Lab 3: Dummy Q-learning (table)

Reinforcement Learning with TensorFlow&OpenAI Gym

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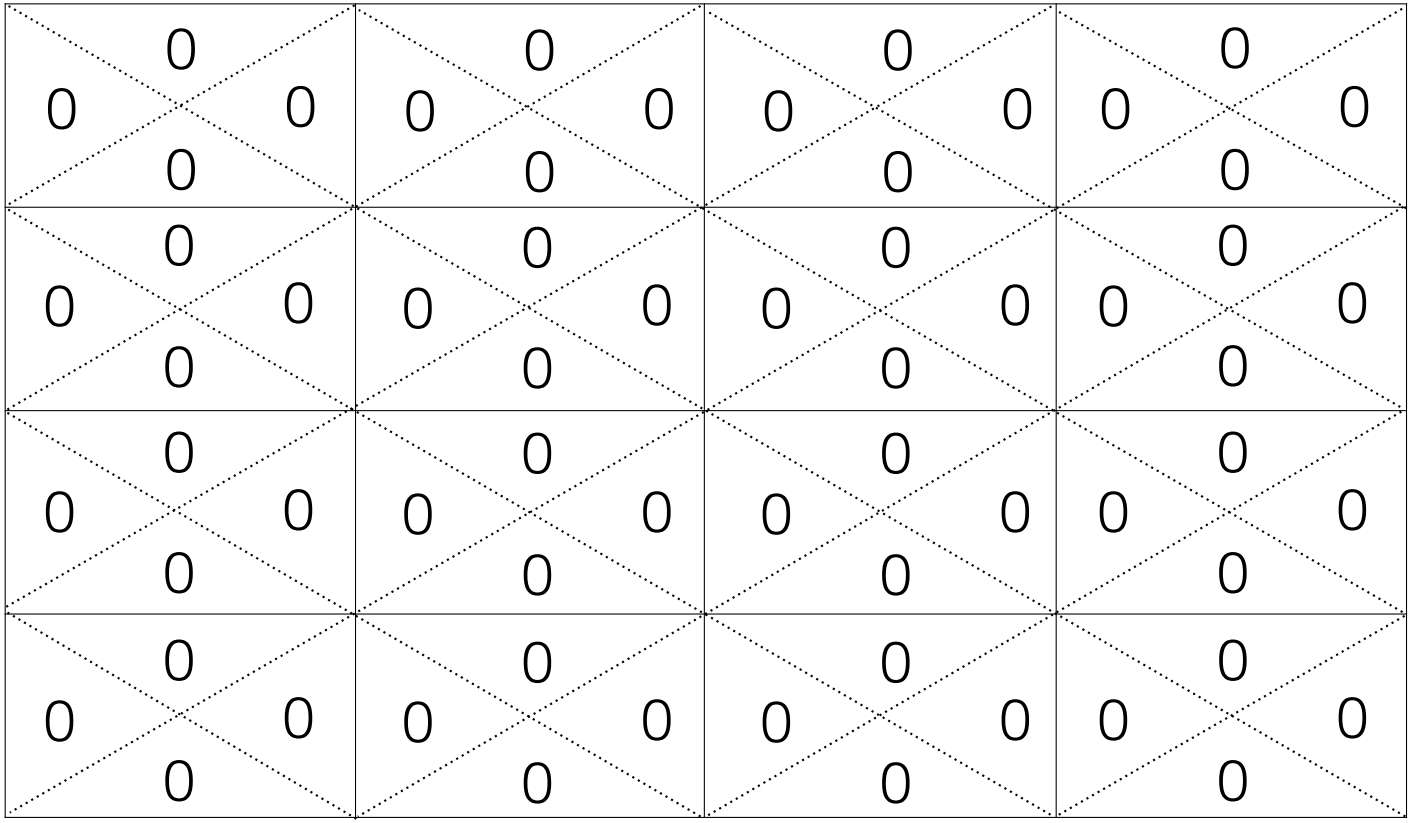
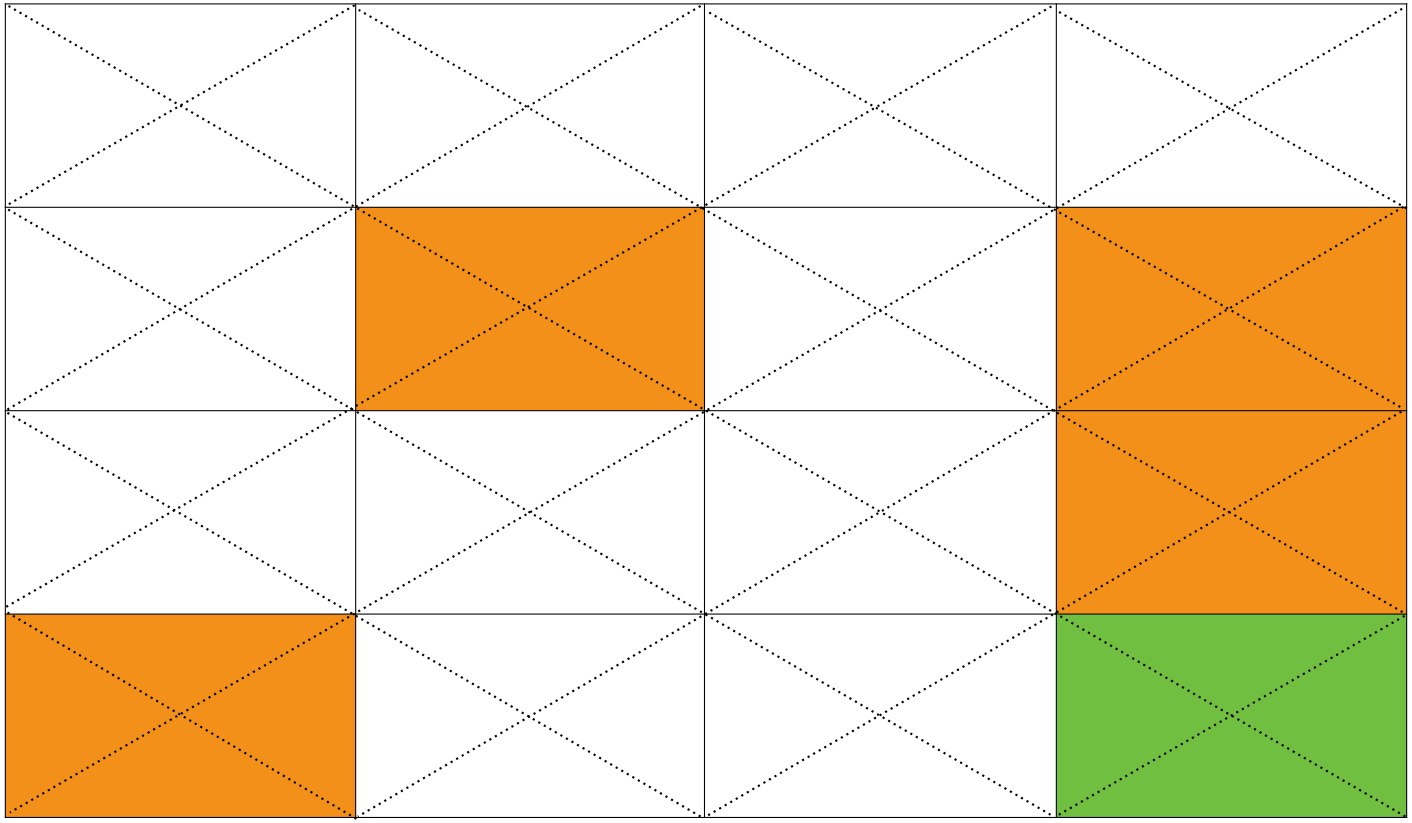
Learning Q(s, a): Table

initial Q values are 0



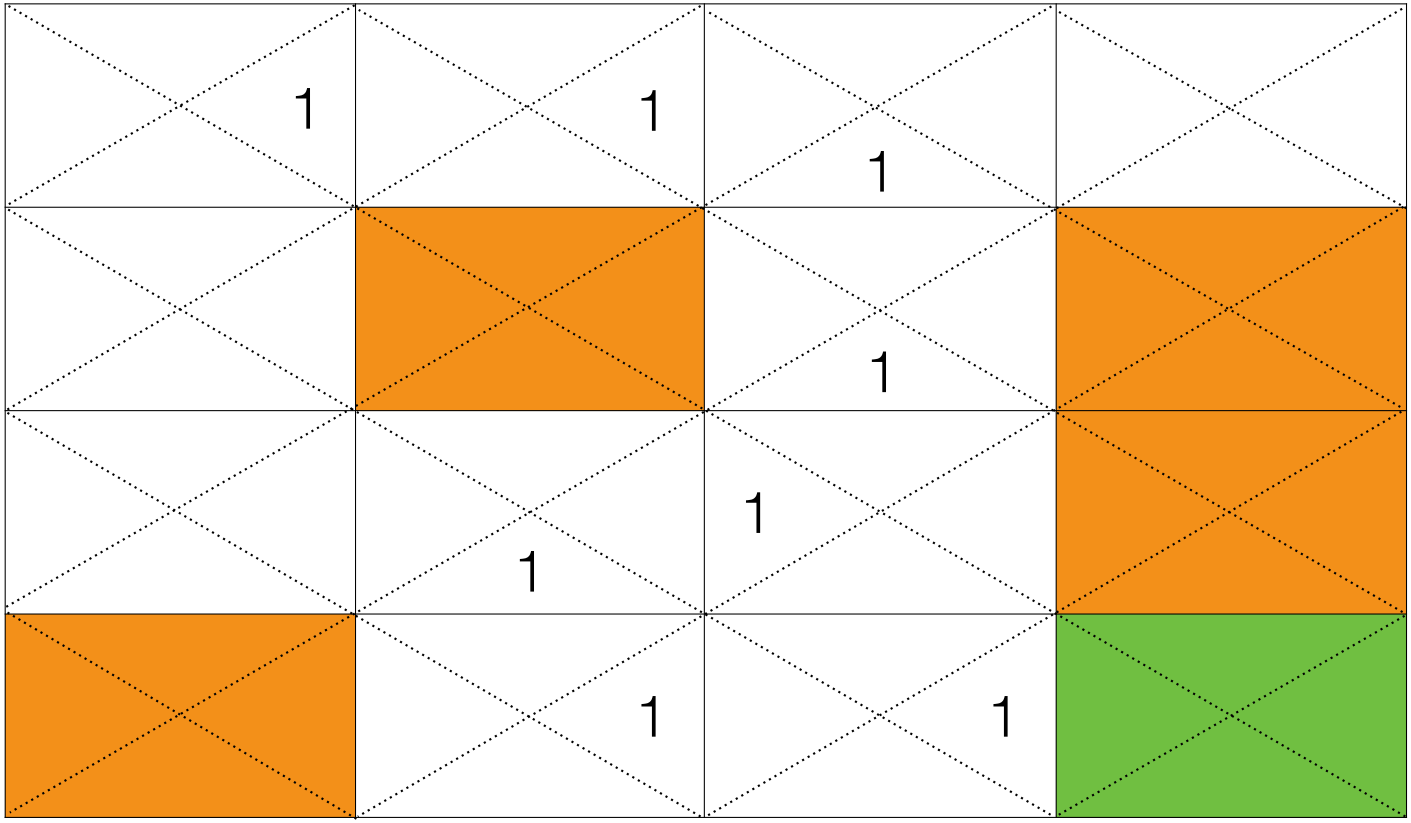
Learning Q(s, a) Table (with many trials)

initial Q values are 0



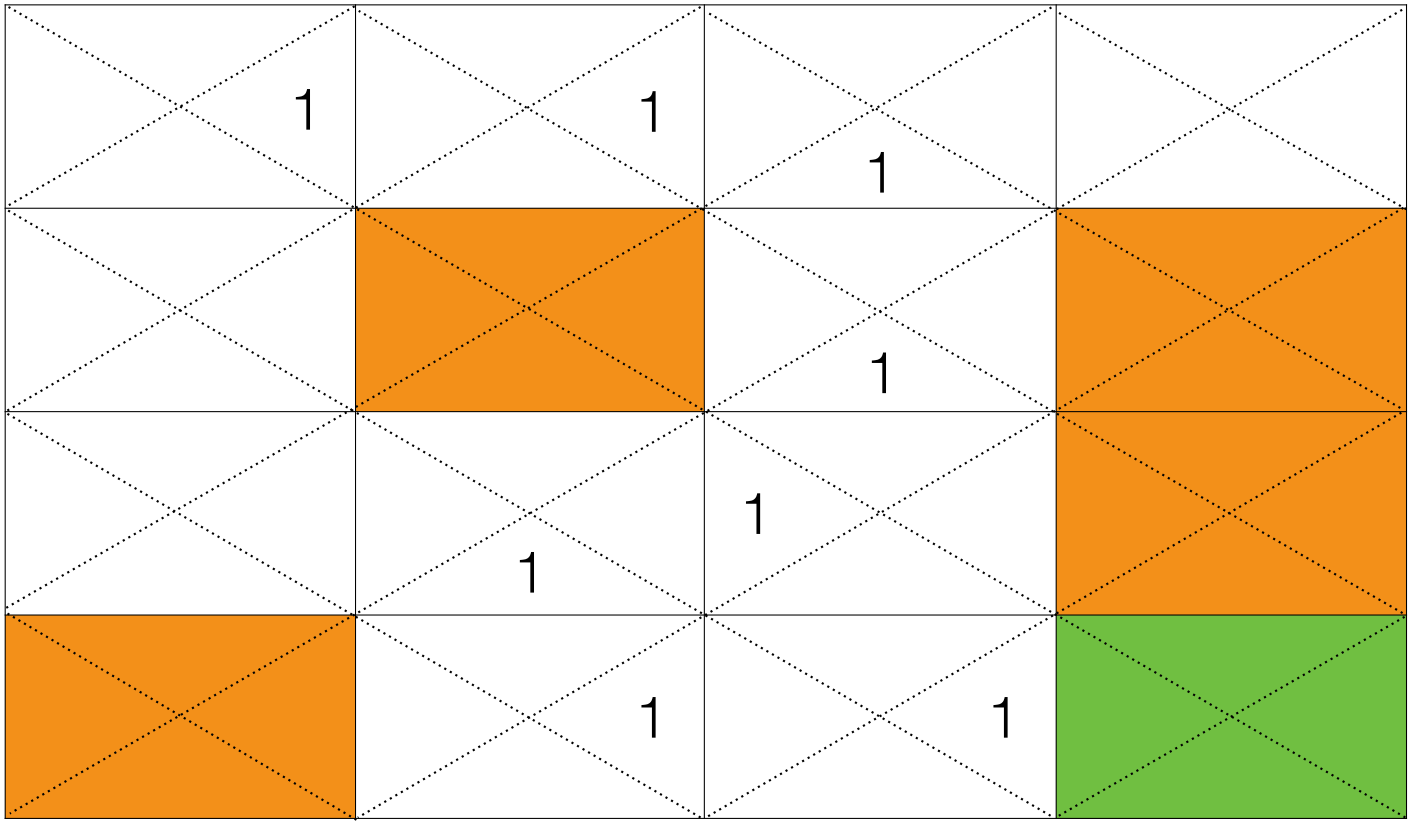
Learning Q(s, a) Table: one success!

initial Q values are 0



Learning Q(s, a) Table: one success!

$$\pi^*(s) = \underset{a}{\operatorname{argmax}}\, Q(s, a)$$



Dummy Q-learning algorithm

For each s, a initialize table entry $\hat{Q}(s, a) \leftarrow 0$

Observe current state s

Do forever:

- Select an action a and execute it
- Receive immediate reward r
- Observe the new state s'
- Update the table entry for $\hat{Q}(s, a)$ as follows:

$$\hat{Q}(s, a) \leftarrow r + \max_{a'} \hat{Q}(s', a')$$

- $s \leftarrow s'$

Machine Learning, T. Mitchell, McGraw Hill, 1997

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```
# Initialize table with all zeros
Q = np.zeros([env.observation_space.n,env.action_space.n])
# Set learning parameters
num_episodes = 2000

# create lists to contain total rewards and steps per episode
rList = []
for i in range(num_episodes):
    # Reset environment and get first new observation
    state = env.reset()
    rAll = 0
    done = False

    # The Q-Table learning algorithm
    while not done:
        action = rargmax(Q[state, :])

        # Get new state and reward from environment
        new_state, reward, done,_ = env.step(action)

        # Update Q-Table with new knowledge using learning rate
        Q[state,action] = reward + np.max(Q[new_state,:])

        state = new_state
```

Machine Learning, T. Mitchell, McGraw Hill, 1997

Code: setup

```
import gym
import numpy as np
import matplotlib.pyplot as plt
from gym.envs.registration import register
import random as pr

def rargmax(vector):   # https://gist.github.com/stober/1943451
    """ Argmax that chooses randomly among eligible maximum indices. """
    m = np.amax(vector)
    indices = np.nonzero(vector == m)[0]
    return pr.choice(indices)


register(
    id='FrozenLake-v3',
    entry_point='gym.envs.toy_text:FrozenLakeEnv',
    kwargs={'map_name': '4x4',
            'is_slippery': False}
)
env = gym.make('FrozenLake-v3')
```

https://medium.com/emergent-future/simple-reinforcement-learning-with-tensorflow-part-0-q-learning-with-tables-and-neural-networks-d195264329d0#.pjz9g59ap

Code: (dummy) Q-learning

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        # Get new state and reward from environment
        new_state, reward, done,_ = env.step(action)

        # Update Q-Table with new knowledge using learning rate
        Q[state,action] = reward + np.max(Q[new_state,:])

        rAll += reward
        state = new_state

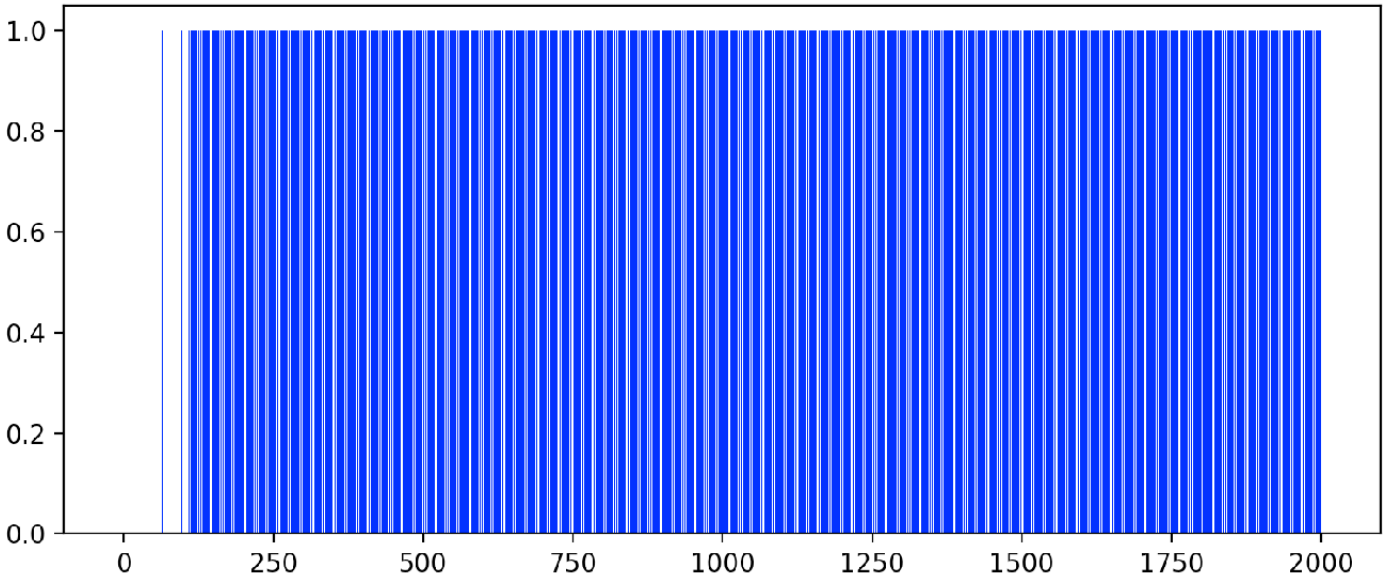
    rList.append(rAll)
```

https://medium.com/emergent-future/simple-reinforcement-learning-with-tensorflow-part-0-q-learning-with-tables-and-neural-networks-d195264329d0#.pjz9g59ap

Code: result reporting

```
print("Success rate: " + str(sum(rList)/num_episodes))
print("Final Q-Table Values")
print ("LEFT DOWN RIGHT UP")
print(Q)
plt.bar(range(len(rList)), rList, color="blue")
plt.show()
```

Success rate: 0.95

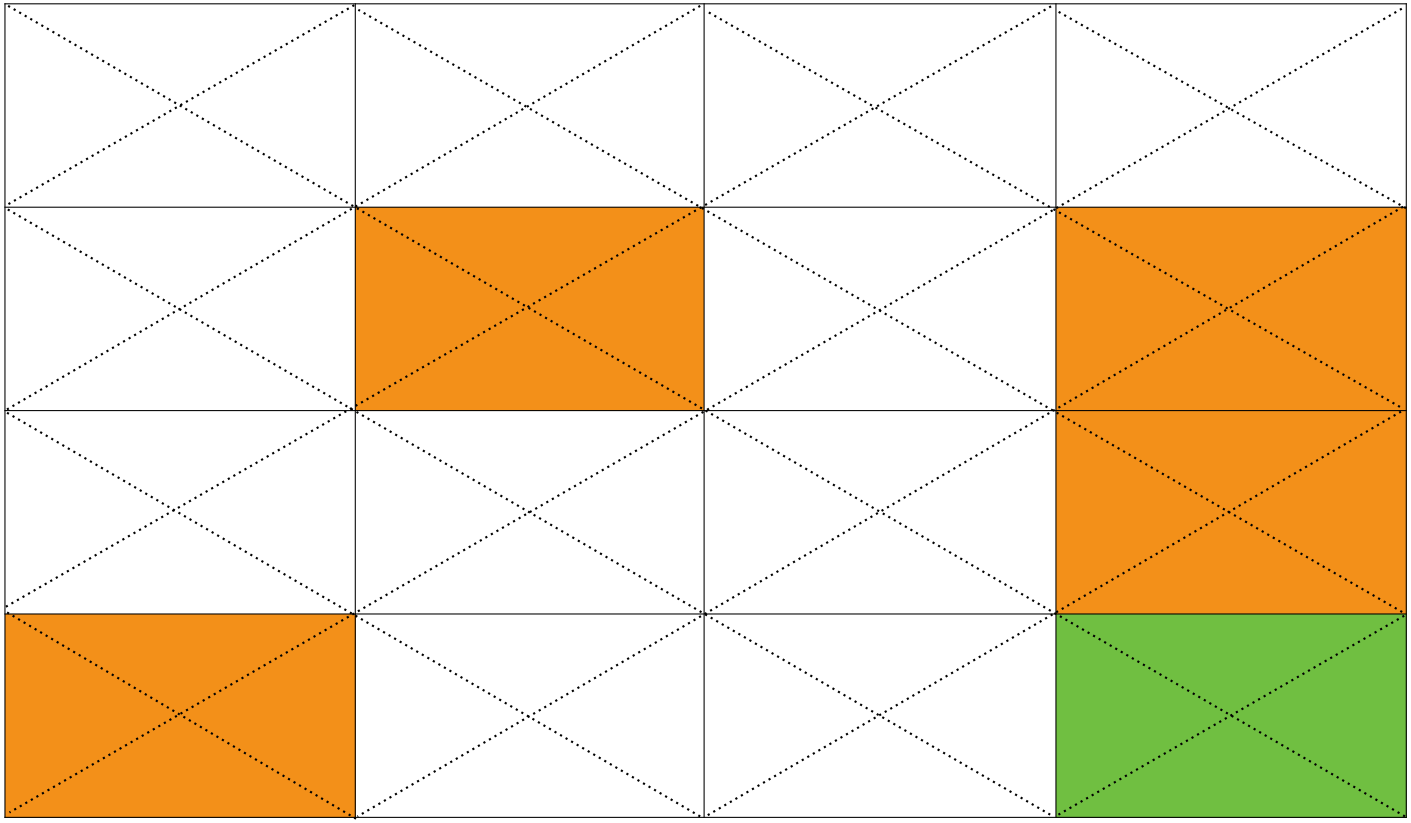


Q = np.zeros([env.observation_space.n, env.action_space.n])

print(Q)

LEFT DOWN RIGHT UP

```
[[ 0.  0.  1.  0.]
 [ 0.  0.  1.  0.]
 [ 0.  1.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  1.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  1.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  0.  0.  0.]
 [ 0.  0.  1.  0.]
 [ 0.  0.  0.  0.]]
```



Next

Exploit&exploration and discounted future reward