Navigation

January 17, 2019

1 Tony Quertier - Project 1 : Navigation

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

Run the next code cell to install a few packages.

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

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.

```
In [2]: from unityagents import UnityEnvironment
        import numpy as np
        import torch
        from collections import deque
        import matplotlib.pyplot as plt
        %matplotlib inline

        from dqn_agent import Agent
```

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")
```

In [3]: # please do not modify the line below
        env = UnityEnvironment(file_name="Banana_Windows_x86_64/Banana.exe")

```
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: , , ,
```

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.

In [4]: # get the default brain
        brain_name = env.brain_names[0]
        brain = env.brains[brain_name]

1.0.2 2. Examine the State and Action Spaces

The simulation contains a single agent that navigates a large environment. At each time step, it has four actions at its disposal: - 0 - walk forward - 1 - walk backward - 2 - turn left - 3 - turn right

The state space has 37 dimensions and contains the agent's velocity, along with ray-based perception of objects around agent's forward direction. A reward of +1 is provided for collecting a yellow banana, and a reward of -1 is provided for collecting a blue banana.

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

In [5]: # 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)

2

```python
# 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)
```

```
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
```

1.0.3   3. Train the agent

```python
In [6]: agent = Agent(state_size, action_size, seed=0)

        def train(n_episodes=2000, max_t=1000, eps_start=1.0, eps_end=0.01, eps_decay=0.995):
            """Deep Q-Learning.

            Params
            ======
                n_episodes (int): maximum number of training episodes
                max_t (int): maximum number of timesteps per episode
                eps_start (float): starting value of epsilon, for epsilon-greedy action select
                eps_end (float): minimum value of epsilon
                eps_decay (float): multiplicative factor (per episode) for decreasing epsilon
            """
            scores = []                       # list containing scores from each episode
            scores_window = deque(maxlen=100)  # last 100 scores
            eps = eps_start                    # initialize epsilon
            for i_episode in range(1, n_episodes+1):
                print(".")
                #state = env.reset()
                env_info = env.reset(train_mode=True)[brain_name]
                state = env_info.vector_observations[0]
                score = 0
                for t in range(max_t):
                    action = agent.act(state, eps).astype(np.int32)
                    env_temp = env.step(action)[brain_name]
                    next_state = env_temp.vector_observations[0]
                    reward = env_temp.rewards[0]
```

```python
                done = env_temp.local_done[0]
                agent.step(state, action, reward, next_state, done)
                state = next_state
                score += reward
                if done:
                    break
            scores_window.append(score)       # save most recent score
            scores.append(score)              # save most recent score
            eps = max(eps_end, eps_decay*eps) # decrease epsilon
            print('\rEpisode {}\tAverage Score: {:.2f}'.format(i_episode, np.mean(scores_w:
            if i_episode % 100 == 0:
                print('\rEpisode {}\tAverage Score: {:.2f}'.format(i_episode, np.mean(score
            if np.mean(scores_window)>=13.0:
                print('\nEnvironment solved in {:d} episodes!\tAverage Score: {:.2f}'.forma
                torch.save(agent.qnetwork_local.state_dict(), 'model.pth')
                break
        return scores

    scores = train()

    # plot the scores


    fig = plt.figure()
    ax = fig.add_subplot(111)
    plt.plot(np.arange(len(scores)), scores)
    plt.ylabel('Score')
    plt.xlabel('Episode #')
    plt.show()
```

.
```
Episode 1        Average Score: 0.00.
Episode 2        Average Score: 0.50.
Episode 3        Average Score: 0.67.
Episode 4        Average Score: 0.25.
Episode 5        Average Score: -0.20.
Episode 6        Average Score: -0.50.
Episode 7        Average Score: -0.57.
Episode 8        Average Score: -0.50.
Episode 9        Average Score: -0.44.
Episode 10        Average Score: -0.30.
Episode 11        Average Score: -0.27.
Episode 12        Average Score: -0.25.
Episode 13        Average Score: -0.31.
Episode 14        Average Score: -0.36.
Episode 15        Average Score: -0.33.
Episode 16        Average Score: -0.38.
Episode 17        Average Score: -0.41.
```

```
Episode 18      Average Score: -0.33.
Episode 19      Average Score: -0.37.
Episode 20      Average Score: -0.20.
Episode 21      Average Score: -0.14.
Episode 22      Average Score: -0.09.
Episode 23      Average Score: -0.09.
Episode 24      Average Score: -0.04.
Episode 25      Average Score: -0.16.
Episode 26      Average Score: -0.15.
Episode 27      Average Score: -0.11.
Episode 28      Average Score: -0.14.
Episode 29      Average Score: -0.17.
Episode 30      Average Score: -0.17.
Episode 31      Average Score: -0.10.
Episode 32      Average Score: -0.09.
Episode 33      Average Score: -0.12.
Episode 34      Average Score: -0.12.
Episode 35      Average Score: -0.09.
Episode 36      Average Score: -0.08.
Episode 37      Average Score: -0.08.
Episode 38      Average Score: -0.05.
Episode 39      Average Score: -0.03.
Episode 40      Average Score: -0.03.
Episode 41      Average Score: 0.05.
Episode 42      Average Score: 0.05.
Episode 43      Average Score: 0.07.
Episode 44      Average Score: 0.11.
Episode 45      Average Score: 0.11.
Episode 46      Average Score: 0.11.
Episode 47      Average Score: 0.11.
Episode 48      Average Score: 0.10.
Episode 49      Average Score: 0.14.
Episode 50      Average Score: 0.16.
Episode 51      Average Score: 0.18.
Episode 52      Average Score: 0.21.
Episode 53      Average Score: 0.23.
Episode 54      Average Score: 0.22.
Episode 55      Average Score: 0.20.
Episode 56      Average Score: 0.21.
Episode 57      Average Score: 0.25.
Episode 58      Average Score: 0.24.
Episode 59      Average Score: 0.22.
Episode 60      Average Score: 0.20.
Episode 61      Average Score: 0.18.
Episode 62      Average Score: 0.24.
Episode 63      Average Score: 0.25.
Episode 64      Average Score: 0.30.
Episode 65      Average Score: 0.31.
```

```
Episode 66       Average Score: 0.35.
Episode 67       Average Score: 0.34.
Episode 68       Average Score: 0.37.
Episode 69       Average Score: 0.41.
Episode 70       Average Score: 0.41.
Episode 71       Average Score: 0.39.
Episode 72       Average Score: 0.42.
Episode 73       Average Score: 0.45.
Episode 74       Average Score: 0.49.
Episode 75       Average Score: 0.49.
Episode 76       Average Score: 0.50.
Episode 77       Average Score: 0.55.
Episode 78       Average Score: 0.53.
Episode 79       Average Score: 0.52.
Episode 80       Average Score: 0.53.
Episode 81       Average Score: 0.52.
Episode 82       Average Score: 0.54.
Episode 83       Average Score: 0.54.
Episode 84       Average Score: 0.55.
Episode 85       Average Score: 0.59.
Episode 86       Average Score: 0.57.
Episode 87       Average Score: 0.57.
Episode 88       Average Score: 0.59.
Episode 89       Average Score: 0.61.
Episode 90       Average Score: 0.62.
Episode 91       Average Score: 0.67.
Episode 92       Average Score: 0.71.
Episode 93       Average Score: 0.70.
Episode 94       Average Score: 0.70.
Episode 95       Average Score: 0.68.
Episode 96       Average Score: 0.71.
Episode 97       Average Score: 0.71.
Episode 98       Average Score: 0.70.
Episode 99       Average Score: 0.71.
Episode 100       Average Score: 0.73
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Episode 101       Average Score: 0.76.
Episode 102       Average Score: 0.77.
Episode 103       Average Score: 0.76.
Episode 104       Average Score: 0.84.
Episode 105       Average Score: 0.90.
Episode 106       Average Score: 0.91.
Episode 107       Average Score: 0.93.
Episode 108       Average Score: 0.96.
Episode 109       Average Score: 0.99.
Episode 110       Average Score: 0.99.
Episode 111       Average Score: 0.99.
Episode 112       Average Score: 1.04.
```

```
Episode 113      Average Score: 1.06.
Episode 114      Average Score: 1.10.
Episode 115      Average Score: 1.13.
Episode 116      Average Score: 1.16.
Episode 117      Average Score: 1.19.
Episode 118      Average Score: 1.23.
Episode 119      Average Score: 1.30.
Episode 120      Average Score: 1.28.
Episode 121      Average Score: 1.28.
Episode 122      Average Score: 1.30.
Episode 123      Average Score: 1.33.
Episode 124      Average Score: 1.38.
Episode 125      Average Score: 1.45.
Episode 126      Average Score: 1.48.
Episode 127      Average Score: 1.49.
Episode 128      Average Score: 1.52.
Episode 129      Average Score: 1.63.
Episode 130      Average Score: 1.66.
Episode 131      Average Score: 1.65.
Episode 132      Average Score: 1.68.
Episode 133      Average Score: 1.79.
Episode 134      Average Score: 1.83.
Episode 135      Average Score: 1.84.
Episode 136      Average Score: 1.91.
Episode 137      Average Score: 1.94.
Episode 138      Average Score: 1.93.
Episode 139      Average Score: 1.95.
Episode 140      Average Score: 2.00.
Episode 141      Average Score: 1.99.
Episode 142      Average Score: 2.02.
Episode 143      Average Score: 2.04.
Episode 144      Average Score: 2.11.
Episode 145      Average Score: 2.18.
Episode 146      Average Score: 2.23.
Episode 147      Average Score: 2.27.
Episode 148      Average Score: 2.32.
Episode 149      Average Score: 2.36.
Episode 150      Average Score: 2.40.
Episode 151      Average Score: 2.43.
Episode 152      Average Score: 2.42.
Episode 153      Average Score: 2.43.
Episode 154      Average Score: 2.44.
Episode 155      Average Score: 2.47.
Episode 156      Average Score: 2.49.
Episode 157      Average Score: 2.50.
Episode 158      Average Score: 2.54.
Episode 159      Average Score: 2.59.
Episode 160      Average Score: 2.65.
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Episode 161     Average Score: 2.72.
Episode 162     Average Score: 2.70.
Episode 163     Average Score: 2.71.
Episode 164     Average Score: 2.72.
Episode 165     Average Score: 2.80.
Episode 166     Average Score: 2.80.
Episode 167     Average Score: 2.84.
Episode 168     Average Score: 2.85.
Episode 169     Average Score: 2.93.
Episode 170     Average Score: 2.99.
Episode 171     Average Score: 3.03.
Episode 172     Average Score: 3.06.
Episode 173     Average Score: 3.08.
Episode 174     Average Score: 3.10.
Episode 175     Average Score: 3.14.
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Episode 177     Average Score: 3.19.
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Episode 180     Average Score: 3.29.
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Episode 182     Average Score: 3.37.
Episode 183     Average Score: 3.44.
Episode 184     Average Score: 3.47.
Episode 185     Average Score: 3.49.
Episode 186     Average Score: 3.55.
Episode 187     Average Score: 3.62.
Episode 188     Average Score: 3.61.
Episode 189     Average Score: 3.69.
Episode 190     Average Score: 3.78.
Episode 191     Average Score: 3.83.
Episode 192     Average Score: 3.80.
Episode 193     Average Score: 3.92.
Episode 194     Average Score: 3.93.
Episode 195     Average Score: 3.99.
Episode 196     Average Score: 4.01.
Episode 197     Average Score: 4.07.
Episode 198     Average Score: 4.10.
Episode 199     Average Score: 4.17.
Episode 200     Average Score: 4.14
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Episode 201     Average Score: 4.12.
Episode 202     Average Score: 4.17.
Episode 203     Average Score: 4.24.
Episode 204     Average Score: 4.26.
Episode 205     Average Score: 4.28.
Episode 206     Average Score: 4.39.
Episode 207     Average Score: 4.44.
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Episode 208        Average Score: 4.49.
Episode 209        Average Score: 4.49.
Episode 210        Average Score: 4.48.
Episode 211        Average Score: 4.55.
Episode 212        Average Score: 4.53.
Episode 213        Average Score: 4.57.
Episode 214        Average Score: 4.62.
Episode 215        Average Score: 4.67.
Episode 216        Average Score: 4.72.
Episode 217        Average Score: 4.83.
Episode 218        Average Score: 4.87.
Episode 219        Average Score: 4.89.
Episode 220        Average Score: 4.96.
Episode 221        Average Score: 5.04.
Episode 222        Average Score: 5.07.
Episode 223        Average Score: 5.11.
Episode 224        Average Score: 5.09.
Episode 225        Average Score: 5.12.
Episode 226        Average Score: 5.17.
Episode 227        Average Score: 5.24.
Episode 228        Average Score: 5.34.
Episode 229        Average Score: 5.33.
Episode 230        Average Score: 5.34.
Episode 231        Average Score: 5.33.
Episode 232        Average Score: 5.44.
Episode 233        Average Score: 5.43.
Episode 234        Average Score: 5.47.
Episode 235        Average Score: 5.48.
Episode 236        Average Score: 5.45.
Episode 237        Average Score: 5.53.
Episode 238        Average Score: 5.59.
Episode 239        Average Score: 5.64.
Episode 240        Average Score: 5.67.
Episode 241        Average Score: 5.75.
Episode 242        Average Score: 5.78.
Episode 243        Average Score: 5.78.
Episode 244        Average Score: 5.77.
Episode 245        Average Score: 5.75.
Episode 246        Average Score: 5.77.
Episode 247        Average Score: 5.83.
Episode 248        Average Score: 5.86.
Episode 249        Average Score: 5.86.
Episode 250        Average Score: 5.87.
Episode 251        Average Score: 5.88.
Episode 252        Average Score: 5.93.
Episode 253        Average Score: 6.00.
Episode 254        Average Score: 6.06.
Episode 255        Average Score: 6.08.
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Episode 256        Average Score: 6.12.
Episode 257        Average Score: 6.14.
Episode 258        Average Score: 6.17.
Episode 259        Average Score: 6.17.
Episode 260        Average Score: 6.18.
Episode 261        Average Score: 6.21.
Episode 262        Average Score: 6.33.
Episode 263        Average Score: 6.39.
Episode 264        Average Score: 6.44.
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Episode 266        Average Score: 6.44.
Episode 267        Average Score: 6.43.
Episode 268        Average Score: 6.54.
Episode 269        Average Score: 6.47.
Episode 270        Average Score: 6.45.
Episode 271        Average Score: 6.51.
Episode 272        Average Score: 6.51.
Episode 273        Average Score: 6.57.
Episode 274        Average Score: 6.56.
Episode 275        Average Score: 6.58.
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Episode 277        Average Score: 6.71.
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Episode 279        Average Score: 6.83.
Episode 280        Average Score: 6.85.
Episode 281        Average Score: 6.87.
Episode 282        Average Score: 6.93.
Episode 283        Average Score: 6.86.
Episode 284        Average Score: 6.88.
Episode 285        Average Score: 6.90.
Episode 286        Average Score: 6.88.
Episode 287        Average Score: 6.81.
Episode 288        Average Score: 6.87.
Episode 289        Average Score: 6.82.
Episode 290        Average Score: 6.75.
Episode 291        Average Score: 6.73.
Episode 292        Average Score: 6.77.
Episode 293        Average Score: 6.68.
Episode 294        Average Score: 6.74.
Episode 295        Average Score: 6.76.
Episode 296        Average Score: 6.75.
Episode 297        Average Score: 6.76.
Episode 298        Average Score: 6.84.
Episode 299        Average Score: 6.80.
Episode 300        Average Score: 6.85
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Episode 301        Average Score: 6.85.
Episode 302        Average Score: 6.85.
```
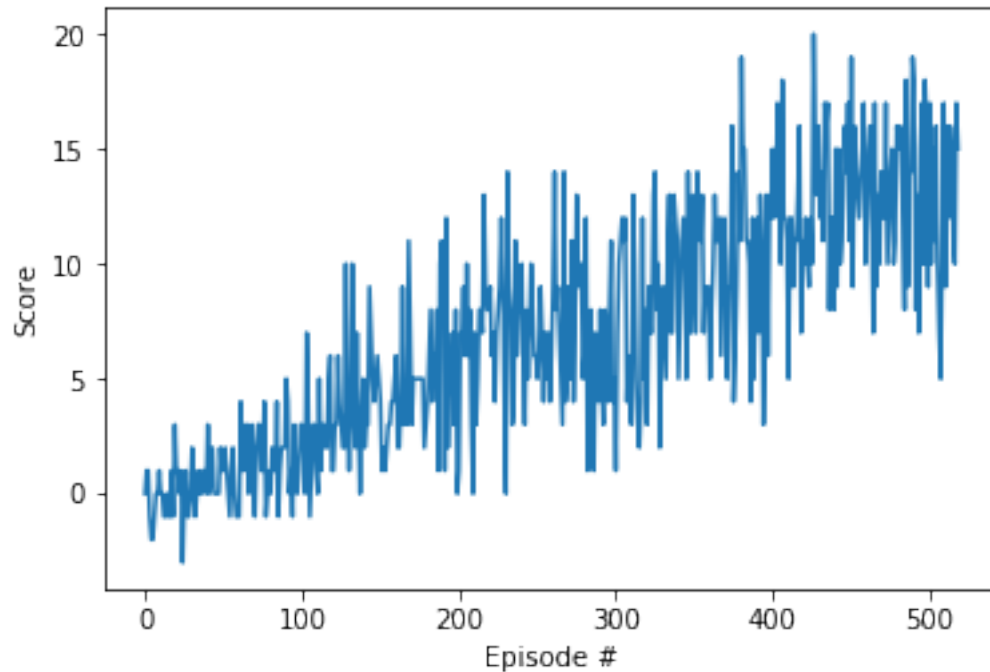
```
Episode 303        Average Score: 6.88.
Episode 304        Average Score: 6.90.
Episode 305        Average Score: 6.96.
Episode 306        Average Score: 6.97.
Episode 307        Average Score: 7.03.
Episode 308        Average Score: 6.99.
Episode 309        Average Score: 7.02.
Episode 310        Average Score: 7.06.
Episode 311        Average Score: 7.02.
Episode 312        Average Score: 7.12.
Episode 313        Average Score: 7.17.
Episode 314        Average Score: 7.14.
Episode 315        Average Score: 7.09.
Episode 316        Average Score: 7.04.
Episode 317        Average Score: 6.95.
Episode 318        Average Score: 6.98.
Episode 319        Average Score: 6.95.
Episode 320        Average Score: 6.95.
Episode 321        Average Score: 6.89.
Episode 322        Average Score: 6.92.
Episode 323        Average Score: 6.92.
Episode 324        Average Score: 6.95.
Episode 325        Average Score: 7.01.
Episode 326        Average Score: 7.07.
Episode 327        Average Score: 7.06.
Episode 328        Average Score: 7.04.
Episode 329        Average Score: 6.97.
Episode 330        Average Score: 6.99.
Episode 331        Average Score: 7.08.
Episode 332        Average Score: 7.01.
Episode 333        Average Score: 6.97.
Episode 334        Average Score: 7.00.
Episode 335        Average Score: 7.10.
Episode 336        Average Score: 7.13.
Episode 337        Average Score: 7.09.
Episode 338        Average Score: 7.16.
Episode 339        Average Score: 7.20.
Episode 340        Average Score: 7.23.
Episode 341        Average Score: 7.18.
Episode 342        Average Score: 7.20.
Episode 343        Average Score: 7.28.
Episode 344        Average Score: 7.32.
Episode 345        Average Score: 7.38.
Episode 346        Average Score: 7.36.
Episode 347        Average Score: 7.40.
Episode 348        Average Score: 7.39.
Episode 349        Average Score: 7.40.
Episode 350        Average Score: 7.47.
```

```
Episode 351      Average Score: 7.52.
Episode 352      Average Score: 7.53.
Episode 353      Average Score: 7.58.
Episode 354      Average Score: 7.63.
Episode 355      Average Score: 7.70.
Episode 356      Average Score: 7.76.
Episode 357      Average Score: 7.78.
Episode 358      Average Score: 7.80.
Episode 359      Average Score: 7.85.
Episode 360      Average Score: 7.88.
Episode 361      Average Score: 7.84.
Episode 362      Average Score: 7.78.
Episode 363      Average Score: 7.80.
Episode 364      Average Score: 7.84.
Episode 365      Average Score: 7.88.
Episode 366      Average Score: 7.94.
Episode 367      Average Score: 8.03.
Episode 368      Average Score: 7.95.
Episode 369      Average Score: 8.00.
Episode 370      Average Score: 8.07.
Episode 371      Average Score: 8.08.
Episode 372      Average Score: 8.08.
Episode 373      Average Score: 8.06.
Episode 374      Average Score: 8.11.
Episode 375      Average Score: 8.20.
Episode 376      Average Score: 8.11.
Episode 377      Average Score: 8.07.
Episode 378      Average Score: 8.07.
Episode 379      Average Score: 8.11.
Episode 380      Average Score: 8.17.
Episode 381      Average Score: 8.30.
Episode 382      Average Score: 8.33.
Episode 383      Average Score: 8.47.
Episode 384      Average Score: 8.52.
Episode 385      Average Score: 8.55.
Episode 386      Average Score: 8.62.
Episode 387      Average Score: 8.65.
Episode 388      Average Score: 8.70.
Episode 389      Average Score: 8.70.
Episode 390      Average Score: 8.75.
Episode 391      Average Score: 8.79.
Episode 392      Average Score: 8.81.
Episode 393      Average Score: 8.91.
Episode 394      Average Score: 8.94.
Episode 395      Average Score: 8.90.
Episode 396      Average Score: 8.93.
Episode 397      Average Score: 8.98.
Episode 398      Average Score: 8.93.
```

```
Episode 399        Average Score: 9.02.
Episode 400        Average Score: 9.09
.
Episode 401        Average Score: 9.23.
Episode 402        Average Score: 9.28.
Episode 403        Average Score: 9.31.
Episode 404        Average Score: 9.37.
Episode 405        Average Score: 9.40.
Episode 406        Average Score: 9.39.
Episode 407        Average Score: 9.45.
Episode 408        Average Score: 9.53.
Episode 409        Average Score: 9.59.
Episode 410        Average Score: 9.66.
Episode 411        Average Score: 9.68.
Episode 412        Average Score: 9.67.
Episode 413        Average Score: 9.69.
Episode 414        Average Score: 9.73.
Episode 415        Average Score: 9.81.
Episode 416        Average Score: 9.90.
Episode 417        Average Score: 9.99.
Episode 418        Average Score: 10.03.
Episode 419        Average Score: 10.05.
Episode 420        Average Score: 10.08.
Episode 421        Average Score: 10.15.
Episode 422        Average Score: 10.18.
Episode 423        Average Score: 10.21.
Episode 424        Average Score: 10.23.
Episode 425        Average Score: 10.22.
Episode 426        Average Score: 10.18.
Episode 427        Average Score: 10.30.
Episode 428        Average Score: 10.36.
Episode 429        Average Score: 10.47.
Episode 430        Average Score: 10.57.
Episode 431        Average Score: 10.60.
Episode 432        Average Score: 10.67.
Episode 433        Average Score: 10.73.
Episode 434        Average Score: 10.79.
Episode 435        Average Score: 10.82.
Episode 436        Average Score: 10.92.
Episode 437        Average Score: 10.93.
Episode 438        Average Score: 10.92.
Episode 439        Average Score: 10.92.
Episode 440        Average Score: 10.89.
Episode 441        Average Score: 10.99.
Episode 442        Average Score: 11.00.
Episode 443        Average Score: 11.04.
Episode 444        Average Score: 11.02.
Episode 445        Average Score: 11.02.
```

```
Episode 446      Average Score: 11.10.
Episode 447      Average Score: 11.12.
Episode 448      Average Score: 11.19.
Episode 449      Average Score: 11.29.
Episode 450      Average Score: 11.27.
Episode 451      Average Score: 11.36.
Episode 452      Average Score: 11.38.
Episode 453      Average Score: 11.40.
Episode 454      Average Score: 11.42.
Episode 455      Average Score: 11.44.
Episode 456      Average Score: 11.43.
Episode 457      Average Score: 11.50.
Episode 458      Average Score: 11.56.
Episode 459      Average Score: 11.64.
Episode 460      Average Score: 11.65.
Episode 461      Average Score: 11.72.
Episode 462      Average Score: 11.79.
Episode 463      Average Score: 11.85.
Episode 464      Average Score: 11.85.
Episode 465      Average Score: 11.81.
Episode 466      Average Score: 11.87.
Episode 467      Average Score: 11.84.
Episode 468      Average Score: 11.91.
Episode 469      Average Score: 11.92.
Episode 470      Average Score: 11.94.
Episode 471      Average Score: 11.96.
Episode 472      Average Score: 12.03.
Episode 473      Average Score: 12.11.
Episode 474      Average Score: 12.12.
Episode 475      Average Score: 12.08.
Episode 476      Average Score: 12.18.
Episode 477      Average Score: 12.27.
Episode 478      Average Score: 12.28.
Episode 479      Average Score: 12.25.
Episode 480      Average Score: 12.30.
Episode 481      Average Score: 12.26.
Episode 482      Average Score: 12.27.
Episode 483      Average Score: 12.27.
Episode 484      Average Score: 12.27.
Episode 485      Average Score: 12.24.
Episode 486      Average Score: 12.32.
Episode 487      Average Score: 12.37.
Episode 488      Average Score: 12.39.
Episode 489      Average Score: 12.48.
Episode 490      Average Score: 12.58.
Episode 491      Average Score: 12.64.
Episode 492      Average Score: 12.65.
Episode 493      Average Score: 12.65.
```

```
Episode 494        Average Score: 12.61.
Episode 495        Average Score: 12.73.
Episode 496        Average Score: 12.83.
Episode 497        Average Score: 12.80.
Episode 498        Average Score: 12.92.
Episode 499        Average Score: 12.95.
Episode 500        Average Score: 12.92
.
Episode 501        Average Score: 12.94.
Episode 502        Average Score: 12.92.
Episode 503        Average Score: 12.94.
Episode 504        Average Score: 12.88.
Episode 505        Average Score: 12.89.
Episode 506        Average Score: 12.89.
Episode 507        Average Score: 12.78.
Episode 508        Average Score: 12.71.
Episode 509        Average Score: 12.70.
Episode 510        Average Score: 12.76.
Episode 511        Average Score: 12.80.
Episode 512        Average Score: 12.84.
Episode 513        Average Score: 12.84.
Episode 514        Average Score: 12.91.
Episode 515        Average Score: 12.95.
Episode 516        Average Score: 12.95.
Episode 517        Average Score: 12.92.
Episode 518        Average Score: 12.93.
Episode 519        Average Score: 13.01
Environment solved in 419 episodes!        Average Score: 13.01
```

1.0.4   4. Test the agent

```
In [9]: brain_name = env.brain_names[0] # get the name of the brains from the Unity environmen
        brain = env.brains[brain_name]
        env_info = env.reset(train_mode=False)[brain_name] # reset the environment and obtain

        # initialize agent with state size and action size.
        agent = Agent(len(env_info.vector_observations[0]), brain.vector_action_space_size, se

        # load the trained weights
        agent.qnetwork_local.load_state_dict(torch.load('model.pth'))

        state = env_info.vector_observations[0]   # get the first state
        score = 0 # initialize the score
        while True: # loop until the episode ends
            action = agent.act(state, 0).astype(np.int32) # select a greedy action
            env_info = env.step(action)[brain_name] # take that action
            score += env_info.rewards[0] # update the score with the reward for taking that ac
            next_state = env_info.vector_observations[0] # the next state
            state = next_state # set current state to next state
            done = env_info.local_done[0] # get the value of the done bool, indicating the epi
            # end episode if done is true
            if done:
                break
```

```
    print("Score: {}".format(score)) # print the score
```

Score: 17.0

When finished, you can close the environment.

In [ ]: env.close()