# Navigation

July 18, 2021

## 1 Navigation

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In this notebook, you will learn how to use the Unity ML-Agents environment for the first project of the Deep Reinforcement Learning Nanodegree.

### 1.0.1 1. Start the Environment

We begin by importing some necessary packages. If the code cell below returns an error, please revisit the project instructions to double-check that you have installed Unity ML-Agents and NumPy.

[1]:
```
from unityagents import UnityEnvironment
import numpy as np
```

Next, we will start the environment! ***Before running the code cell below***, change the `file_name` parameter to match the location of the Unity environment that you downloaded.

- **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"`

For instance, if you are using a Mac, then you downloaded `Banana.app`. If this file is in the same folder as the notebook, then the line below should appear as follows:

```
env = UnityEnvironment(file_name="Banana.app")
```

[2]:
```
#env = UnityEnvironment(file_name="Banana_Linux/Banana.x86_64")
env = UnityEnvironment(file_name="Banana.app")
```

```
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: , , ,
```

[3]:

```
# get the default brain
brain_name = env.brain_names[0]
brain = env.brains[brain_name]
brain
```

[3]:

```
<unityagents.brain.BrainParameters at 0x7fda99b92978>
```

[4]:

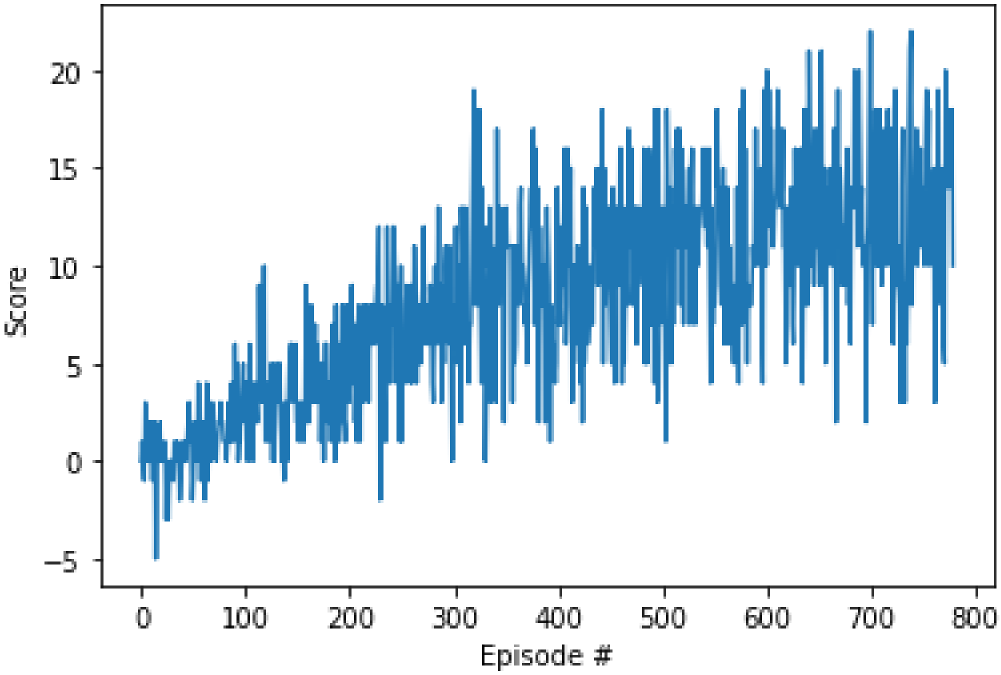
```
import torch
from lib.agents import AgentExperienceReplay, AgentPrioritizedExperienceReplay
from lib.models import QNetwork, DuelingQNetwork

from lib.dqn import dqn

import matplotlib.pyplot as plt
%matplotlib inline
# reset the environment
env_info = env.reset(train_mode=True)[brain_name]

# number of agents in the environment
print('Number of agents:', len(env_info.agents))

# number of actions
action_size = brain.vector_action_space_size
print('Number of actions:', action_size)

# examine the state space
state = env_info.vector_observations[0]
print('States look like:', state)
state_size = len(state)
print('States have length:', state_size)

def create_dueling_model(state_size, action_size, seed):
    return DuelingQNetwork(state_size, action_size, seed)

def create_linear_model(state_size, action_size, seed):
    return QNetwork(state_size, action_size, seed)

n_episodes=2000
```

```
scores = []
agent_info = []
# Prioritised Experience replay with Dueling Network
agent = AgentPrioritizedExperienceReplay(state_size=state_size,␣
 ↪action_size=action_size, seed=0,
                                    create_model=create_dueling_model,
                                    double_dqn=False
                                   )
agent_info.append({'agent': agent, 'name':␣
 ↪'prioritized_experiences_dueling_network', 'test': True})

# Prioritised Experience replay with Dueling Network and Double Q learning
agent = AgentPrioritizedExperienceReplay(state_size=state_size,␣
 ↪action_size=action_size, seed=0,
                                    create_model=create_dueling_model,
                                    double_dqn=True
                                   )
agent_info.append({'agent': agent, 'name':␣
 ↪'prioritized_experiences_dueling_network_double', 'test': True})

# Prioritised Experience replay with Linear Network
agent = AgentPrioritizedExperienceReplay(state_size=state_size,␣
 ↪action_size=action_size, seed=0,
                                    create_model=create_linear_model,
                                    double_dqn=False
                                   )
agent_info.append({'agent': agent, 'name':␣
 ↪'prioritized_experiences_linear_network', 'test': True})

# Prioritised Experience replay with Linear Network and Double Q learning
agent = AgentPrioritizedExperienceReplay(state_size=state_size,␣
 ↪action_size=action_size, seed=0,
                                    create_model=create_linear_model,
                                    double_dqn=True
                                   )
agent_info.append({'agent': agent, 'name':␣
 ↪'prioritized_experiences_linear_network_double', 'test': True})

# Experience replay with Dueling Network
agent = AgentExperienceReplay(state_size=state_size, action_size=action_size,␣
 ↪seed=0,
                                    create_model=create_dueling_model,
                                    double_dqn=False
                                   )
agent_info.append({'agent': agent, 'name':␣
 ↪'uniform_experiences_dueling_network', 'test': True})
```

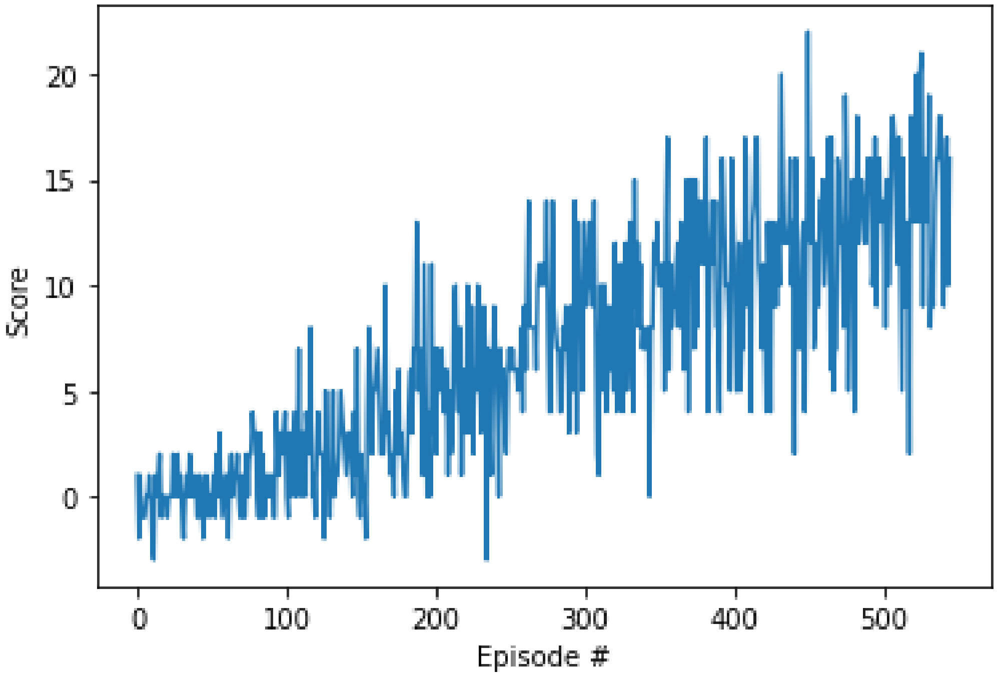
```
# Experience replay with Dueling Network and Double Q learning
agent = AgentExperienceReplay(state_size=state_size, action_size=action_size,␣
 ↪seed=0,
                                   create_model=create_dueling_model,
                                   double_dqn=True
                                  )
agent_info.append({'agent': agent, 'name':␣
 ↪'uniform_experiences_dueling_network_double', 'test': True})

# Experience replay with Linear Network
agent = AgentExperienceReplay(state_size=state_size, action_size=action_size,␣
 ↪seed=0,
                                create_model=create_linear_model,
                                double_dqn=False
                                  )
agent_info.append({'agent': agent, 'name':␣
 ↪'uniform_experiences_linear_network', 'test': True})

# Prioritised Experience replay with Linear Network and Double Q learning
agent = AgentExperienceReplay(state_size=state_size, action_size=action_size,␣
 ↪seed=0,
                                create_model=create_linear_model,
                                double_dqn=True
                                  )
agent_info.append({'agent': agent, 'name':␣
 ↪'uniform_experiences_linear_network_double', 'test': True})


for info in agent_info:
    if info["test"]:
        agent_name = info['name']
        print(f"\n\n{agent_name}")
        env_info = env.reset(train_mode=True)[brain_name]
        agent = info['agent']
        scores.append(dqn(env,
                          brain_name,
                          agent,
                          n_episodes=n_episodes,
                          checkpoint=13,
                          agent_name=agent_name))
        agent.save_model(agent_name)


# plot the scores
for instance_scores in scores:
```

```python
    print(f"\n{info['name']}\n")
    fig = plt.figure()
    ax = fig.add_subplot(111)
    plt.plot(np.arange(len(instance_scores)), instance_scores)
    plt.ylabel('Score')
    plt.xlabel('Episode #')
    plt.show()
```

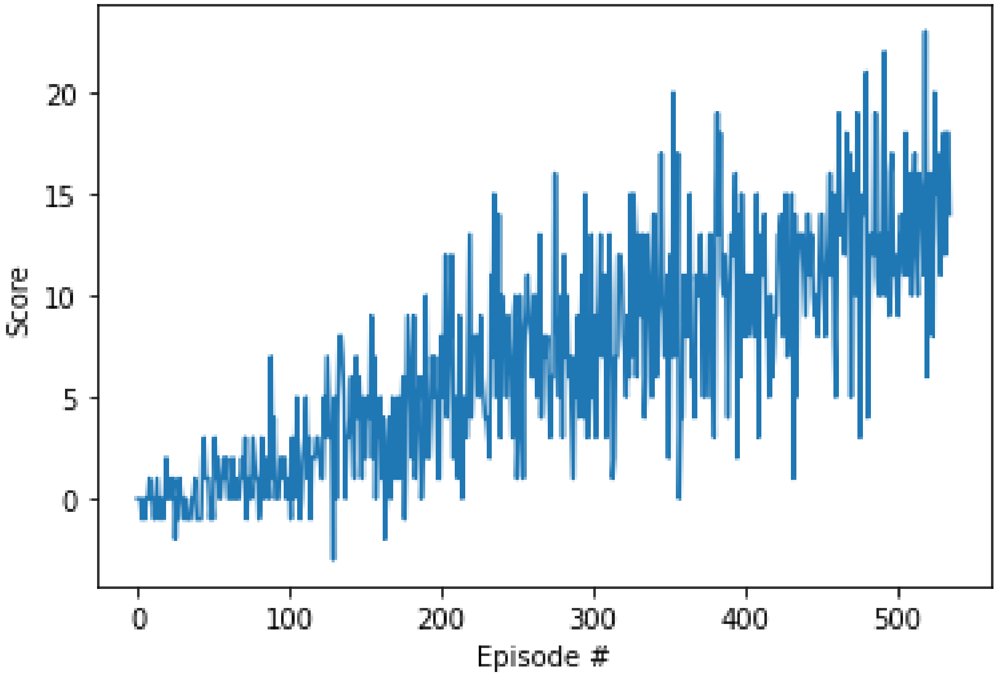
```
Number of agents: 1
Number of actions: 4
States look like: [1.         0.         0.         0.         0.84408134 0.
 0.         1.         0.         0.0748472  0.         1.
 0.         0.         0.25755    1.         0.         0.
 0.         0.74177343 0.         1.         0.         0.
 0.25854847 0.         0.         1.         0.         0.09355672
 0.         1.         0.         0.         0.31969345 0.
 0.        ]
States have length: 37


prioritized_experiences_dueling_network
Episode 100     Average Score: 0.90
Episode 200     Average Score: 3.53
Episode 300     Average Score: 6.51
Episode 400     Average Score: 9.17
Episode 500     Average Score: 10.19
Episode 600     Average Score: 11.24
Episode 700     Average Score: 12.86
Episode 779     Average Score: 13.00
Environment solved in 679 episodes!     Average Score: 13.00
save not implemented
save not implemented


prioritized_experiences_dueling_network_double
Episode 100     Average Score: 0.47
Episode 200     Average Score: 3.01
Episode 300     Average Score: 6.62
Episode 400     Average Score: 9.60
Episode 500     Average Score: 11.67
Episode 545     Average Score: 13.02
Environment solved in 445 episodes!     Average Score: 13.02
save not implemented
save not implemented


prioritized_experiences_linear_network
Episode 100     Average Score: 0.52
Episode 200     Average Score: 3.26
Episode 300     Average Score: 6.82
Episode 400     Average Score: 9.44
Episode 500     Average Score: 11.51
Episode 536     Average Score: 13.00
Environment solved in 436 episodes!     Average Score: 13.00
save not implemented
save not implemented


prioritized_experiences_linear_network_double
Episode 100     Average Score: 0.33
Episode 200     Average Score: 3.12
Episode 300     Average Score: 6.28
Episode 400     Average Score: 9.50
Episode 500     Average Score: 12.16
Episode 547     Average Score: 13.08
Environment solved in 447 episodes!     Average Score: 13.08
save not implemented
save not implemented


uniform_experiences_dueling_network
Episode 100     Average Score: 0.69
Episode 200     Average Score: 4.21
Episode 300     Average Score: 8.25
Episode 400     Average Score: 10.01
Episode 500     Average Score: 11.11
Episode 600     Average Score: 12.86
Episode 610     Average Score: 13.01
Environment solved in 510 episodes!     Average Score: 13.01


uniform_experiences_dueling_network_double
Episode 100     Average Score: 0.87
Episode 200     Average Score: 5.31
Episode 300     Average Score: 7.87
Episode 400     Average Score: 10.49
Episode 500     Average Score: 11.59
Episode 567     Average Score: 13.06
Environment solved in 467 episodes!     Average Score: 13.06


uniform_experiences_linear_network
Episode 100     Average Score: 1.08
Episode 200     Average Score: 3.83
Episode 300     Average Score: 7.76
Episode 400     Average Score: 9.49
Episode 500     Average Score: 11.86
Episode 544     Average Score: 13.03
Environment solved in 444 episodes!     Average Score: 13.03


uniform_experiences_linear_network_double
Episode 100     Average Score: 0.69
Episode 200     Average Score: 3.78
Episode 300     Average Score: 7.46
Episode 400     Average Score: 9.81
Episode 500     Average Score: 12.16
Episode 529     Average Score: 13.03
Environment solved in 429 episodes!     Average Score: 13.03

uniform_experiences_linear_network_double
```



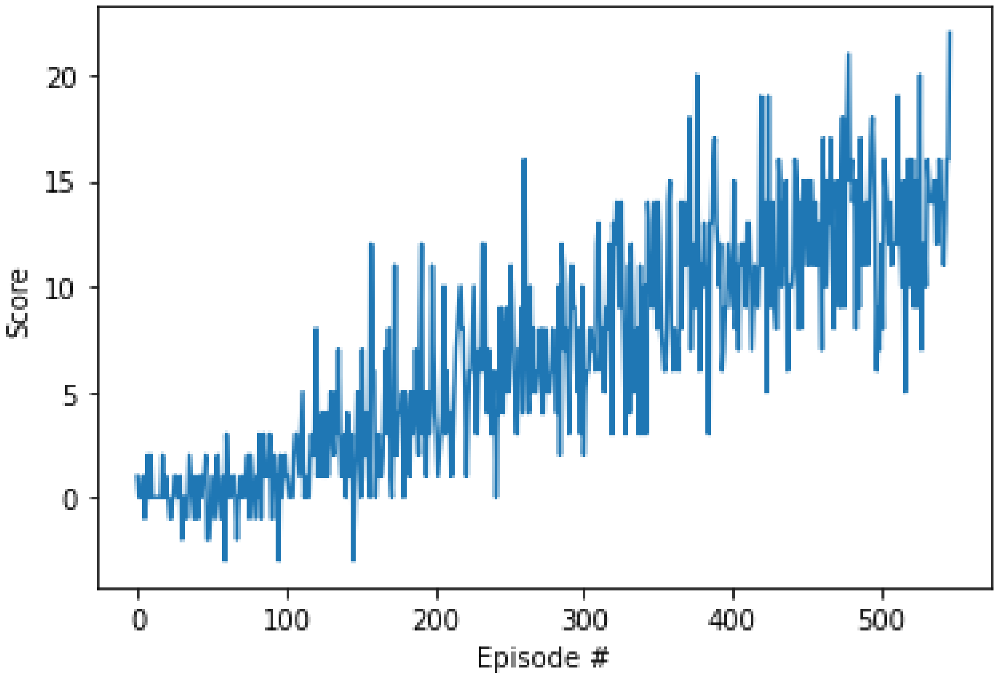
```
uniform_experiences_linear_network_double
```



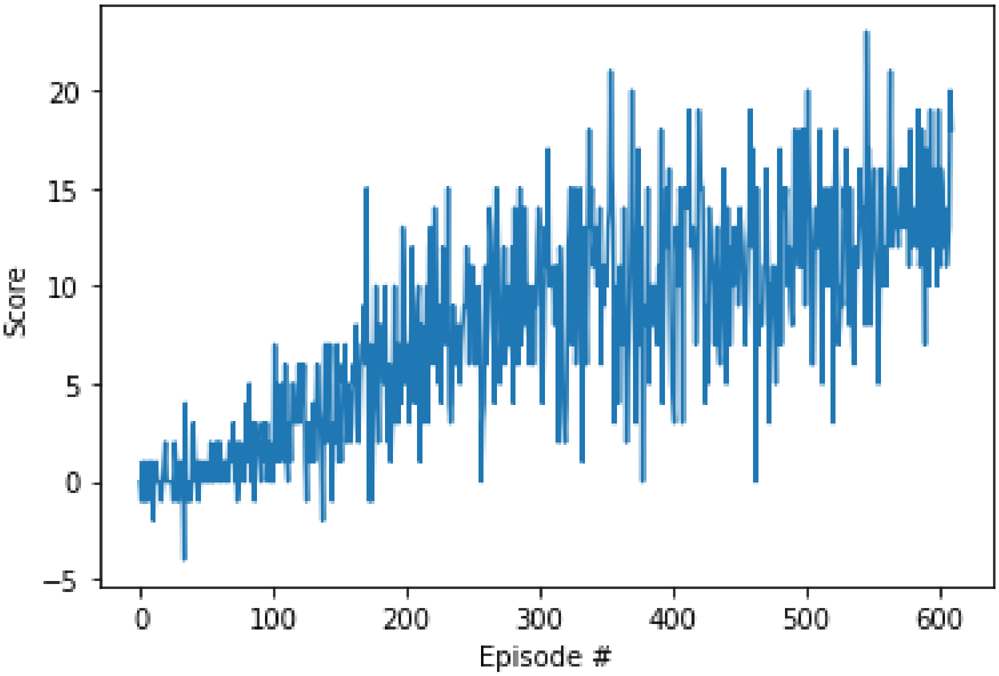
`uniform_experiences_linear_network_double`



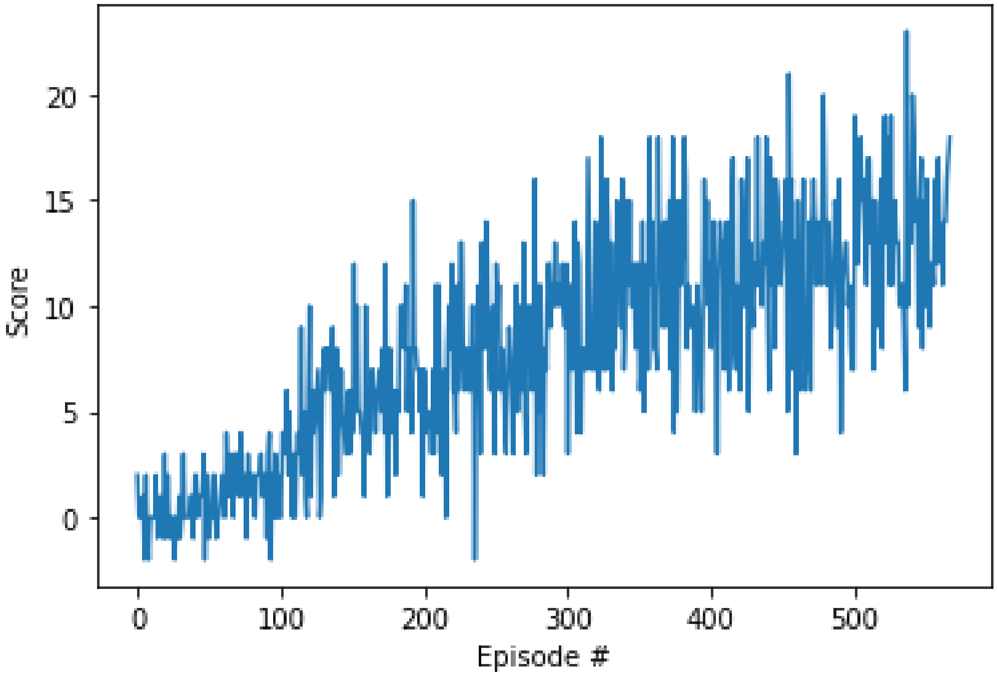
```
uniform_experiences_linear_network_double
```



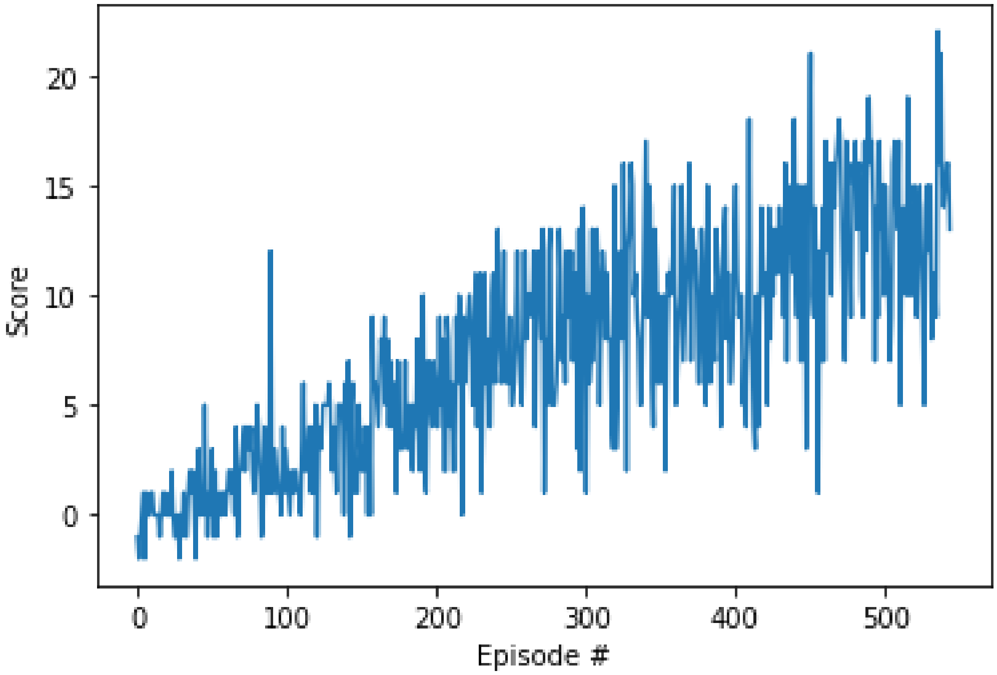
```
uniform_experiences_linear_network_double
```



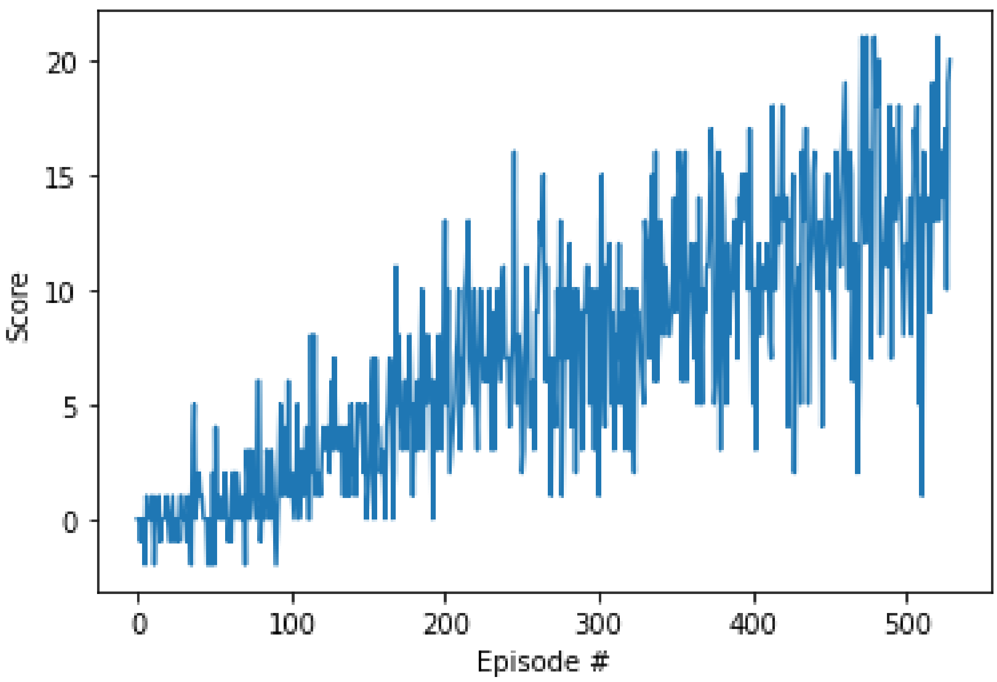
`uniform_experiences_linear_network_double`



```
uniform_experiences_linear_network_double
```



```
uniform_experiences_linear_network_double
```



[5]:
```
env.close()
```