

CS449/549: Learning for Robotics

Bilkent University

Fall 2024

Due date: December 18, 2024, at 23:59

Homework 4: Implementing SAC with HER for Continuous Control

Introduction

In this assignment, you will implement and evaluate the Soft Actor-Critic (SAC) algorithm with Hindsight Experience Replay (HER) in the `FetchReach` environment from the Gymnasium Robotics Suite. The objective is to solve a continuous control task with sparse rewards, leveraging HER to improve sample efficiency.

Background

The `FetchReach` task requires controlling a robotic arm to move its end-effector to a target position in 3D space. The environment provides sparse rewards, making it challenging for standard reinforcement learning algorithms. SAC is a powerful off-policy actor-critic algorithm that employs entropy regularization to encourage exploration. HER enhances learning efficiency in goal-oriented tasks by relabeling unsuccessful trajectories as alternative goals.

To learn more about these techniques, you may refer to the following papers:

- SAC: Soft Actor-Critic Algorithms and Applications
- HER: Hindsight Experience Replay

Task

Your task is to implement the SAC algorithm with HER and test your agent in the `FetchReach` environment. You will train and evaluate your agent using six different random seeds, averaging the results to assess robustness.

Requirements

- Use Python 3.x with machine learning libraries such as PyTorch or TensorFlow.
- Ensure compatibility with Linux or macOS systems. If using Windows, your code must run without rendering.
- Disable rendering during training to reduce runtime.
- Provide detailed instructions for running your code and reproducing results.

Evaluation

Your implementation will be evaluated based on:

- **Correctness of Implementation:** Ensure your SAC with HER implementation adheres to the algorithms described in the provided papers.
- **Code Clarity and Documentation:** Your code should be well-organized and adequately commented.
- **Performance:** Your agent must consistently reach the target position in the `FetchReach` environment, achieving a success rate of at least 95% over 100 episodes.

Reporting Your Results

Submit your code files along with a report that includes:

1. An explanation of the SAC and HER algorithms.
2. A summary of your implementation.
3. Graphs or tables showing success rates over episodes for each random seed.
4. Analysis of the results, discussing stability and policy reliability.
5. Discussion of variations observed between seeds and potential reasons.