Navigation

October 4, 2019

```
In [1]: !pip -q install ./python
```

```
tensorflow 1.7.1 has requirement numpy>=1.13.3, but you'll have numpy 1.12.1 which is incompatib
ipython 6.5.0 has requirement prompt-toolkit<2.0.0,>=1.0.15, but you'll have prompt-toolkit 2.0.
```

Note: This code is made using help from various sources like udacity and various people's implementation. I'll try to improve upon this code as i learn

0.1 Deep Q-Network Architecture

The network is something like this:

1. `input_size = state_size = 37`
2. 2 linear layers, one with 128 nodes as output and other with 64 nodes as output with relu activation for both
3. A third linear layer with 4 outputs for 4 actions

0.2 Learning algo to use

The algo used in this project will be Q-learning algo with experience relay and fixed Q targets. The optimization of network will be done through `Adam` optimizer

0.2.1 Hyperparameters used

- `BUFFER_SIZE = int(1e5)` : replay buffer size
- `BATCH_SIZE = 64` : minibatch size
- `GAMMA = 0.99` : discount factor
- `TAU = 1e-3` : for soft update of target parameters
- `LR = 5e-4` : learning rate
- `UPDATE_EVERY = 4` : how often to update the network
- `EPS_DECAY=0.995` : the reduction factor of the epsilon-greedy policy

0.3 Environment Information

The environment we will use is Unity MLAgents

```
In [2]: from unityagents import UnityEnvironment
        from dqn_agent import Agent
        from collections import deque

        import numpy as np
        import random
        import os
        import torch
        import matplotlib.pyplot as plt
```

Next, we'll start the environment. To run on a new machine, before running the environment, change the `file_name` parameter to the path where the Unity environment is installed in the machine.

Here are the various paths for different operating systems:

- Mac: `"path/to/Banana.app"`
- Windows (x86): `"path/to/Banana_Windows_x86/Banana.exe"`
- Windows (x86_64): `"path/to/Banana_Windows_x86_64/Banana.exe"`
- Linux (x86): `"path/to/Banana_Linux/Banana.x86"`
- Linux (x86_64): `"path/to/Banana_Linux/Banana.x86_64"`
- Linux (x86, headless): `"path/to/Banana_Linux_NoVis/Banana.x86"`
- Linux (x86_64, headless): `"path/to/Banana_Linux_NoVis/Banana.x86_64"`

The environment has 4 actions: `0`: walk forward `1`: walk backward `2`: turn left `3`: turn right

State space has 37 dimensions. A reward of +1 will be awarded for collecting yellow banana and -1 for purple banana

```
In [3]: env = UnityEnvironment(file_name='/data/Banana_Linux_NoVis/Banana.x86_64')

INFO:unityagents:
'Academy' started successfully!
Unity Academy name: Academy
        Number of Brains: 1
        Number of External Brains : 1
        Lesson number : 0
        Reset Parameters :

Unity brain name: BananaBrain
        Number of Visual Observations (per agent): 0
        Vector Observation space type: continuous
        Vector Observation space size (per agent): 37
        Number of stacked Vector Observation: 1
        Vector Action space type: discrete
        Vector Action space size (per agent): 4
        Vector Action descriptions: , , ,
```

```
In [4]: brain_name = env.brain_names[0]
        brain = env.brains[brain_name]
```

0.4 Train the agent with DQN

In [5]:
```
agent = Agent(state_size=37, action_size=4, seed=32, fc1_units=128, fc2_units=64)
```

In [6]:
```
save_path = 'checkpoint.pth'
episode_num = 1
def save_model(model, episode_num):
    if model is not None:
        checkpoint = {
            'episode_num': episode_num,
            'state_dict': model.state_dict()
        }
        torch.save(checkpoint, save_path)
        print('\r\tsave episode' + str(episode_num), end='')

def load_model(model):
    if os.path.exists(save_path) and model is not None:
        checkpoint = torch.load(save_path)
        episode_num = checkpoint['episode_num']
        model.load_state_dict(checkpoint['state_dict'])
        print('Loaded episode number: ', episode_num)
        return episode_num
    return 1

episode_num = load_model(agent.qnetwork_local)
print(episode_num)
```

```
Loaded episode number:  700
700
```

In [7]:
```
def dqn(n_episodes=2000, max_t=100000, eps_start=1., eps_end=.01, eps_decay=.995):
    scores = []
    scores_window = deque(maxlen=100)
    eps = eps_start

    for i_episode in range(n_episodes):
        env_info = env.reset(train_mode=True)[brain_name]
        state = env_info.vector_observations[0]
        score = 0
        for t in range(max_t):
            action = (int)(agent.act(state, eps))
            env_info = env.step(action)[brain_name]
            next_state = env_info.vector_observations[0]
            reward = env_info.rewards[0]
            done = env_info.local_done[0]
            agent.step(state, action, reward, next_state, done)
            state = next_state
            score+=reward
```

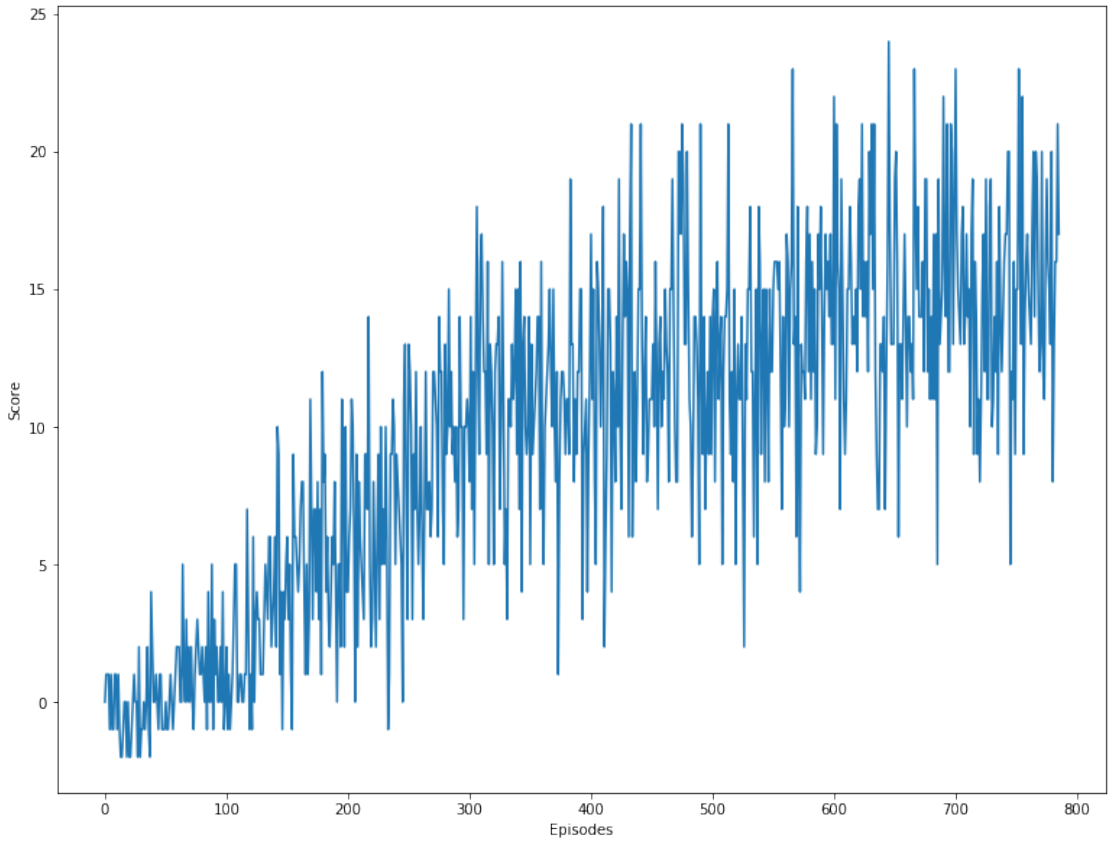
```
                    if done: break
                scores_window.append(score)
                scores.append(score)
                eps = max(eps_end, eps_decay * eps)
                print('\rEpisode {}\tAverage Score: {:.2f}'.format(i_episode, np.mean(scores_win
                if i_episode % 100 == 0:
                    print('\rEpisode {}\tAverage Score: {:.2f}'.format(i_episode, np.mean(scores
                    save_model(agent.qnetwork_local, i_episode)
                if np.mean(scores_window) >= 15.:
                    print('\nEnvironment solved in {:d} episodes!\tAverage Score: {:.2f}'.format

                    torch.save(agent.qnetwork_local.state_dict(), 'model.pth')
                    break
            return scores
```

```
In [9]: scores = dqn()
```

```
Episode 785        Average Score: 15.05
Environment solved in 685 episodes!        Average Score: 15.05
```

```
In [10]: fig = plt.figure(figsize=(13, 10))
         ax = fig.add_subplot(111)
         plt.plot(np.arange(len(scores)), scores)
         plt.ylabel('Score')
         plt.xlabel('Episodes')
         plt.show()
```



0.5 Testing the trained

```
In [8]: agent.qnetwork_local.load_state_dict(torch.load('model.pth'))

        env_info = env.reset(train_mode=False)[brain_name]

        state = env_info.vector_observations[0]
        score = 0

        while True:
            action = agent.act(state)
            env_info = env.step(action)[brain_name]
            next_state = env_info.vector_observations[0]
            reward = env_info.rewards[0]
            done = env_info.local_done[0]
            score+=reward
            state = next_state
            if done: break

        print('Score:', score)
```

```
Score: 16.0
```

```
In [ ]: env.close()
```

0.6 Future work to consider:

I'm planning to add following features in this: * Duelling DQN * Double DQN * Prioritized Experienced Replay

```
In [ ]:
```