GPT2PPO: Auto Regressive Proximal Policy Optimization

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***Abstract*—This document is a model and instructions for LaTeX. This and the IEEEtran.cls file define the components of your paper [title, text, heads, etc.]. *CRITICAL: Do Not Use Symbols, Special Characters, Footnotes, or Math in Paper Title or Abstract.**

***Index Terms*—Reinforcement Learning, PPO, GPT2**

I. Introduction

In this project we explore the use of transformers in the context of Reinforcement Learning. The majority of theoretical works assume that problems follow a Markovian process, which is not always the case. Some problems need the contxt of previous states and actions to make an informed decision on the next decision. As a result, we propose an addition to the basic Proximal Policy Optimization (PPO) algorithm by using the Generative Pre-trained Transformer 2 (GPT2) model as the encoder for the critic network. This will allow the critic network to take into account the context of previous states and actions as well as apply attention to past states and actions that may be important. We will test this model on the LunarLander-v2 and Acrobot-v1 OpenAi Gym environments with discrete action spaces and compare it to the original PPO algorithm. Additionally we will test the model on BipedalWalker-v3 with continuous action spaces and compare it to the original PPO algorithm.

II. Previous Work

III. Background

All of the environments used in this project are from the OpenAI Gym library [1]. The environments are described below.

A. Lunar Lander

The Lunar Lander environment is a rocket trajectory optimization problem[1] shown in Figure 1. The goal is to actuate the lander to the landing pad at coordinates (0,0) without crashing. OpenAI Gym offers two versions of the environment: discrete or continuous. In this work we only use the discrete version. The state space is a 8-dimensional vector containing the x and y positional coordinates of the agent, its x and y linear velocities, its angle, its angular velocity, and two booleans that represent whether each leg is in contact with the ground or not. The action space is a single discrete scalar with values ranging from 0 to 3. The values corresponspond to the following actions: do nothing, fire left orientation engine, fire main engine, fire right orientation engine. The reward structure contains both positive and negative rewards. If the lander moves away from the landing pad, it gains a negative reward. If the lander crashes, it receives an -100 reward. If it comes to rest, it receives an +100 reward. Each leg with ground contact is +10 points. Firing the main engine is -0.3 points each frame. Firing the side engine is -0.03 points each frame. Firing the side engine is -0.03 points each frame. The landers initial state is at the top center of the environment with a random intial force applied to its center. The episode ends if the lander crashes, goes outside of the viewport, or comes to a resting position.

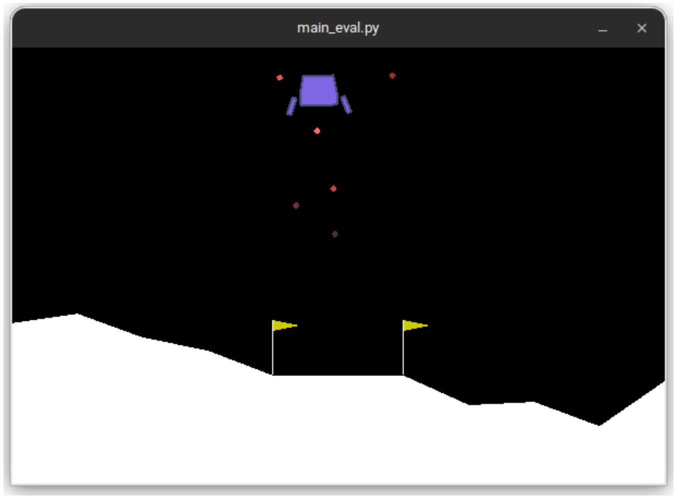

Fig. 1. The Lunar Lander environment.

B. Acrobot

Open AI Gym's implementation of the Acrobot environment[2] is based off the work of Sutton and Barto [2] shown

[1]OpenAI Gym Lunar Lander: https://www.gymlibrary.dev/environments/box2d/lunar_lander

[2]OpenAI Gym Acrobot: https://www.gymlibrary.dev/environments/classic_control/acrobot

in Figure 2. The environment is a 2-link pendulum with only the second joint actuated with a discrete action space. The goal is to swing the end of the pendulum up to a given height. The state space is a 6-dimensional vector containing the sin and cos of the two joint angles and the joint angular velocities. The action space is a single discrete scalar with values ranging from 0 to 5. The values corresponspond to the following actions: apply +1, 0, or -1 torque to the actuated joint. The reward structure contains only negative rewards. At each timestep the agent receives a reward of -1 for each step that does not reach the goal. If the goal is reached the agent receives a reward of 0. The episode ends if the agent reaches the goal height or if the episode exceeds the maximum number of timesteps.

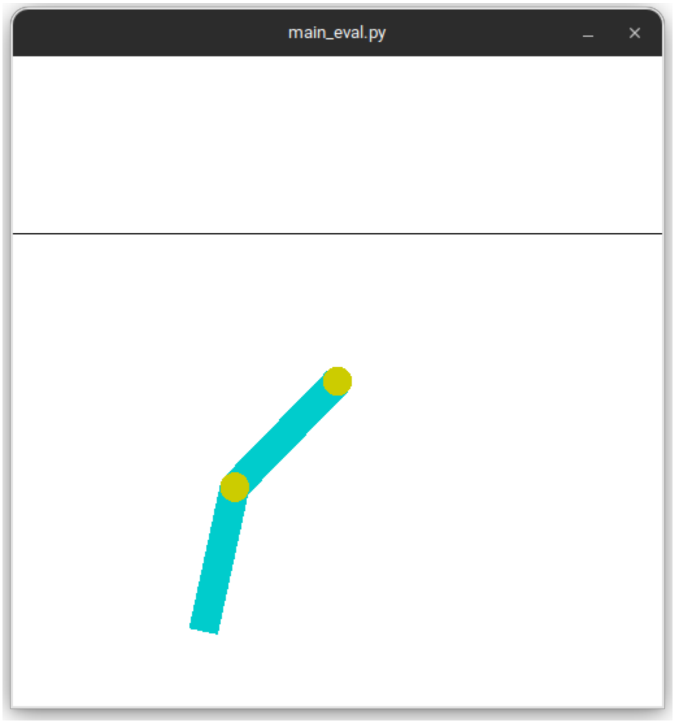

Fig. 2. The Acrobot environment.

C. Bipedal Walker

The Bipedal Walker environment is a 2D simulation of a bipedal walker robot with 4-joints[3] shown in Figure 3. The goal is to keep the walker upright for as long as possible. The state space is a 24-dimensional vector containing: the hull angle speed, angular velocity, horizontal speed, vertical speed, position of joints and joints angular speed, legs contact with ground, and 10 lidar rangefinder measurements. Notably, there are no coordinates given in the state vector. The action space is a 4 dimensional vector containing continuous values of each joints motor speed between -1 and 1. The reward structure contains both positive and negative rewards. A positive reward is given for moving forward. If the agent falls it receives a reward of -100. Applying motor torque costs a small amount of reward. The agent's intial state is standing at the left of the terrain with the hull horizontal, with both legs in the same position with a slight knee angle. The episode terminates if the agent's hull makes contact with the ground or if the agent reaches the end of the terrain length.

[3]OpenAI Gym Acrobot: https://www.gymlibrary.dev/environments/box2d/bipedal_walker

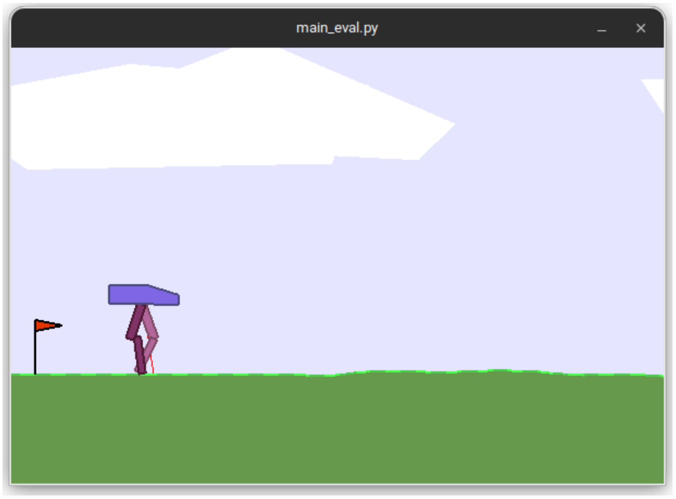

Fig. 3. The Bipedal Walker environment.

IV. Methodology

A. Reinforcement Learning Methods

V. Code Design

A. Utilized Libraries

B. File Structure

C. Training and Testing Models

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main_eval.py text here kasljf aslkdjasdlk aslksdakljaslkj askajklaskjlsjkls s.

D. Models

rllib/examples/PPOExample.py
rllib/PPO3.py

E. main_train.py

F. main_eval.py

VI. Results

VII. Conclusion

References

[1] G. Brockman, V. Cheung, L. Pettersson, J. Schneider, J. Schulman, J. Tang, and W. Zaremba, "Openai gym," *arXiv preprint arXiv:1606.01540*, 2016.

[2] R. S. Sutton and A. G. Barto, *Reinforcement learning: An introduction*. MIT press, 2018.

Appendix

A. Team Member Contributions

Andrei Cozma. text here.
Hunter Price. text here.