

Continuous_Control

May 21, 2020

1 Continuous Control

You are welcome to use this coding environment to train your agent for the project. Follow the instructions below to get started!

1.0.1 1. Start the Environment

Run the next code cell to install a few packages. This line will take a few minutes to run!

```
In [1]: print('start')
```

start

```
In [2]: !pip -q install ./python
```

```
tensorflow 1.7.1 has requirement numpy>=1.13.3, but you'll have numpy 1.12.1 which is incompatible.  
ipython 6.5.0 has requirement prompt-toolkit<2.0.0,>=1.0.15, but you'll have prompt-toolkit 3.0.0.
```

The environments corresponding to both versions of the environment are already saved in the Workspace and can be accessed at the file paths provided below.

Please select one of the two options below for loading the environment.

```
from unityagents import UnityEnvironment  
import numpy as np
```

2 select this option to load version 1 (with a single agent) of the environment

```
env = UnityEnvironment(file_name='/data/Reacher_One_Linux_NoVis/Reacher_One_Linux_NoVis.x86_64')
```

3 select this option to load version 2 (with 20 agents) of the environment

4 `env = UnityEnvironment(file_name='/data/Reacher_Linux_NoVis/Reacher.x86_64')`

Environments contain *brains* which are responsible for deciding the actions of their associated agents. Here we check for the first brain available, and set it as the default brain we will be controlling from Python.

5 get the default brain

```
brain_name = env.brain_names[0] brain = env.brains[brain_name]
```

5.0.1 2. Examine the State and Action Spaces

Run the code cell below to print some information about the environment.

6 reset the environment

```
env_info = env.reset(train_mode=True)[brain_name]
```

7 number of agents

```
num_agents = len(env_info.agents) print('Number of agents:', num_agents)
```

8 size of each action

```
action_size = brain.vector_action_space_size print('Size of each action:', action_size)
```

9 examine the state space

```
states = env_info.vector_observations state_size = states.shape[1] print('There are {} agents. Each  
observes a state with length: {}'.format(states.shape[0], state_size)) print('The state for the first  
agent looks like:', states[0])
```

9.0.1 3. Take Random Actions in the Environment

In the next code cell, you will learn how to use the Python API to control the agent and receive feedback from the environment.

Note that **in this coding environment, you will not be able to watch the agents while they are training**, and you should set `train_mode=True` to restart the environment.

```
env_info = env.reset(train_mode=True)[brain_name] # reset the environment  
states = env_info.vector_observations # get the current state (for each agent) scores =  
np.zeros(num_agents) # initialize the score (for each agent) while True: actions =  
np.random.randn(num_agents, action_size) # select an action (for each agent) actions =
```

```

np.clip(actions, -1, 1) # all actions between -1 and 1
env_info = env.step(actions)[brain_name] #
send all actions to the environment
next_states = env_info.vector_observations # get next state (for
each agent)
rewards = env_info.rewards # get reward (for each agent)
dones = env_info.local_done
# see if episode finished
scores += env_info.rewards # update the score (for each agent)
states = next_states # roll over states to next time step
if np.any(dones): # exit loop if episode finished
    break
print("Total score (averaged over agents) this episode: {}".format(np.mean(scores)))
    When finished, you can close the environment.
    env.close()

```

9.0.2 4. It's Your Turn!

Now it's your turn to train your own agent to solve the environment! A few **important notes**: - When training the environment, set `train_mode=True`, so that the line for resetting the environment looks like the following:

```
env_info = env.reset(train_mode=True)[brain_name]
```

- To structure your work, you're welcome to work directly in this Jupyter notebook, or you might like to start over with a new file! You can see the list of files in the workspace by clicking on *Jupyter* in the top left corner of the notebook.
- In this coding environment, you will not be able to watch the agents while they are training. However, *after training the agents*, you can download the saved model weights to watch the agents on your own machine!

```

In [3]: import numpy as np
import random
import copy
from collections import namedtuple, deque
import torch
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim
from model import Actor, Critic
from agent import Agent

import datetime

```

```

from unityagents import UnityEnvironment
import numpy as np

```

```

In [4]: env = UnityEnvironment(file_name='/data/Reacher_One_Linux_NoVis/Reacher_One_Linux_NoVis.

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

# reset the environment
env_info = env.reset(train_mode=True)[brain_name]

```

```

# number of agents
num_agents = len(env_info.agents)
print('Number of agents:', num_agents)

# size of each action
action_size = brain.vector_action_space_size
print('Size of each action:', action_size)

# examine the state space
states = env_info.vector_observations
state_size = states.shape[1]
print('Number of Agents:{} . Each observes a state with length: {}'.format(states.shape[0], state_size))
print('The state for the first agent looks like:', states[0])

# Instantiate the agent with base values
agent = Agent(state_size=state_size, action_size=action_size, random_seed=10)

```

INFO:unityagents:

'Academy' started successfully!

Unity Academy name: Academy

Number of Brains: 1

Number of External Brains : 1

Lesson number : 0

Reset Parameters :

goal_speed -> 1.0

goal_size -> 5.0

Unity brain name: ReacherBrain

Number of Visual Observations (per agent): 0

Vector Observation space type: continuous

Vector Observation space size (per agent): 33

Number of stacked Vector Observation: 1

Vector Action space type: continuous

Vector Action space size (per agent): 4

Vector Action descriptions: , , ,

Number of agents: 1

Size of each action: 4

Number of Agents:1 . Each observes a state with length: 33

The state for the first agent looks like: [0.00000000e+00 -4.00000000e+00 0.00000000e+00

-0.00000000e+00 -0.00000000e+00 -4.37113883e-08 0.00000000e+00

0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00

0.00000000e+00 0.00000000e+00 -1.00000000e+01 0.00000000e+00

1.00000000e+00 -0.00000000e+00 -0.00000000e+00 -4.37113883e-08

0.00000000e+00 0.00000000e+00 0.00000000e+00 0.00000000e+00

```

0.00000000e+00    0.00000000e+00    5.75471878e+00   -1.00000000e+00
5.55726671e+00    0.00000000e+00    1.00000000e+00    0.00000000e+00
-1.68164849e-01]

```

```

In [5]: def ddpq(n_episodes=1000, max_t=10000, env=env):
        """DDQN Algorithm.

        Params
        =====
        n_episodes (int): maximum number of training episodes
        max_t (int): maximum number of timesteps per episode
        print_every (int): frequency of printing information throughout iteration """

        scores = []
        scores_deque = deque(maxlen=100)

        for i_episode in range(1, n_episodes+1):
            env_info = env.reset(train_mode=True)[brain_name]
            agent.reset()
            state = env_info.vector_observations[0]                # get the current state
            score = 0

            for t in range(max_t):
                action = agent.act(state)                        # select an action

                env_info = env.step(action)[brain_name]          # send the action to the env
                next_state = env_info.vector_observations[0]      # get the next state
                reward = env_info.rewards[0]                     # get the reward
                done = env_info.local_done[0]                     # see if episode has finished
                agent.step(state, action, reward, next_state, done) # take step with agent
                score += reward                                   # update the score with this
                state = next_state                                # roll over the state to next
                if done:                                          # exit loop if episode finish
                    break

            scores_deque.append(score)                            # save most recent score
            scores.append(score)                                  # save most recent score

            print('\rEpisode {} \tCurrent Score: {:.2f} \tAverage Score: {:.2f}'.format(i_episode,
                                                                                        score,
                                                                                        np.mean(scores_deque)))

            print('\rEpisode number: {} \tAverage Score 100 period: {:.2f}'.format(i_episode,
                                                                                        np.mean(scores_deque)))

            torch.save(agent.actor_local.state_dict(), 'checkpoint_actor.pth')
            torch.save(agent.critic_local.state_dict(), 'checkpoint_critic.pth')

            if np.mean(scores_deque) >= 30.0:
                print('\nEnvironment solved in {:d} Episodes \tAverage Score: {:.2f}'.format(i_episode,
                                                                                            np.mean(scores_deque)))
                torch.save(agent.actor_local.state_dict(), 'checkpoint_actor.pth')

```

```

        torch.save(agent.critic_local.state_dict(), 'checkpoint_critic.pth')
        break

    return scores

In [6]: start_time = datetime.datetime.now()
        scores = ddp(n_episodes = 500, env=env)

        end_time = datetime.datetime.now()
        print(start_time - end_time)

```

```

Episode 1      Current Score: 0.46      Average Score: 0.46
Episode number: 1      Average Score 100 period: 0.46
Episode 2      Current Score: 1.81      Average Score: 1.13
Episode number: 2      Average Score 100 period: 1.13
Episode 3      Current Score: 0.55      Average Score: 0.94
Episode number: 3      Average Score 100 period: 0.94
Episode 4      Current Score: 1.48      Average Score: 1.07
Episode number: 4      Average Score 100 period: 1.07
Episode 5      Current Score: 0.86      Average Score: 1.03
Episode number: 5      Average Score 100 period: 1.03
Episode 6      Current Score: 0.33      Average Score: 0.91
Episode number: 6      Average Score 100 period: 0.91
Episode 7      Current Score: 0.13      Average Score: 0.80
Episode number: 7      Average Score 100 period: 0.80
Episode 8      Current Score: 0.63      Average Score: 0.78
Episode number: 8      Average Score 100 period: 0.78
Episode 9      Current Score: 0.61      Average Score: 0.76
Episode number: 9      Average Score 100 period: 0.76
Episode 10     Current Score: 0.93      Average Score: 0.78
Episode number: 10     Average Score 100 period: 0.78
Episode 11     Current Score: 1.46      Average Score: 0.84
Episode number: 11     Average Score 100 period: 0.84
Episode 12     Current Score: 1.00      Average Score: 0.85
Episode number: 12     Average Score 100 period: 0.85
Episode 13     Current Score: 0.42      Average Score: 0.82
Episode number: 13     Average Score 100 period: 0.82
Episode 14     Current Score: 2.67      Average Score: 0.95
Episode number: 14     Average Score 100 period: 0.95
Episode 15     Current Score: 1.38      Average Score: 0.98
Episode number: 15     Average Score 100 period: 0.98
Episode 16     Current Score: 0.57      Average Score: 0.96
Episode number: 16     Average Score 100 period: 0.96
Episode 17     Current Score: 0.96      Average Score: 0.96
Episode number: 17     Average Score 100 period: 0.96
Episode 18     Current Score: 1.00      Average Score: 0.96
Episode number: 18     Average Score 100 period: 0.96
Episode 19     Current Score: 1.50      Average Score: 0.99

```

Episode number: 19		Average Score 100	period: 0.99
Episode 20	Current	Score: 2.28	Average Score: 1.05
Episode number: 20		Average Score 100	period: 1.05
Episode 21	Current	Score: 2.39	Average Score: 1.12
Episode number: 21		Average Score 100	period: 1.12
Episode 22	Current	Score: 1.48	Average Score: 1.13
Episode number: 22		Average Score 100	period: 1.13
Episode 23	Current	Score: 1.26	Average Score: 1.14
Episode number: 23		Average Score 100	period: 1.14
Episode 24	Current	Score: 1.56	Average Score: 1.15
Episode number: 24		Average Score 100	period: 1.15
Episode 25	Current	Score: 1.84	Average Score: 1.18
Episode number: 25		Average Score 100	period: 1.18
Episode 26	Current	Score: 1.58	Average Score: 1.20
Episode number: 26		Average Score 100	period: 1.20
Episode 27	Current	Score: 3.33	Average Score: 1.28
Episode number: 27		Average Score 100	period: 1.28
Episode 28	Current	Score: 2.11	Average Score: 1.31
Episode number: 28		Average Score 100	period: 1.31
Episode 29	Current	Score: 1.29	Average Score: 1.31
Episode number: 29		Average Score 100	period: 1.31
Episode 30	Current	Score: 3.06	Average Score: 1.36
Episode number: 30		Average Score 100	period: 1.36
Episode 31	Current	Score: 2.13	Average Score: 1.39
Episode number: 31		Average Score 100	period: 1.39
Episode 32	Current	Score: 4.54	Average Score: 1.49
Episode number: 32		Average Score 100	period: 1.49
Episode 33	Current	Score: 2.36	Average Score: 1.51
Episode number: 33		Average Score 100	period: 1.51
Episode 34	Current	Score: 1.46	Average Score: 1.51
Episode number: 34		Average Score 100	period: 1.51
Episode 35	Current	Score: 1.97	Average Score: 1.53
Episode number: 35		Average Score 100	period: 1.53
Episode 36	Current	Score: 4.83	Average Score: 1.62
Episode number: 36		Average Score 100	period: 1.62
Episode 37	Current	Score: 3.66	Average Score: 1.67
Episode number: 37		Average Score 100	period: 1.67
Episode 38	Current	Score: 2.58	Average Score: 1.70
Episode number: 38		Average Score 100	period: 1.70
Episode 39	Current	Score: 4.65	Average Score: 1.77
Episode number: 39		Average Score 100	period: 1.77
Episode 40	Current	Score: 5.90	Average Score: 1.88
Episode number: 40		Average Score 100	period: 1.88
Episode 41	Current	Score: 3.93	Average Score: 1.93
Episode number: 41		Average Score 100	period: 1.93
Episode 42	Current	Score: 4.65	Average Score: 1.99
Episode number: 42		Average Score 100	period: 1.99
Episode 43	Current	Score: 2.00	Average Score: 1.99

Episode number: 43		Average Score 100	period: 1.99
Episode 44	Current	Score: 4.19	Average Score: 2.04
Episode number: 44		Average Score 100	period: 2.04
Episode 45	Current	Score: 4.91	Average Score: 2.10
Episode number: 45		Average Score 100	period: 2.10
Episode 46	Current	Score: 2.20	Average Score: 2.11
Episode number: 46		Average Score 100	period: 2.11
Episode 47	Current	Score: 4.24	Average Score: 2.15
Episode number: 47		Average Score 100	period: 2.15
Episode 48	Current	Score: 5.10	Average Score: 2.21
Episode number: 48		Average Score 100	period: 2.21
Episode 49	Current	Score: 5.02	Average Score: 2.27
Episode number: 49		Average Score 100	period: 2.27
Episode 50	Current	Score: 4.41	Average Score: 2.31
Episode number: 50		Average Score 100	period: 2.31
Episode 51	Current	Score: 5.33	Average Score: 2.37
Episode number: 51		Average Score 100	period: 2.37
Episode 52	Current	Score: 2.41	Average Score: 2.37
Episode number: 52		Average Score 100	period: 2.37
Episode 53	Current	Score: 3.24	Average Score: 2.39
Episode number: 53		Average Score 100	period: 2.39
Episode 54	Current	Score: 6.57	Average Score: 2.47
Episode number: 54		Average Score 100	period: 2.47
Episode 55	Current	Score: 6.33	Average Score: 2.54
Episode number: 55		Average Score 100	period: 2.54
Episode 56	Current	Score: 6.64	Average Score: 2.61
Episode number: 56		Average Score 100	period: 2.61
Episode 57	Current	Score: 3.93	Average Score: 2.63
Episode number: 57		Average Score 100	period: 2.63
Episode 58	Current	Score: 3.48	Average Score: 2.65
Episode number: 58		Average Score 100	period: 2.65
Episode 59	Current	Score: 6.40	Average Score: 2.71
Episode number: 59		Average Score 100	period: 2.71
Episode 60	Current	Score: 5.93	Average Score: 2.77
Episode number: 60		Average Score 100	period: 2.77
Episode 61	Current	Score: 6.91	Average Score: 2.83
Episode number: 61		Average Score 100	period: 2.83
Episode 62	Current	Score: 5.41	Average Score: 2.87
Episode number: 62		Average Score 100	period: 2.87
Episode 63	Current	Score: 7.34	Average Score: 2.95
Episode number: 63		Average Score 100	period: 2.95
Episode 64	Current	Score: 4.53	Average Score: 2.97
Episode number: 64		Average Score 100	period: 2.97
Episode 65	Current	Score: 8.52	Average Score: 3.06
Episode number: 65		Average Score 100	period: 3.06
Episode 66	Current	Score: 6.86	Average Score: 3.11
Episode number: 66		Average Score 100	period: 3.11
Episode 67	Current	Score: 2.93	Average Score: 3.11

Episode number: 67		Average Score 100	period: 3.11
Episode 68	Current	Score: 5.10	Average Score: 3.14
Episode number: 68		Average Score 100	period: 3.14
Episode 69	Current	Score: 4.46	Average Score: 3.16
Episode number: 69		Average Score 100	period: 3.16
Episode 70	Current	Score: 8.48	Average Score: 3.24
Episode number: 70		Average Score 100	period: 3.24
Episode 71	Current	Score: 7.16	Average Score: 3.29
Episode number: 71		Average Score 100	period: 3.29
Episode 72	Current	Score: 4.69	Average Score: 3.31
Episode number: 72		Average Score 100	period: 3.31
Episode 73	Current	Score: 5.15	Average Score: 3.34
Episode number: 73		Average Score 100	period: 3.34
Episode 74	Current	Score: 5.75	Average Score: 3.37
Episode number: 74		Average Score 100	period: 3.37
Episode 75	Current	Score: 3.98	Average Score: 3.38
Episode number: 75		Average Score 100	period: 3.38
Episode 76	Current	Score: 7.93	Average Score: 3.44
Episode number: 76		Average Score 100	period: 3.44
Episode 77	Current	Score: 8.59	Average Score: 3.50
Episode number: 77		Average Score 100	period: 3.50
Episode 78	Current	Score: 5.36	Average Score: 3.53
Episode number: 78		Average Score 100	period: 3.53
Episode 79	Current	Score: 7.67	Average Score: 3.58
Episode number: 79		Average Score 100	period: 3.58
Episode 80	Current	Score: 8.97	Average Score: 3.65
Episode number: 80		Average Score 100	period: 3.65
Episode 81	Current	Score: 4.59	Average Score: 3.66
Episode number: 81		Average Score 100	period: 3.66
Episode 82	Current	Score: 12.20	Average Score: 3.76
Episode number: 82		Average Score 100	period: 3.76
Episode 83	Current	Score: 8.96	Average Score: 3.82
Episode number: 83		Average Score 100	period: 3.82
Episode 84	Current	Score: 10.71	Average Score: 3.91
Episode number: 84		Average Score 100	period: 3.91
Episode 85	Current	Score: 6.85	Average Score: 3.94
Episode number: 85		Average Score 100	period: 3.94
Episode 86	Current	Score: 18.94	Average Score: 4.12
Episode number: 86		Average Score 100	period: 4.12
Episode 87	Current	Score: 14.28	Average Score: 4.23
Episode number: 87		Average Score 100	period: 4.23
Episode 88	Current	Score: 11.70	Average Score: 4.32
Episode number: 88		Average Score 100	period: 4.32
Episode 89	Current	Score: 24.09	Average Score: 4.54
Episode number: 89		Average Score 100	period: 4.54
Episode 90	Current	Score: 10.41	Average Score: 4.60
Episode number: 90		Average Score 100	period: 4.60
Episode 91	Current	Score: 16.54	Average Score: 4.74

Episode number: 91	Average Score 100	period: 4.74
Episode 92	Current Score: 7.68	Average Score: 4.77
Episode number: 92	Average Score 100	period: 4.77
Episode 93	Current Score: 19.59	Average Score: 4.93
Episode number: 93	Average Score 100	period: 4.93
Episode 94	Current Score: 7.99	Average Score: 4.96
Episode number: 94	Average Score 100	period: 4.96
Episode 95	Current Score: 14.67	Average Score: 5.06
Episode number: 95	Average Score 100	period: 5.06
Episode 96	Current Score: 10.78	Average Score: 5.12
Episode number: 96	Average Score 100	period: 5.12
Episode 97	Current Score: 8.79	Average Score: 5.16
Episode number: 97	Average Score 100	period: 5.16
Episode 98	Current Score: 15.53	Average Score: 5.27
Episode number: 98	Average Score 100	period: 5.27
Episode 99	Current Score: 13.53	Average Score: 5.35
Episode number: 99	Average Score 100	period: 5.35
Episode 100	Current Score: 14.58	Average Score: 5.44
Episode number: 100	Average Score 100	period: 5.44
Episode 101	Current Score: 13.75	Average Score: 5.57
Episode number: 101	Average Score 100	period: 5.57
Episode 102	Current Score: 19.18	Average Score: 5.75
Episode number: 102	Average Score 100	period: 5.75
Episode 103	Current Score: 14.95	Average Score: 5.89
Episode number: 103	Average Score 100	period: 5.89
Episode 104	Current Score: 22.94	Average Score: 6.11
Episode number: 104	Average Score 100	period: 6.11
Episode 105	Current Score: 22.06	Average Score: 6.32
Episode number: 105	Average Score 100	period: 6.32
Episode 106	Current Score: 28.22	Average Score: 6.60
Episode number: 106	Average Score 100	period: 6.60
Episode 107	Current Score: 31.80	Average Score: 6.91
Episode number: 107	Average Score 100	period: 6.91
Episode 108	Current Score: 21.22	Average Score: 7.12
Episode number: 108	Average Score 100	period: 7.12
Episode 109	Current Score: 24.08	Average Score: 7.35
Episode number: 109	Average Score 100	period: 7.35
Episode 110	Current Score: 28.65	Average Score: 7.63
Episode number: 110	Average Score 100	period: 7.63
Episode 111	Current Score: 22.54	Average Score: 7.84
Episode number: 111	Average Score 100	period: 7.84
Episode 112	Current Score: 27.50	Average Score: 8.11
Episode number: 112	Average Score 100	period: 8.11
Episode 113	Current Score: 21.10	Average Score: 8.31
Episode number: 113	Average Score 100	period: 8.31
Episode 114	Current Score: 24.99	Average Score: 8.54
Episode number: 114	Average Score 100	period: 8.54
Episode 115	Current Score: 32.85	Average Score: 8.85

Episode number: 115	Average Score 100	period: 8.85
Episode 116	Current Score: 24.11	Average Score: 9.09
Episode number: 116	Average Score 100	period: 9.09
Episode 117	Current Score: 31.89	Average Score: 9.40
Episode number: 117	Average Score 100	period: 9.40
Episode 118	Current Score: 24.00	Average Score: 9.63
Episode number: 118	Average Score 100	period: 9.63
Episode 119	Current Score: 27.25	Average Score: 9.88
Episode number: 119	Average Score 100	period: 9.88
Episode 120	Current Score: 34.39	Average Score: 10.21
Episode number: 120	Average Score 100	period: 10.21
Episode 121	Current Score: 33.24	Average Score: 10.51
Episode number: 121	Average Score 100	period: 10.51
Episode 122	Current Score: 23.59	Average Score: 10.74
Episode number: 122	Average Score 100	period: 10.74
Episode 123	Current Score: 32.84	Average Score: 11.05
Episode number: 123	Average Score 100	period: 11.05
Episode 124	Current Score: 27.88	Average Score: 11.31
Episode number: 124	Average Score 100	period: 11.31
Episode 125	Current Score: 25.59	Average Score: 11.55
Episode number: 125	Average Score 100	period: 11.55
Episode 126	Current Score: 33.66	Average Score: 11.87
Episode number: 126	Average Score 100	period: 11.87
Episode 127	Current Score: 31.51	Average Score: 12.15
Episode number: 127	Average Score 100	period: 12.15
Episode 128	Current Score: 31.84	Average Score: 12.45
Episode number: 128	Average Score 100	period: 12.45
Episode 129	Current Score: 28.51	Average Score: 12.72
Episode number: 129	Average Score 100	period: 12.72
Episode 130	Current Score: 27.49	Average Score: 12.97
Episode number: 130	Average Score 100	period: 12.97
Episode 131	Current Score: 31.87	Average Score: 13.27
Episode number: 131	Average Score 100	period: 13.27
Episode 132	Current Score: 35.20	Average Score: 13.57
Episode number: 132	Average Score 100	period: 13.57
Episode 133	Current Score: 25.28	Average Score: 13.80
Episode number: 133	Average Score 100	period: 13.80
Episode 134	Current Score: 36.06	Average Score: 14.15
Episode number: 134	Average Score 100	period: 14.15
Episode 135	Current Score: 37.11	Average Score: 14.50
Episode number: 135	Average Score 100	period: 14.50
Episode 136	Current Score: 36.39	Average Score: 14.81
Episode number: 136	Average Score 100	period: 14.81
Episode 137	Current Score: 37.02	Average Score: 15.15
Episode number: 137	Average Score 100	period: 15.15
Episode 138	Current Score: 36.95	Average Score: 15.49
Episode number: 138	Average Score 100	period: 15.49
Episode 139	Current Score: 36.09	Average Score: 15.81

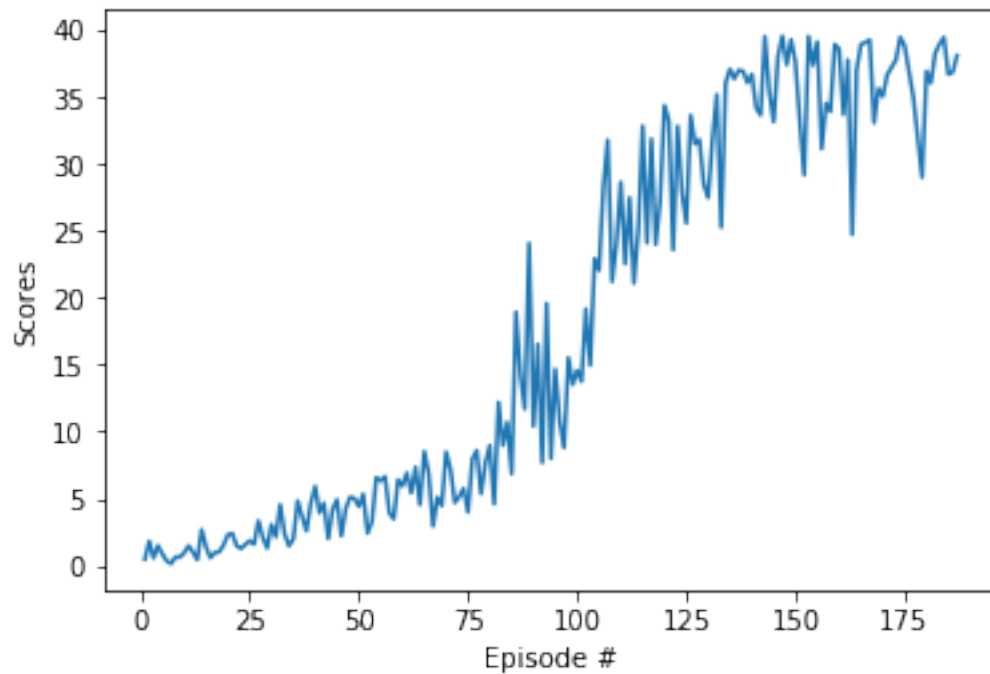
Episode number: 139	Average Score 100	period: 15.81
Episode 140	Current Score: 36.72	Average Score: 16.11
Episode number: 140	Average Score 100	period: 16.11
Episode 141	Current Score: 34.24	Average Score: 16.42
Episode number: 141	Average Score 100	period: 16.42
Episode 142	Current Score: 33.67	Average Score: 16.71
Episode number: 142	Average Score 100	period: 16.71
Episode 143	Current Score: 39.55	Average Score: 17.08
Episode number: 143	Average Score 100	period: 17.08
Episode 144	Current Score: 35.44	Average Score: 17.40
Episode number: 144	Average Score 100	period: 17.40
Episode 145	Current Score: 33.17	Average Score: 17.68
Episode number: 145	Average Score 100	period: 17.68
Episode 146	Current Score: 38.07	Average Score: 18.04
Episode number: 146	Average Score 100	period: 18.04
Episode 147	Current Score: 39.58	Average Score: 18.39
Episode number: 147	Average Score 100	period: 18.39
Episode 148	Current Score: 37.43	Average Score: 18.71
Episode number: 148	Average Score 100	period: 18.71
Episode 149	Current Score: 39.31	Average Score: 19.06
Episode number: 149	Average Score 100	period: 19.06
Episode 150	Current Score: 37.61	Average Score: 19.39
Episode number: 150	Average Score 100	period: 19.39
Episode 151	Current Score: 33.19	Average Score: 19.67
Episode number: 151	Average Score 100	period: 19.67
Episode 152	Current Score: 29.19	Average Score: 19.93
Episode number: 152	Average Score 100	period: 19.93
Episode 153	Current Score: 39.56	Average Score: 20.30
Episode number: 153	Average Score 100	period: 20.30
Episode 154	Current Score: 37.41	Average Score: 20.61
Episode number: 154	Average Score 100	period: 20.61
Episode 155	Current Score: 39.16	Average Score: 20.93
Episode number: 155	Average Score 100	period: 20.93
Episode 156	Current Score: 31.14	Average Score: 21.18
Episode number: 156	Average Score 100	period: 21.18
Episode 157	Current Score: 34.54	Average Score: 21.49
Episode number: 157	Average Score 100	period: 21.49
Episode 158	Current Score: 33.93	Average Score: 21.79
Episode number: 158	Average Score 100	period: 21.79
Episode 159	Current Score: 38.95	Average Score: 22.12
Episode number: 159	Average Score 100	period: 22.12
Episode 160	Current Score: 38.61	Average Score: 22.44
Episode number: 160	Average Score 100	period: 22.44
Episode 161	Current Score: 33.70	Average Score: 22.71
Episode number: 161	Average Score 100	period: 22.71
Episode 162	Current Score: 37.80	Average Score: 23.03
Episode number: 162	Average Score 100	period: 23.03
Episode 163	Current Score: 24.74	Average Score: 23.21

Episode number: 163	Average Score 100	period: 23.21
Episode 164	Current Score: 37.04	Average Score: 23.53
Episode number: 164	Average Score 100	period: 23.53
Episode 165	Current Score: 38.96	Average Score: 23.84
Episode number: 165	Average Score 100	period: 23.84
Episode 166	Current Score: 39.09	Average Score: 24.16
Episode number: 166	Average Score 100	period: 24.16
Episode 167	Current Score: 39.29	Average Score: 24.52
Episode number: 167	Average Score 100	period: 24.52
Episode 168	Current Score: 33.08	Average Score: 24.80
Episode number: 168	Average Score 100	period: 24.80
Episode 169	Current Score: 35.65	Average Score: 25.12
Episode number: 169	Average Score 100	period: 25.12
Episode 170	Current Score: 35.07	Average Score: 25.38
Episode number: 170	Average Score 100	period: 25.38
Episode 171	Current Score: 36.68	Average Score: 25.68
Episode number: 171	Average Score 100	period: 25.68
Episode 172	Current Score: 37.24	Average Score: 26.00
Episode number: 172	Average Score 100	period: 26.00
Episode 173	Current Score: 37.79	Average Score: 26.33
Episode number: 173	Average Score 100	period: 26.33
Episode 174	Current Score: 39.49	Average Score: 26.67
Episode number: 174	Average Score 100	period: 26.67
Episode 175	Current Score: 38.85	Average Score: 27.01
Episode number: 175	Average Score 100	period: 27.01
Episode 176	Current Score: 36.90	Average Score: 27.30
Episode number: 176	Average Score 100	period: 27.30
Episode 177	Current Score: 35.00	Average Score: 27.57
Episode number: 177	Average Score 100	period: 27.57
Episode 178	Current Score: 31.91	Average Score: 27.83
Episode number: 178	Average Score 100	period: 27.83
Episode 179	Current Score: 29.01	Average Score: 28.05
Episode number: 179	Average Score 100	period: 28.05
Episode 180	Current Score: 36.95	Average Score: 28.33
Episode number: 180	Average Score 100	period: 28.33
Episode 181	Current Score: 36.06	Average Score: 28.64
Episode number: 181	Average Score 100	period: 28.64
Episode 182	Current Score: 38.30	Average Score: 28.90
Episode number: 182	Average Score 100	period: 28.90
Episode 183	Current Score: 38.98	Average Score: 29.20
Episode number: 183	Average Score 100	period: 29.20
Episode 184	Current Score: 39.47	Average Score: 29.49
Episode number: 184	Average Score 100	period: 29.49
Episode 185	Current Score: 36.72	Average Score: 29.79
Episode number: 185	Average Score 100	period: 29.79
Episode 186	Current Score: 36.87	Average Score: 29.97
Episode number: 186	Average Score 100	period: 29.97
Episode 187	Current Score: 38.12	Average Score: 30.21

Episode number: 187 Average Score 100 period: 30.21

Environment solved in 187 Episodes Average Score: 30.21
-1 day, 23:14:59.147441

```
In [10]: import matplotlib.pyplot as plt
fig = plt.figure()
ax = fig.add_subplot(111)
plt.plot(np.arange(1, len(scores)+1), scores)
plt.ylabel('Scores')
plt.xlabel('Episode #')
plt.show()
```



```
In [8]: #env.close()
```

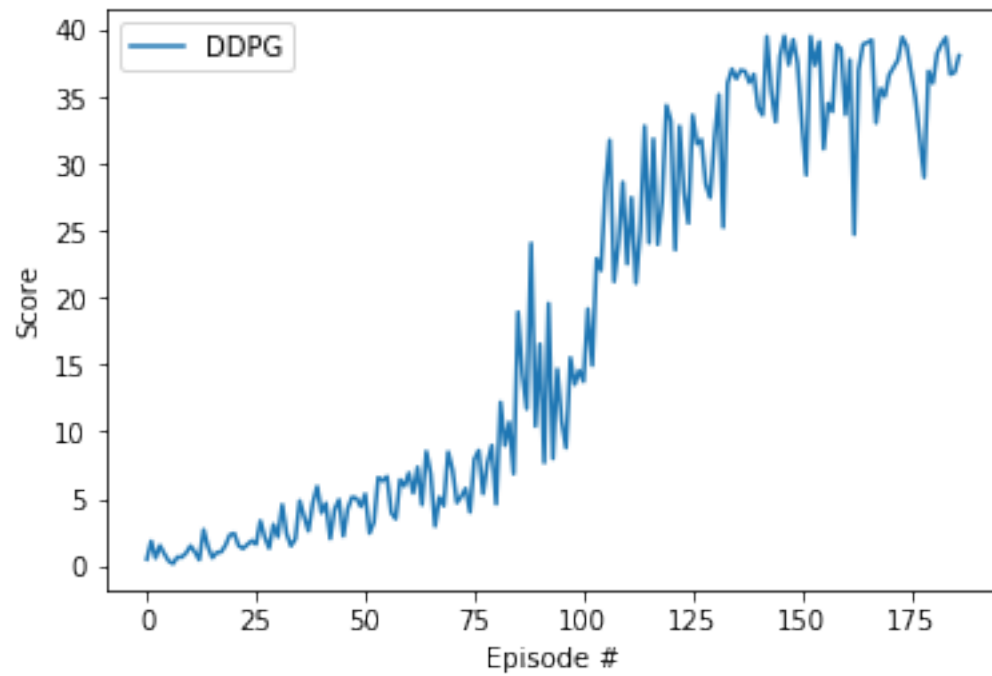
```
In [13]: # plot the scores
```

```
avgs = np.mean(scores)

fig = plt.figure()
ax = fig.add_subplot(111)
plt.plot(np.arange(len(scores)), scores, label='DDPG')

plt.ylabel('Score')
```

```
plt.xlabel('Episode #')  
plt.legend(loc='upper left');  
plt.show()
```



```
In [ ]:
```