UDACITY

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Continuous Control

REVIEW

CODE REVIEW

HISTORY

Meets Specifications

Dear Udacian,

Great job getting acquainted with the Deep Deterministic Policy Gradients algorithm and successfully implementing it to solve the Reacher environment. The implementation is pretty good and the environment is solved in 190 episodes. The architectures used for the actor and critic network are decent in size with two and three hidden layers, respectively. Good work using `relu` and `leaky_relu` activations in the actor and critic networks, respectively, along with `batch normalization`. The report is extremely informative and covers the important aspects of the implementation. 😄

I would suggest you to go through Deep Reinforcement Learning for Self Driving Car by MIT. You'd get to know more about reinforcement learning algorithms in broader and real-world perspective and, more importantly, how to apply these techniques to real-world problems.

All the best for future endeavors. ✨

Training Code

The repository includes functional, well-documented, and organized code for training the agent.

Awesome

- Good work implementing DDPG algorithm to solve robotic-arms Reacher environment.
- Implementation of the Actor and Critic networks is correct.

- Good work using the target networks for Actor and Critic networks. The original DDPG paper suggests it as well.
- Good work using soft updates for the target network.
- Good choice to use tau to perform soft update.
- Correct usage of replay memory to store and recall experience tuples.
- The implementation is easy to debug and easily extensible, good work keeping it highly modular.

The code is written in PyTorch and Python 3.

Awesome

The code is written in PyTorch and Python 3.

Lately, PyTorch and TensorFlow happen to be most extensively used frameworks in deep learning. It would be good to get some insight by comparing them, please see the following resources:

- Sebastian Thrun on TensorFlow
- PyTorch vs TensorFlow—spotting the difference
- Tensorflow or PyTorch : The Force is Strong with which One?

The submission includes the saved model weights of the successful agent.

Awesome

- Saved model weights of the successful agent have been submitted.
- The `checkpoint_actor.pth` and `checkpoint_critic.pth` files are present in the submission.

README

The GitHub submission includes a `README.md` file in the root of the repository.

Awesome

- Great work documenting the project details and submitting the README file.

The README describes the the project environment details (i.e., the state and action spaces, and when the environment is considered solved).

Awesome

- Great work providing the details of the project environment in the `Introduction` section of the README.
- The `Introduction` subsection describes the state space, action space, and the reward function.
- The `Distributed Training` subsection explains about the different versions of the environments.
- The `Solving the Environment` subsection explains about when the environments are considered solved.

The README has instructions for installing dependencies or downloading needed files.

Awesome

- Great work providing the all the necessary instructions in the `Download Unity Environment` section to download the environment and install the dependencies.

The README describes how to run the code in the repository, to train the agent. For additional resources on creating READMEs or using Markdown, see here and here.

Awesome

- Great work providing necessary instructions to run the code in the `Instructions` section.
- All the cells in `Continuous_Control.ipynb` file should be executed to train the agent.

Report

The submission includes a file in the root of the GitHub repository (one of `Report.md`, `Report.ipynb`, or

The submission includes a file in the root of the GitHub repository (one of `Report.md`, `Report.ipynb`, or `Report.pdf`) that provides a description of the implementation.

Awesome

- Report for the project with all the details of the implementation has been provided in the submission.

The report clearly describes the learning algorithm, along with the chosen hyperparameters. It also describes the model architectures for any neural networks.

Awesome

Great work providing the details of the implemented agent. Details of the learning algorithm used, hyper-parameters, and architectural information of the deep learning model have been provided.

- Good decision to choose DDPG algorithm for the continuous action space problem.
- Good work including model architecture in the report.

3.1 Actor

Layer	# units	Activation function
Batch Normalization	_	_
Input layer	state_size (33)	_
First hidden layer	256	ReLU
Second hidden layer	128	ReLU
Output layer	action_size (4)	Tanh

3.2 Critic

Layer	# units	Activation function
Batch Normalization	_	_
Input layer	state_size (33)	_
First hidden layer	256	Leaky_ReLU
Concatenation	256+action_size (260)	_

Second hidden layer	128	Leaky_ReLU
Third hidden layer	128	Leaky_ReLU
Output layer	1	_

- Good decision choosing to use `batch normalization`.
- Hyperparameters you have used seem to be good.

Hyperparameter	Value
Replay buffer size	1e6
Batch size (number of samples to get from Replay)	512
γ (discount factor of expected reward)	0.99
τ (update the target networks)	1e-3
Actor Learning rate	2e-4
Critic Learning rate	3e-4
Number of max training episodes	2000
Max number of timesteps per episode	1000

Suggestions

To experiment more with the architecture and hyperparameters, you can check the following resources:

- Deep Deterministic Policy Gradients in TensorFlow
- Continuous control with Deep Reinforcement Learning

A plot of rewards per episode is included to illustrate that either:

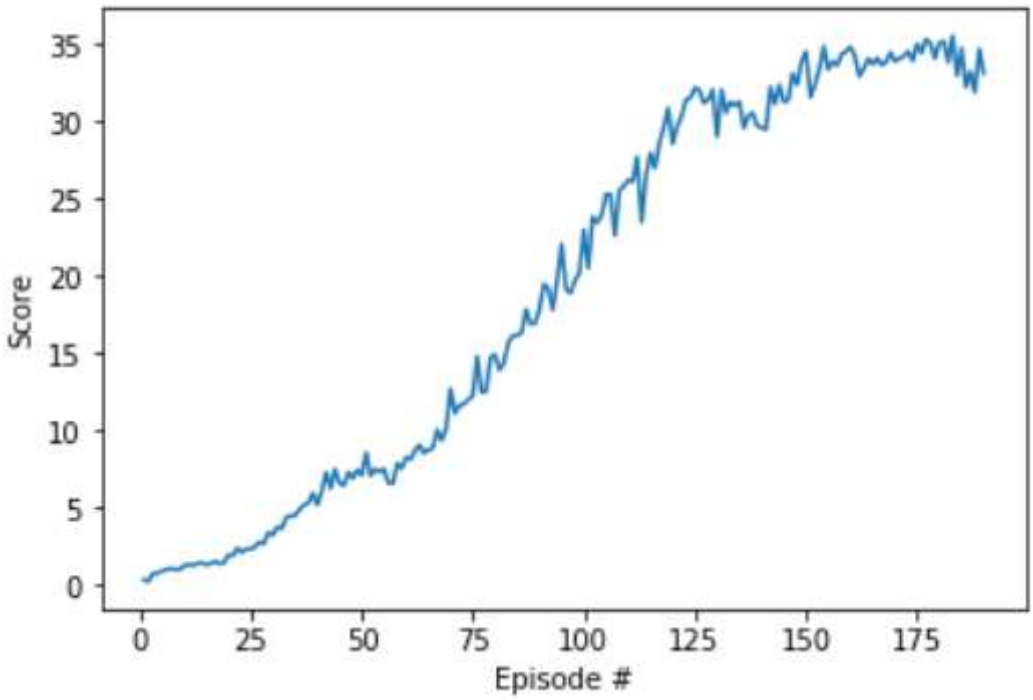
- *[version 1]* the agent receives an average reward (over 100 episodes) of at least +30, or
- *[version 2]* the agent is able to receive an average reward (over 100 episodes, and over all 20 agents) of at least +30.

The submission reports the number of episodes needed to solve the environment.

Awesome

- Discussion for the rewards is provided in the report.

- The rewards plot seems to be good and average score of +30 is achieved in 190 episodes.



Reinforcement learning algorithms are really hard to make work.
But it is substantial to put efforts in reinforcement learning as it is close to Artificial General Intelligence.
This article is a must read: Deep Reinforcement Learning Doesn't Work Yet.

The submission has concrete future ideas for improving the agent's performance.

Awesome

- Thanks for providing the following concrete ideas for improvement:
  - Different algorithms like TRPO, PPO, A3C, A2C
  - Weight initialization methods
  - Prioritized Experience Replay

Suggestions

- Please check the following resources also:
  - Prioritized Experience Replay
  - Distributed Prioritized Experience Replay
  - Reinforcement Learning with Prediction-Based Rewards

- Proximal Policy Optimization
- OpenAI Five
- Curiosity-driven Exploration by Self-supervised Prediction

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