Autonomous Lunar Landing

Course: Reinforcement Learning

Project Objective

The goal of this project is to train an autonomous agent using Reinforcement Learning (RL) to land a spacecraft safely on the Moon in the **OpenAI Gym Lunar Lander** environment. The agent must learn to stabilize the lander, minimize fuel consumption, and land smoothly while dealing with gravity, inertia, and dynamic uncertainties.

Motivation for Choosing Lunar Lander

Complex problem: The agent must optimize multiple constraints (fuel efficiency, stability, and precision) in a complex, partially observable environment.

Strong foundation for RL applications: The project offers an opportunity to apply key RL concepts such as policy learning, reward shaping, and exploration-exploitation tradeoffs.

Implemented RL Agents

I plan to implement and compare different RL algorithms:

- **DQN** (Deep Q-Network): Discrete action control with experience replay.
- **PPO** (Proximal Policy Optimization): Policy gradient method for better stability.
- **SAC** (Soft Actor-Critic) [if time permits]: Handles continuous action spaces efficiently.

Expected Results & Challenges

Expected Outcomes:

- A trained RL agent capable of landing safely with a high success rate.
- Performance comparison of DQN vs PPO vs SAC (learning speed, stability, final reward).
- Graphs and visualizations of training curves, landing attempts, and agent improvements.

Challenges:

- Exploration vs Exploitation: The agent must balance random actions with optimizing learned strategies.
- Reward Shaping: Proper tuning of the reward function is crucial for efficient learning.

Conclusion

This project will demonstrate the power of Deep RL for autonomous spacecraft landing. The results could be extended to drone landings, robotic control, or real-world aerospace applications.