Reinforcement Learning

Lecture 2: OpenAI gym

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Lecture Overview

This lecture shows how to set up a modern RL environment ready for training using **OpenAI gym** and a Multi-armed Bandits implementation as in chapter 2 of [1].

1 OpenAI gym

- what is it?
- how does it map to RL concepts?
- gym.Env methods and attributes
- nested spaces example

2 Colab coding

- a random agent
- exploring different environments
- minimal REINFORCE example
- multi-arm bandit problems

OpenAI gym what is it?

OpenAI gym

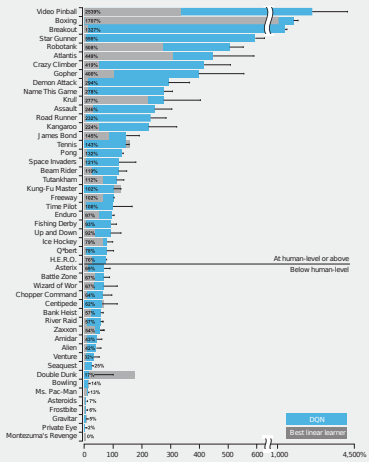
What is it?

- Collection of environments
- Most environments are freely available
- Standardised API makes comparisons and benchmarking easier
- Test same RL algorithms on many different problems

For example:

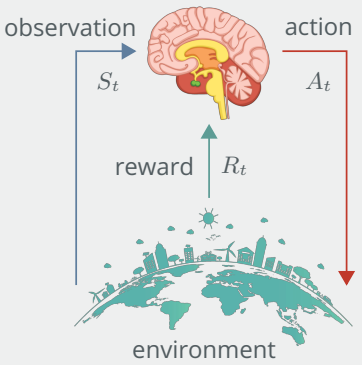
- Atari 2600 games
- Classic control problems
- Physics simulations

Environments and performance in [2]



OpenAI gym how does it map to RL concepts?

RL Agents



Algorithm: minimal example

```
import gym
env = gym.make('CartPole-v0')

agent = Agent()

# init the environment to base state
# and get initial observation state
s = env.reset()

# loop until environment says it's done
done = False
while not done:
    a = agent.sample_action(s)
    s, r, done, info = env.step(a)
env.close()
```

OpenAI gym gym.Env methods and attributes

Core methods

In gym/core.py:

- **s = env.reset()** - reset the environment and return the initial observation state
- **s,r,done,info = env.step(action)** - takes a single step and returns a tuple with the next state, the reward, whether the environment is now done, and some meta diagnostic info
- **env.close()** - cleanup function
- **env.seed(int)** - seed all the environment randomness
- **env.render()** - (optional) render the env state: print text, show an image...

Env attributes

- **env.action_space** - gym.Space object that describes the shape and type of actions
- **env.observation_space** - gym.Space object that describes the shape and type of observations
- **env.reward_range** - tuple of per-step reward range, defaults to $(-\infty, \infty)$

gym.Space in /gym/spaces/space.py:

- **Box, Discrete, Binary, ...**
- **Tuple, Dict** - can contain nested observation spaces

OpenAI gym nested spaces example

Example: nested observation space – gym/spaces/dict.py

```
env.nested_observation_space = spaces.Dict({
    'sensors':  spaces.Dict({
        'position': spaces.Box(low=-100, high=100, shape=(3,)),
        'velocity': spaces.Box(low=-1, high=1, shape=(3,)),
        'front_cam': spaces.Tuple((
            spaces.Box(low=0, high=1, shape=(10, 10, 3)),
            spaces.Box(low=0, high=1, shape=(10, 10, 3))
        )),
        'rear_cam': spaces.Box(low=0, high=1, shape=(10, 10, 3)),
    }),
    'ext_controller': spaces.MultiDiscrete((5, 2, 2))
})
```

Colab coding demo

Click this link:

Link to Colab code

In this demo we will cover:

- A random agent
- Exploring different environments
- Plotting and measuring baselines
- Minimal REINFORCE example
- Multi-armed Bandits – chapter two of [1]

References I

[1] Richard S Sutton and Andrew G Barto.
Reinforcement learning: An introduction (second edition). Available online. MIT press, 2018.

[2] Volodymyr Mnih et al. “Human-level control through deep reinforcement learning”. In: nature 518.7540 (2015), pp. 529–533.