

report

February 21, 2020

```
[1]: from unityagents import UnityEnvironment
import torch
from ddpq_agent import Agent
import numpy as np
from collections import deque
import time
import matplotlib.pyplot as plt
%matplotlib inline
```

```
[2]: #Configuration
env_path = 'D:/20_agents/Reacher.exe'
actor_model = 'actor.pth'
critic_model = 'model.pth'
random_seed = 64
num_episodes = 160
max_num_timesteps = 1500
```

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[3]: #Start enviroment
env = UnityEnvironment(file_name=env_path)
brain_name = env.brain_names[0]
brain = env.brains[brain_name]
env_info = env.reset(train_mode=True)[brain_name]
num_agents = len(env_info.agents)
action_size = brain.vector_action_space_size
states = env_info.vector_observations
state_size = states.shape[1]
```

```
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
```

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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: , , ,

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[4]: #Start agent
agent = Agent(state_size=state_size, action_size=action_size,
    ↪random_seed=random_seed)

```

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[5]: #Train model
def train():
    scores_deque = deque(maxlen=100)
    scores_global = []
    t0 = time.time()
    for i_episode in range(1, num_episodes+1):
        env_info = env.reset(train_mode=True)[brain_name]
        states = env_info.vector_observations
        scores = np.zeros(num_agents)
        agent.reset()
        score_average = 0

        for timestep in range(max_num_timesteps):
            actions = agent.act(states)
            env_info = env.step(actions)[brain_name]
            next_states = env_info.vector_observations
            rewards = env_info.rewards
            dones = env_info.local_done
            agent.step(states, actions, rewards, next_states, dones, timestep)
            states = next_states
            scores += rewards
            if np.any(dones):
                break

        score = np.mean(scores)
        scores_deque.append(score)
        score_average = np.mean(scores_deque)
        scores_global.append(score)
        t1 = (time.time()-t0)/60.
        print(f'Episode: {i_episode}\tTime(Min): {round(t1,2)}\tScore:
    ↪{round(score,2)}\tMax: {round(np.max(scores),2)}\tMin: {round(np.
    ↪min(scores),2)}\tAvg queue: {round(np.mean(scores_deque),2)}')

    if len(scores_deque) == 100 and np.mean(scores_deque) >= 30:
        print('Completed!')
        env.close()

```

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        torch.save(agent.actor_local.state_dict(), actor_model)
        torch.save(agent.critic_local.state_dict(), critic_model)
        break

    return scores_global

```

```
[6]: results = train()
```

```

Episode: 1      Time(Min): 0.42 Score: 0.13      Max: 0.9      Min: 0.0
Avg queue: 0.13
Episode: 2      Time(Min): 0.87 Score: 0.21      Max: 0.64      Min: 0.0
Avg queue: 0.17
Episode: 3      Time(Min): 1.31 Score: 0.16      Max: 1.41      Min: 0.0
Avg queue: 0.17
Episode: 4      Time(Min): 1.76 Score: 0.77      Max: 1.66      Min: 0.2
Avg queue: 0.32
Episode: 5      Time(Min): 2.2   Score: 0.8       Max: 1.47      Min: 0.0
Avg queue: 0.42
Episode: 6      Time(Min): 2.66 Score: 0.7       Max: 1.46      Min: 0.15
Avg queue: 0.46
Episode: 7      Time(Min): 3.12 Score: 0.91      Max: 1.87      Min: 0.33
Avg queue: 0.53
Episode: 8      Time(Min): 3.55 Score: 0.91      Max: 2.5       Min: 0.25
Avg queue: 0.57
Episode: 9      Time(Min): 3.98 Score: 0.98      Max: 1.87      Min: 0.15
Avg queue: 0.62
Episode: 10     Time(Min): 4.41 Score: 1.13      Max: 2.87      Min: 0.0
Avg queue: 0.67
Episode: 11     Time(Min): 4.85 Score: 0.85      Max: 2.04      Min: 0.0
Avg queue: 0.69
Episode: 12     Time(Min): 5.29 Score: 1.29      Max: 2.51      Min: 0.41
Avg queue: 0.74
Episode: 13     Time(Min): 5.74 Score: 1.37      Max: 4.02      Min: 0.1
Avg queue: 0.79
Episode: 14     Time(Min): 6.19 Score: 1.26      Max: 2.82      Min: 0.2
Avg queue: 0.82
Episode: 15     Time(Min): 6.65 Score: 1.59      Max: 2.94      Min: 0.71
Avg queue: 0.87
Episode: 16     Time(Min): 7.11 Score: 1.44      Max: 2.92      Min: 0.55
Avg queue: 0.91
Episode: 17     Time(Min): 7.58 Score: 1.88      Max: 3.82      Min: 0.82
Avg queue: 0.96
Episode: 18     Time(Min): 8.05 Score: 1.69      Max: 3.07      Min: 0.14
Avg queue: 1.0
Episode: 19     Time(Min): 8.53 Score: 2.15      Max: 4.57      Min: 0.45
Avg queue: 1.06
Episode: 20     Time(Min): 9.02 Score: 2.19      Max: 3.2       Min: 1.35

```

Avg queue: 1.12				
Episode: 21	Time(Min): 9.51	Score: 2.49	Max: 5.03	Min: 0.94
Avg queue: 1.19				
Episode: 22	Time(Min): 10.01	Score: 2.58	Max: 5.95	Min: 0.9
Avg queue: 1.25				
Episode: 23	Time(Min): 10.52	Score: 2.63	Max: 5.79	Min:
0.52	Avg queue: 1.31			
Episode: 24	Time(Min): 11.04	Score: 2.74	Max: 5.48	Min: 0.4
Avg queue: 1.37				
Episode: 25	Time(Min): 11.56	Score: 3.51	Max: 6.35	Min:
1.95	Avg queue: 1.45			
Episode: 26	Time(Min): 12.09	Score: 3.93	Max: 6.93	Min:
0.45	Avg queue: 1.55			
Episode: 27	Time(Min): 12.63	Score: 2.79	Max: 7.59	Min: 0.0
Avg queue: 1.6				
Episode: 28	Time(Min): 13.18	Score: 3.72	Max: 7.47	Min:
1.65	Avg queue: 1.67			
Episode: 29	Time(Min): 13.74	Score: 3.74	Max: 6.82	Min:
0.47	Avg queue: 1.74			
Episode: 30	Time(Min): 14.3	Score: 3.84	Max: 8.84	Min: 1.46
Avg queue: 1.81				
Episode: 31	Time(Min): 14.88	Score: 5.17	Max: 10.7	Min:
0.76	Avg queue: 1.92			
Episode: 32	Time(Min): 15.46	Score: 4.84	Max: 10.2	Min:
0.15	Avg queue: 2.01			
Episode: 33	Time(Min): 16.05	Score: 5.5	Max: 8.21	Min:
1.39	Avg queue: 2.12			
Episode: 34	Time(Min): 16.65	Score: 6.56	Max: 10.89	Min:
2.19	Avg queue: 2.25			
Episode: 35	Time(Min): 17.25	Score: 6.98	Max: 10.82	Min:
2.42	Avg queue: 2.38			
Episode: 36	Time(Min): 17.87	Score: 7.13	Max: 12.23	Min:
3.32	Avg queue: 2.52			
Episode: 37	Time(Min): 18.49	Score: 8.23	Max: 12.77	Min:
4.26	Avg queue: 2.67			
Episode: 38	Time(Min): 19.13	Score: 8.38	Max: 12.19	Min: 4.6
Avg queue: 2.82				
Episode: 39	Time(Min): 19.77	Score: 8.88	Max: 12.91	Min:
2.87	Avg queue: 2.98			
Episode: 40	Time(Min): 20.41	Score: 8.62	Max: 14.19	Min:
3.81	Avg queue: 3.12			
Episode: 41	Time(Min): 21.07	Score: 8.91	Max: 14.32	Min:
4.62	Avg queue: 3.26			
Episode: 42	Time(Min): 21.74	Score: 8.15	Max: 18.14	Min:
0.27	Avg queue: 3.38			
Episode: 43	Time(Min): 22.41	Score: 8.57	Max: 16.65	Min:
4.67	Avg queue: 3.5			
Episode: 44	Time(Min): 23.09	Score: 9.27	Max: 16.7	Min:

2.11	Avg queue: 3.63			
Episode: 45	Time(Min): 23.77	Score: 11.23	Max: 23.98	Min:
6.63	Avg queue: 3.8			
Episode: 46	Time(Min): 24.47	Score: 11.24	Max: 14.36	Min:
7.05	Avg queue: 3.96			
Episode: 47	Time(Min): 25.17	Score: 11.37	Max: 17.13	Min:
7.92	Avg queue: 4.12			
Episode: 48	Time(Min): 25.89	Score: 14.02	Max: 23.39	Min:
7.86	Avg queue: 4.32			
Episode: 49	Time(Min): 26.6	Score: 12.39	Max: 15.98	Min: 1.9
Avg queue: 4.49				
Episode: 50	Time(Min): 27.33	Score: 12.28	Max: 16.29	Min:
5.87	Avg queue: 4.64			
Episode: 51	Time(Min): 28.06	Score: 13.5	Max: 26.29	Min:
8.32	Avg queue: 4.82			
Episode: 52	Time(Min): 28.79	Score: 14.81	Max: 27.13	Min:
3.42	Avg queue: 5.01			
Episode: 53	Time(Min): 29.52	Score: 13.64	Max: 19.06	Min:
3.41	Avg queue: 5.17			
Episode: 54	Time(Min): 30.26	Score: 15.0	Max: 26.01	Min:
9.63	Avg queue: 5.35			
Episode: 55	Time(Min): 30.99	Score: 15.88	Max: 31.23	Min:
10.0	Avg queue: 5.54			
Episode: 56	Time(Min): 31.73	Score: 15.04	Max: 20.08	Min:
2.37	Avg queue: 5.71			
Episode: 57	Time(Min): 32.46	Score: 17.83	Max: 22.16	Min:
12.52	Avg queue: 5.93			
Episode: 58	Time(Min): 33.19	Score: 19.33	Max: 34.74	Min:
8.53	Avg queue: 6.16			
Episode: 59	Time(Min): 33.93	Score: 21.71	Max: 30.91	Min:
15.77	Avg queue: 6.42			
Episode: 60	Time(Min): 34.67	Score: 23.5	Max: 38.09	Min:
17.2	Avg queue: 6.71			
Episode: 61	Time(Min): 35.41	Score: 24.05	Max: 38.81	Min:
15.03	Avg queue: 6.99			
Episode: 62	Time(Min): 36.15	Score: 24.43	Max: 35.21	Min:
12.86	Avg queue: 7.27			
Episode: 63	Time(Min): 36.9	Score: 26.42	Max: 38.0	Min: 18.67
Avg queue: 7.58				
Episode: 64	Time(Min): 37.64	Score: 24.72	Max: 38.57	Min:
11.82	Avg queue: 7.84			
Episode: 65	Time(Min): 38.38	Score: 27.66	Max: 38.52	Min:
15.93	Avg queue: 8.15			
Episode: 66	Time(Min): 39.11	Score: 25.45	Max: 33.06	Min:
17.01	Avg queue: 8.41			
Episode: 67	Time(Min): 39.85	Score: 30.68	Max: 36.97	Min:
20.07	Avg queue: 8.74			
Episode: 68	Time(Min): 40.58	Score: 28.56	Max: 38.92	Min:

16.82	Avg queue: 9.03			
Episode: 69	Time(Min): 41.31	Score: 32.19	Max: 38.88	Min:
25.39	Avg queue: 9.37			
Episode: 70	Time(Min): 42.04	Score: 31.14	Max: 37.61	Min:
22.65	Avg queue: 9.68			
Episode: 71	Time(Min): 42.77	Score: 33.44	Max: 39.39	Min:
25.51	Avg queue: 10.02			
Episode: 72	Time(Min): 43.51	Score: 34.54	Max: 39.33	Min:
24.83	Avg queue: 10.36			
Episode: 73	Time(Min): 44.24	Score: 33.28	Max: 38.96	Min:
22.26	Avg queue: 10.67			
Episode: 74	Time(Min): 44.97	Score: 33.2	Max: 38.76	Min:
27.16	Avg queue: 10.98			
Episode: 75	Time(Min): 45.7	Score: 34.04	Max: 38.36	Min: 29.31
	Avg queue: 11.28			
Episode: 76	Time(Min): 46.43	Score: 34.88	Max: 39.18	Min:
27.55	Avg queue: 11.59			
Episode: 77	Time(Min): 47.16	Score: 35.02	Max: 39.07	Min:
28.81	Avg queue: 11.9			
Episode: 78	Time(Min): 47.9	Score: 35.23	Max: 38.75	Min: 29.96
	Avg queue: 12.2			
Episode: 79	Time(Min): 48.63	Score: 35.52	Max: 38.11	Min:
30.35	Avg queue: 12.49			
Episode: 80	Time(Min): 49.37	Score: 35.67	Max: 38.64	Min:
31.21	Avg queue: 12.78			
Episode: 81	Time(Min): 50.1	Score: 36.64	Max: 39.43	Min: 33.15
	Avg queue: 13.08			
Episode: 82	Time(Min): 50.83	Score: 36.34	Max: 38.81	Min:
32.89	Avg queue: 13.36			
Episode: 83	Time(Min): 51.56	Score: 36.41	Max: 39.16	Min:
31.74	Avg queue: 13.64			
Episode: 84	Time(Min): 52.3	Score: 35.7	Max: 38.8	Min: 30.81
	Avg queue: 13.9			
Episode: 85	Time(Min): 53.03	Score: 36.99	Max: 39.07	Min:
32.81	Avg queue: 14.17			
Episode: 86	Time(Min): 53.76	Score: 37.15	Max: 39.45	Min:
33.68	Avg queue: 14.44			
Episode: 87	Time(Min): 54.49	Score: 36.62	Max: 38.66	Min:
34.23	Avg queue: 14.69			
Episode: 88	Time(Min): 55.23	Score: 36.77	Max: 39.09	Min:
32.03	Avg queue: 14.94			
Episode: 89	Time(Min): 55.96	Score: 37.22	Max: 39.4	Min:
32.96	Avg queue: 15.2			
Episode: 90	Time(Min): 56.69	Score: 36.25	Max: 39.35	Min:
30.2	Avg queue: 15.43			
Episode: 91	Time(Min): 57.42	Score: 36.29	Max: 39.43	Min:
33.33	Avg queue: 15.66			
Episode: 92	Time(Min): 58.16	Score: 36.74	Max: 39.6	Min:

31.71	Avg queue: 15.89			
Episode: 93	Time(Min): 58.89	Score: 37.71	Max: 39.45	Min:
32.84	Avg queue: 16.12			
Episode: 94	Time(Min): 59.63	Score: 37.35	Max: 39.44	Min:
33.17	Avg queue: 16.35			
Episode: 95	Time(Min): 60.36	Score: 37.61	Max: 39.32	Min:
33.02	Avg queue: 16.57			
Episode: 96	Time(Min): 61.09	Score: 37.88	Max: 39.35	Min:
34.89	Avg queue: 16.79			
Episode: 97	Time(Min): 61.83	Score: 37.85	Max: 39.41	Min:
33.05	Avg queue: 17.01			
Episode: 98	Time(Min): 62.56	Score: 38.38	Max: 39.38	Min:
34.69	Avg queue: 17.23			
Episode: 99	Time(Min): 63.3	Score: 38.07	Max: 39.51	Min: 32.39
	Avg queue: 17.44			
Episode: 100	Time(Min): 64.03	Score: 38.56	Max: 39.52	Min:
33.96	Avg queue: 17.65			
Episode: 101	Time(Min): 64.76	Score: 38.43	Max: 39.53	Min:
35.49	Avg queue: 18.03			
Episode: 102	Time(Min): 65.49	Score: 38.18	Max: 39.47	Min:
34.82	Avg queue: 18.41			
Episode: 103	Time(Min): 66.22	Score: 38.39	Max: 39.52	Min:
36.88	Avg queue: 18.8			
Episode: 104	Time(Min): 66.96	Score: 39.04	Max: 39.54	Min:
38.0	Avg queue: 19.18			
Episode: 105	Time(Min): 67.69	Score: 38.08	Max: 39.62	Min:
34.42	Avg queue: 19.55			
Episode: 106	Time(Min): 68.42	Score: 38.55	Max: 39.52	Min:
37.3	Avg queue: 19.93			
Episode: 107	Time(Min): 69.15	Score: 37.56	Max: 39.27	Min:
33.19	Avg queue: 20.3			
Episode: 108	Time(Min): 69.88	Score: 37.11	Max: 39.3	Min:
33.22	Avg queue: 20.66			
Episode: 109	Time(Min): 70.61	Score: 37.12	Max: 39.58	Min:
35.55	Avg queue: 21.02			
Episode: 110	Time(Min): 71.34	Score: 37.94	Max: 39.47	Min:
35.84	Avg queue: 21.39			
Episode: 111	Time(Min): 72.07	Score: 37.04	Max: 39.34	Min:
33.14	Avg queue: 21.75			
Episode: 112	Time(Min): 72.8	Score: 37.61	Max: 39.44	Min: 35.56
	Avg queue: 22.11			
Episode: 113	Time(Min): 73.53	Score: 38.04	Max: 39.11	Min:
35.74	Avg queue: 22.48			
Episode: 114	Time(Min): 74.33	Score: 37.41	Max: 39.65	Min:
34.83	Avg queue: 22.84			
Episode: 115	Time(Min): 75.06	Score: 36.92	Max: 39.19	Min:
31.18	Avg queue: 23.19			
Episode: 116	Time(Min): 75.79	Score: 37.24	Max: 39.32	Min:

33.94	Avg queue: 23.55			
Episode: 117	Time(Min): 76.52	Score: 37.16	Max: 39.36	Min:
32.07	Avg queue: 23.9			
Episode: 118	Time(Min): 77.25	Score: 37.09	Max: 39.25	Min:
33.52	Avg queue: 24.26			
Episode: 119	Time(Min): 77.98	Score: 37.43	Max: 39.31	Min:
34.75	Avg queue: 24.61			
Episode: 120	Time(Min): 78.71	Score: 38.16	Max: 39.57	Min:
34.99	Avg queue: 24.97			
Episode: 121	Time(Min): 79.44	Score: 36.93	Max: 39.63	Min:
34.59	Avg queue: 25.32			
Episode: 122	Time(Min): 80.17	Score: 35.95	Max: 39.46	Min:
31.18	Avg queue: 25.65			
Episode: 123	Time(Min): 80.9	Score: 36.81	Max: 39.11	Min: 32.6
	Avg queue: 25.99			
Episode: 124	Time(Min): 81.63	Score: 37.56	Max: 39.35	Min:
31.11	Avg queue: 26.34			
Episode: 125	Time(Min): 82.36	Score: 37.5	Max: 39.15	Min:
34.51	Avg queue: 26.68			
Episode: 126	Time(Min): 83.09	Score: 37.79	Max: 39.14	Min:
35.37	Avg queue: 27.02			
Episode: 127	Time(Min): 83.82	Score: 37.58	Max: 39.59	Min:
35.72	Avg queue: 27.37			
Episode: 128	Time(Min): 84.55	Score: 36.25	Max: 38.68	Min:
31.92	Avg queue: 27.69			
Episode: 129	Time(Min): 85.27	Score: 37.34	Max: 39.38	Min:
33.09	Avg queue: 28.03			
Episode: 130	Time(Min): 86.0	Score: 37.87	Max: 39.48	Min: 35.27
	Avg queue: 28.37			
Episode: 131	Time(Min): 86.74	Score: 36.92	Max: 39.1	Min:
31.98	Avg queue: 28.68			
Episode: 132	Time(Min): 87.46	Score: 37.44	Max: 39.25	Min:
31.56	Avg queue: 29.01			
Episode: 133	Time(Min): 88.19	Score: 36.68	Max: 38.57	Min:
32.48	Avg queue: 29.32			
Episode: 134	Time(Min): 88.92	Score: 37.26	Max: 39.22	Min:
33.28	Avg queue: 29.63			
Episode: 135	Time(Min): 89.65	Score: 34.98	Max: 38.19	Min:
27.67	Avg queue: 29.91			
Episode: 136	Time(Min): 90.38	Score: 37.84	Max: 39.02	Min:
35.39	Avg queue: 30.22			
Completed!				

```
[7]: def plot_results(scores):
    fig, ax = plt.subplots(figsize=(12, 6))
    fig.suptitle("Rewards", fontsize=15)
    ax.plot(scores, color="#307EC7", label="line")
```



```

ax.set_xlabel("Timesteps")
ax.set_ylabel("Average Score")
# GRID
ax.grid(True)
ax.grid(b=True, which='major', color='#999999', linestyle='-', linewidth=1)
ax.minorticks_on()
ax.grid(b=True, which='minor', color='#999999', linestyle='-', alpha=0.7,
→linewidth=0.5)
fig.savefig("learning.jpg")

plot_results(results)

```

