ECE499 Report

Reinforcement Learning

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Outline

* Introduction

1. Purpose (background)
2. Reinforcement Learning
3. Open Gym AI (terminologies, wiki page for games)
4. Algorithms (generally introduction of RL algorithms, on-off policies, typical algorithms, applications)
5. Set up computer etc.

* Algorithms

1. QL
2. SARSA
3. DQN

* Applications

(For each game)

1. Implementation of the algorithms / setup / episodes / learning rate etc.
2. Compare graphs
3. Analysis on why one is better than the other
4. Conclusions

* Reflections

1. Challenges
2. What learned
3. Conclusion

* Reference (style?) any standard style if consistent
* Word count (6-8 pages) standard margin font size only core piece of code (image) pseudo code is better
* Due date apr 5th midnight
* Page number
* Introduction

Purpose (background)

Reinforcement Learning

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Algorithms (generally introduction of RL algorithms, on-off policies, typical algorithms, applications)

Set up computer etc.

Purpose

The purpose of this report is to examine various Reinforcement Learning (RL) algorithms on different simulated environments provided by OpenAI gym (OpenAI). The goal is to investigate the performance of the algorithms depending on the types of environment.

Reinforcement Learning

RL is a field from Machine Learning (ML) where it emphasizes on developing its own agents to make a serious of decisions within an environment. RL aims at building the experiences of an agent by trial and error, alongside with a reward and penalty system to determine whether an experience is good or bad. The goal is to transform an agent which takes random actions at first, to making sophisticated decisions after many (typically) trials.

OpenAI gym

The RL algorithms will be trained on OpenAI. This technology is “a toolkit for developing and comparing reinforcement learning algorithms” (OpenAI, 2022). OpenAI provides a wide range of environments, from the entry level of classic control, toy text to more sophisticated 2D and 3D robots. There are a few terminologies which are worth mentioning. OpenAI provides a well-developed wiki page from their Github with each environment’s description, observation, action space, episode termination and rewards.

* Observation is an environment-specific object illustrating the observation of the current environment state, these could include the current coordinate of the car from environment MountainCar-v0, and the velocity of the car.
* Action space is the possible actions that the agent could take, it could be a discrete action space where agent could only pick a fixed range of non-negative numbers as their actions, or a continuous action space where agent could pick any numbers within a range provided.
* Episode termination gives specific parameters on what terminates the environment.
* Rewards are the current reward policy built-in by OpenAI, however, users could develop their own rewards policy.

To sum up, OpenAI is a sophisticated toolkit for RL and environment-specific parameters will be discussed in later sections. This report will test various algorithms on FrozenLake-v0 (non-slippery), and CartPole-v0.

RL algorithms

As RL was first introduced in 1965 in an engineering literature (Sutton & Barto, 2014), it has been studied and refined due to its importance and usefulness in the past few decades. There are many great algorithms which performs differently based on the characteristics of the environment. This report will focus on the following algorithms: Q-learning (QL), State-action-reward-state-action (SARSA) and DQN.

The differences, the strength, the weakness (in general), but then make a conclusion later based on results

Setup

The results of this report are produced on a MacBook Pro (2016), with a processor of 2.9GHz Dual-Core Intel Core i5, 8GB memory, written in python, and uses various the following libraries:

* gym
* random
* numpy
* time
* os

Reference

OpenAI. (2022). *A toolkit for developing and comparing reinforcement learning algorithms*. Gym. Retrieved April 4, 2022, from https://gym.openai.com/docs/

Sutton, R. S., & Barto, A. G. (2014). *Reinforcement Learning: An Introduction*. 1.6 history of Reinforcement Learning. Retrieved April 4, 2022, from http://www.incompleteideas.net/book/ebook/node12.html#:~:text=Farley%20and%20Clark%20described%20another,Mendel%20and%20McClaren%2C%201970).