Reinforcement Learning Lab

Lesson 6: Multi-Armed Bandit

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Environment Setup

The first step for the setup of the laboratory environment is to update the repository and load the miniconda environment.

- Update the repository of the lab:

```
cd RL-Lab
git stash
git pull
git stash pop
```

- Activate the *miniconda* environment:

```
conda activate rl-lab
```

Safe Procedure

Always back up the previous lessons' solutions before executing the repository update.

Today Assignment

In today's lesson, we will implement the Multi-Armed Bandit Environment and the Simple Bandit Algorithm algorithm to solve it. In particular, the file to complete is:

```
RL-Lab/lessons/lesson_6_code.py
```

Inside the file, a python class and a function are partially implemented. The objective of this lesson is to complete it.

- **class MultiArmedBandit()**
- **def banditAlgorithm()**

Expected results can be found in:

```
RL-Lab/results/lesson_6_results.txt
```

Environment: Multi-Armed Bandit

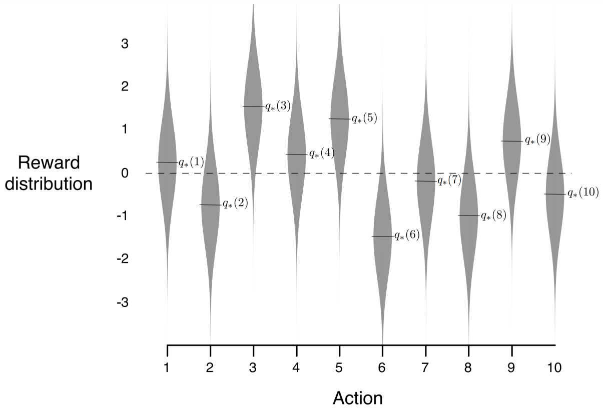
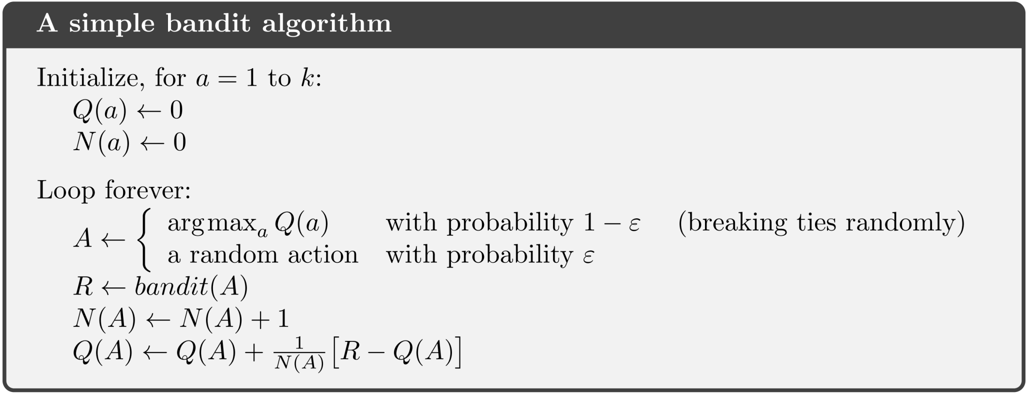


Figure: Visual explanation of the Multi-Armed Bandit environment, from the Sutton and Barto book *Reinforcement Learning: An Introduction*

- The *N-Armed Bandit* environment consists of a set of N possible actions, from 0 to N. At each action has been assigned a value ($q^*(a)$), sampled from a normal distribution with $\mu = 0$ and $\sigma^2 = 1$.
- For a given action a, the environment should return a reward sampled from a normal distribution with $\mu = q^*(a)$ and $\sigma^2 = 1$.

Algorithm: Simple Bandit



A simple bandit algorithm

```
Initialize, for $a = 1$ to $k$:
    $Q(a) \leftarrow 0$
    $N(a) \leftarrow 0$

Loop forever:
    $A \leftarrow \begin{cases} \arg\max_a Q(a) & \text{with probability } 1 - \varepsilon \quad \text{(breaking ties randomly)} \\ \text{a random action} & \text{with probability } \varepsilon \end{cases}$
    $R \leftarrow bandit(A)$
    $N(A) \leftarrow N(A) + 1$
    $Q(A) \leftarrow Q(A) + \frac{1}{N(A)}\left[R - Q(A)\right]$
```

Figure: Pseudocode for Simple Bandit Algorithm, from the Sutton and Barto book *Reinforcement Learning: An Introduction*

Environment: Multi-Armed Bandit

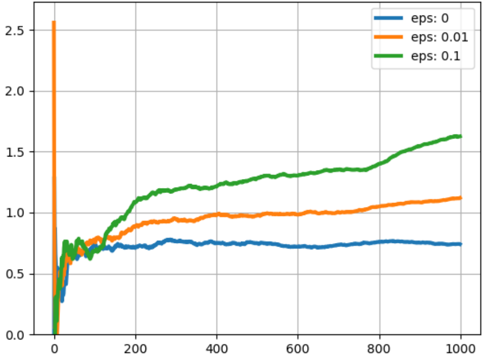
The suggested solution exploits a NumPy function to sample from a normal distribution, numpy.random.normal(). More details can be found on the official website (here).

Seeding

Given the (particularly) high stochasticity of the method and the environment, for this lesson, we fixed a random seed equal to 6.

Hint (Expected results)

The plot on the right is the expected result. Notice that the best results have been obtained with eps=0.1, while the worst one with eps=0 (i.e., no exploration).


eps: 0
eps: 0.01
eps: 0.1