Reinforcement Learning

Practical Session

Alberto Maria Metelli

16th February 2024

Outline

Outline

Library for RL Environments: Gymnasium

"Gymnasium is an open source Python library for developing and comparing reinforcement learning algorithms by providing a standard API to communicate between learning algorithms and environments, as well as a standard set of environments compliant with that API."

- Fork of OpenAI's Gym (`https://github.com/openai/gym`) library (no longer maintained)
- Github: `https://github.com/Farama-Foundation/Gymnasium`
- Documentation: `https://gymnasium.farama.org/`
- Citation: (Towers et al., 2023)

Pictures and quotation from `https://github.com/Farama-Foundation/Gymnasium`

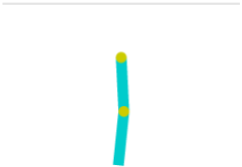
Toy Text

Blackjack

Frozen Lake

Pictures from https://www.gymlibrary.ml/pages/environments/toy_text/

Classic Control



Acrobot

Cart Pole

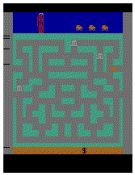
Mountain Car

Mountain Car Continuous

Pendulum

Pictures from https://www.gymlibrary.ml/pages/environments/classic_control/

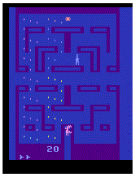
Atari



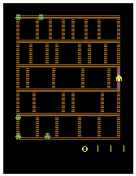
Bank Heist

Battle Zone

Beam Rider

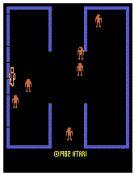


Alien

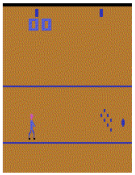


Amidar

Assault

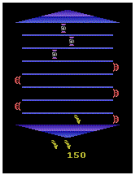


Berzerk



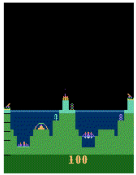
Bowling

Boxing



Asterix

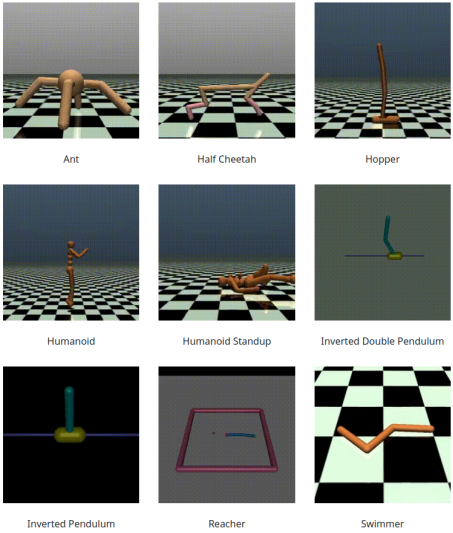
Asteroids



Atlantis

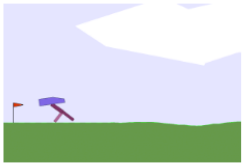
Pictures from https://www.gymlibrary.ml/pages/environments/atari/

Mujoco

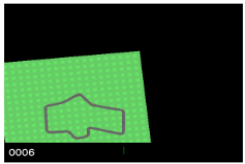


Pictures from https://www.gymlibrary.ml/pages/environments/mujoco/

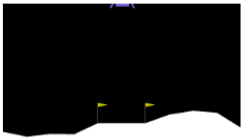
Box2D



Bipedal Walker



Car Racing



Lunar Lander

Pictures from https://www.gymlibrary.ml/pages/environments/box2d/

Outline

Libraries for RL Algorithms

- **OpenAI Baselines** (Dhariwal et al., 2017)
  - `https://github.com/openai/baselines`
  - Under maintenance
  - Based on Tensorflow
- **Stable Baselines** (Hill et al., 2018)
  - `https://github.com/hill-a/stable-baselines`
  - Improved implementations from OpenAI Baselines
  - Better documentation (`https://stable-baselines.readthedocs.io/`)
  - Under maintenance
  - Based on Tensorflow
- **Stable Baselines3** (Raffin et al., 2021)
  - `https://github.com/DLR-RM/stable-baselines3`
  - Next major version of Stable Baselines
  - Based on **PyTorch**

Libraries for RL Algorithms

- TF Agents (`https://github.com/tensorflow/agents`)
- Keras-RL (`https://github.com/keras-rl/keras-rl`)
- Keras-RL2 (`https://github.com/wau/keras-rl2`)
- Tensorforce (`https://github.com/tensorforce/tensorforce`)
- RL Coach (`https://github.com/IntelLabs/coach`)
- Mushroom RL (`https://github.com/MushroomRL/mushroom-rl`)
- RLLib (`https://docs.ray.io/en/master/rllib-env.html`)
- ...

Stable Baselines3

"Stable Baselines3 (SB3) is a set of reliable implementations of reinforcement learning algorithms in PyTorch. It is the next major version of Stable Baselines."

- Github: `https://github.com/DLR-RM/stable-baselines3`
- Documentation: `https://stable-baselines3.readthedocs.io/en/master/index.html`
- Citation: (Raffin et al., 2021)

Picture and quotation from `https://github.com/DLR-RM/stable-baselines3`

Stable Baselines3

- The performance of each algorithm was tested
  - `https://github.com/DLR-RM/stable-baselines3/issues/48`
  - `https://github.com/DLR-RM/stable-baselines3/issues/49`

- Implemented algorithms:
  - ARS*
  - A2C
  - DDPG
  - DQN
  - HER
  - PPO
  - QR-DQN*
  - SAC
  - TD3
  - TQC*
  - TRPO*
  - Maskable PPO*

* Implemented in SB3 Contrib GitHub repository (Github: `https://github.com/Stable-Baselines-Team/stable-baselines3-contrib` - Documentation: `https://sb3-contrib.readthedocs.io/en/master/`)

RL Baselines3 Zoo

"RL Baselines3 Zoo is a training framework for Reinforcement Learning (RL), using Stable Baselines3."

- Github: `https://github.com/DLR-RM/rl-baselines3-zoo`
- Citation: (Raffin, 2020)
- Builds upon Stable Baselines3
- Goals:
  - Interface to train RL agents
  - Benchmark RL algorithms
  - Tuned hyperparameters for each environment-RL algorithm pair

Quotation from `https://github.com/DLR-RM/rl-baselines3-zoo`

Practical Session

We now look at some code!

- **01. Getting Started**
  https://colab.research.google.com/github/albertometelli/rl-phd-2024/blob/main/01_getting_started.ipynb
- **02. Gym Environment**
  https://colab.research.google.com/github/albertometelli/rl-phd-2024/blob/main/02_gym_environment.ipynb
- **03. GPOMDP**
  https://colab.research.google.com/github/albertometelli/rl-phd-2024/blob/main/03_gpomdp.ipynb

References I

P. Dhariwal, C. Hesse, O. Klimov, A. Nichol, M. Plappert, A. Radford, J. Schulman, S. Sidor, Y. Wu, and P. Zhokhov. Openai baselines. `https://github.com/openai/baselines`, 2017.

A. Hill, A. Raffin, M. Ernestus, A. Gleave, A. Kanervisto, R. Traore, P. Dhariwal, C. Hesse, O. Klimov, A. Nichol, M. Plappert, A. Radford, J. Schulman, S. Sidor, and Y. Wu. Stable baselines. `https://github.com/hill-a/stable-baselines`, 2018.

A. Raffin. Rl baselines3 zoo. `https://github.com/DLR-RM/rl-baselines3-zoo`, 2020.

A. Raffin, A. Hill, A. Gleave, A. Kanervisto, M. Ernestus, and N. Dormann. Stable-baselines3: Reliable reinforcement learning implementations. *Journal of Machine Learning Research*, 22(268):1–8, 2021. URL `http://jmlr.org/papers/v22/20-1364.html`.

M. Towers, J. K. Terry, A. Kwiatkowski, J. U. Balis, G. d. Cola, T. Deleu, M. Goulão, A. Kallinteris, A. KG, M. Krimmel, R. Perez-Vicente, A. Pierré, S. Schulhoff, J. J. Tai, A. T. J. Shen, and O. G. Younis. Gymnasium, Mar. 2023. URL `https://zenodo.org/record/8127025`.