Deep reinforcement learning for locomotion

Course: Robot Learning E384.195

Project Overview

This project aims to employ reinforcement learning (RL) techniques to develop control algorithms for a quadruped robot, enabling it to achieve efficient and adaptable locomotion patterns **(e.g. walking, running, jumping and etc.).** The project will involve implementing RL methods to learn the control policy, showcasing the potential of RL in advancing quadruped robot locomotion.

Project Goals

Mandatory:

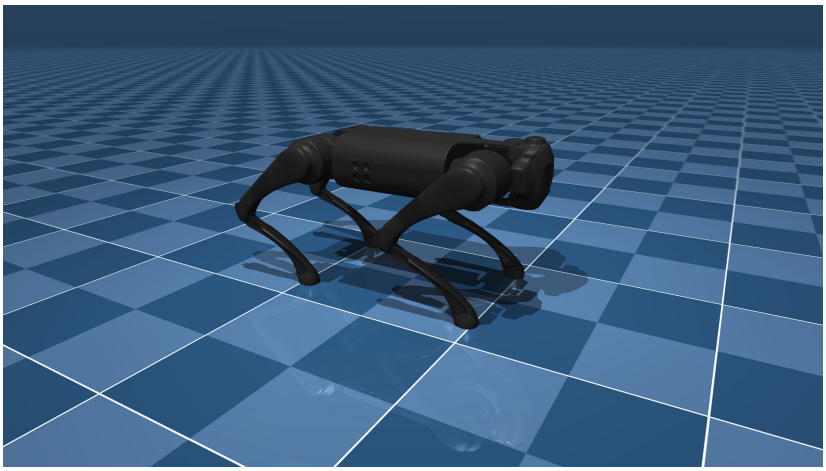
- Implement/Adapt reinforcement learning algorithms to solve locomotion problem for a quadruped robot.
- Successfully achieve **forward** walking behavior of a quadruped robot on a **flat floor**.

Some recommendations for a fascinating project (optional):

- Make your robot walk on slightly different terrains, for example walking on a slightly uneven terrain.
- Command robot with velocity commands (linear and angular velocity), so that the robot can walk with different speeds.
- Make your robot walk to a given goal, for example, the goal can be a desired position to walk to or a trajectory to follow.
- If you are interested in discovering the potential of your algorithms, you can try on more difficult motion behavior, such as running, back-flip, etc.
- Above are just some recommendations, you are encouraged to come up with your own ideas!!!

Project Details

This project requires basic knowledge of deep reinforcement learning that will be covered in this lecture. We provide a simulation environment (i.e. Gym + Mujoco + Unitree robot) for this project. The environment contains only a **flat floor**, but you can edit it if you want to try out on a different terrain. During the project, students need to design/adopt a reinforcement learning algorithm to train a locomotion controller. This project aims to obtain hands-on experience of reinforcement learning in robotics, and discover the potential of RL in locomotion problems. At the end of this project, you should have a trained agent that can control the robot walking on a flat terrain. The performance of your agent heavily will be reflected to your grades on the project. There are some recommendations listed above for more challenging tasks (optional) if you are more interested in RL, which will positively affect your grades.



A Unitree-Go robot in Mujoco simulator

Recommendation of schedule in week (not necessary):

1. Literature research for existing RL algorithms and commonly used techniques for training RL agent. Some useful papers are listed below,
    a. Zhang & Sutton. A deeper look at experience replay. In NIPS workshop, 2017.
    b. Schaul et al. Prioritized experience replay. In ICLR, 2016.
    c. Schulman et al. Proximal Policy Optimization Algorithms. 2017.
    d. Asynchronous Methods for Deep Reinforcement Learning.

2-3. Bring your ideas to code and start to train your agents. (Here you might need, for example, **Advantage Actor Critic (A2C)**, **Proximal Policy Optimization (PPO), Experience Replay, etc.**)

4. Write your report and presentation.

Reporting and Presentation

Each team will be evaluated on multiple aspects:

- **Report:** A concise report following the IEEE LaTeX template guidelines. This report should be 3 page long and a maximum of 6 pages. The report should include an introduction to the problem, a detailed description of your deep learning architecture and approach, experimental results, and conclusions.
- **Final Presentation**: A final presentation to present your complete project, including results, insights, and contributions. This presentation will be evaluated alongside your final report.

Grading

Your project grade will be based on:

- The performance of your agent on a mandatory task. For that, you need to submit your trained model, so that we can evaluate how far the robot can walk within the given time.
- The quality and clarity of your report: emphasis on the scientific contributions.
- Final Presentation.

- Optional tasks are for bonus points.

Important Dates

- Project Start: Dec. 1, 2023
- Project **(i.e. code/model for evaluation)** submission Deadline: Jan. 26, 2024
- Project Report Submission: Jan. 26, 2024
- Final Presentation: Feb. 2, 2024

Conclusion

This project offers Master's students an exciting opportunity to apply their reinforcement learning knowledge to a practical problem in robotics. It emphasizes the development of technical skills, critical thinking, and effective communication, all of which are essential for success in the field of deep learning and artificial intelligence. We look forward to seeing your innovative approaches and solutions to the robot action classification problem. Good luck!