?
- What arguments can you make against the arguments presented in the paper? Present evidence to support this argument.
- What new questions do you have about the topic? What resources are there to answers these questions?