QLearning_SARSA

February 21, 2022

[2]:
```
# Run this only if you are using Google Colab
from google.colab import drive
import os

drive.mount('/content/drive')

# change path here as per your directory structure
# os.chdir('drive/My Drive/CS6700_TA/Tutorial_3')
```

```
Mounted at /content/drive
```

[ ]:
```
# Install relevant libraries
!pip install numpy matplotlib tqdm scipy
```

```
Collecting numpy
  Downloading
numpy-1.22.2-cp39-cp39-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (16.8 MB)
     16.8/16.8 MB
3.8 MB/s eta 0:00:0000:0100:01
Requirement already satisfied: matplotlib in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (3.5.1)
Collecting tqdm
  Using cached tqdm-4.62.3-py2.py3-none-any.whl (76 kB)
Requirement already satisfied: scipy in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (1.8.0)
Requirement already satisfied: python-dateutil>=2.7 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from matplotlib)
(2.8.2)
Requirement already satisfied: cycler>=0.10 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from matplotlib)
(0.11.0)
Requirement already satisfied: packaging>=20.0 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from matplotlib)
(21.3)
Requirement already satisfied: pillow>=6.2.0 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from matplotlib)
```

```
(9.0.1)
Requirement already satisfied: pyparsing>=2.2.1 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from matplotlib)
(3.0.7)
Requirement already satisfied: fonttools>=4.22.0 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from matplotlib)
(4.29.1)
Requirement already satisfied: kiwisolver>=1.0.1 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from matplotlib)
(1.3.2)
Requirement already satisfied: six>=1.5 in
/home/joel/anaconda3/envs/rl/lib/python3.9/site-packages (from python-
dateutil>=2.7->matplotlib) (1.16.0)
Installing collected packages: tqdm, numpy
Successfully installed numpy-1.22.2 tqdm-4.62.3
```

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
from tqdm import tqdm
from IPython.display import clear_output
%matplotlib inline
```

1 Problem Statement

In this section we will implement tabular SARSA and Q-learning algorithms for a grid world navigation task.

1.1 Environment details

The agent can move from one grid coordinate to one of its adjacent grids using one of the four actions: UP, DOWN, LEFT and RIGHT. The goal is to go from a randomly assigned starting position to goal position.

Actions that can result in taking the agent off the grid will not yield any effect. Lets look at the environment.

[ ]:
```
DOWN = 0
UP = 1
LEFT = 2
RIGHT = 3
actions = [DOWN, UP, LEFT, RIGHT]
```

Let us construct a grid in a text file.

[ ]:
```
!cat grid_world2.txt
```

```
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0
```

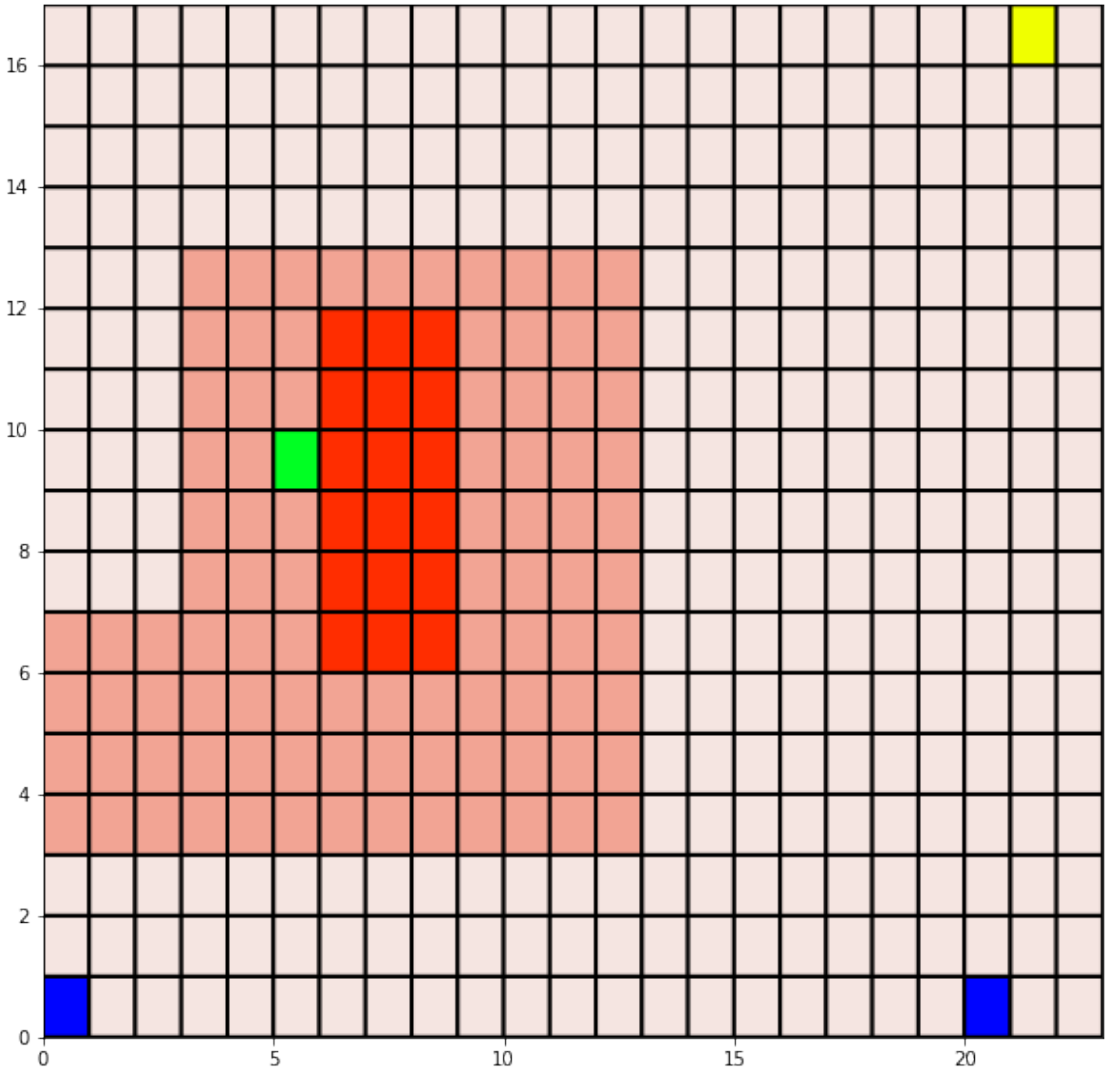
```
1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0
1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0
1 1 1 1 1 1 2 2 2 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 1 1 1 2 2 2 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 1 1 1 2 2 2 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 1 1 1 2 2 2 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 1 1 1 2 2 2 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 1 1 1 2 2 2 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

This is a 17×23 grid. The reward when an agent goes to a cell is negative of the value in that position in the text file (except if it is the goal cell). We will define the goal reward as 100. We will also fix the maximum episode length to 10000.

Now let's make it more difficult. We add stochasticity to the environment: with probability 0.2 agent takes a random action (which can be other than the chosen action). There is also a westerly wind blowing (to the right). Hence, after every time-step, with probability 0.5 the agent also moves an extra step to the right.

Now let's plot the grid world.

[ ]:
```
world = 'grid_world2.txt'
goal_reward = 100
start_states = [(0,0), (0,20), (16,21)]
goal_states=[(9,5)]
max_steps=10000

from grid_world import GridWorldEnv, GridWorldWindyEnv

env = GridWorldEnv(world, goal_reward=goal_reward, start_states=start_states,␣
 ↪goal_states=goal_states,
                max_steps=max_steps, action_fail_prob=0.2)
plt.figure(figsize=(10, 10))
# Go UP
env.step(UP)
env.render(ax=plt, render_agent=True)
```



1.1.1 Legend

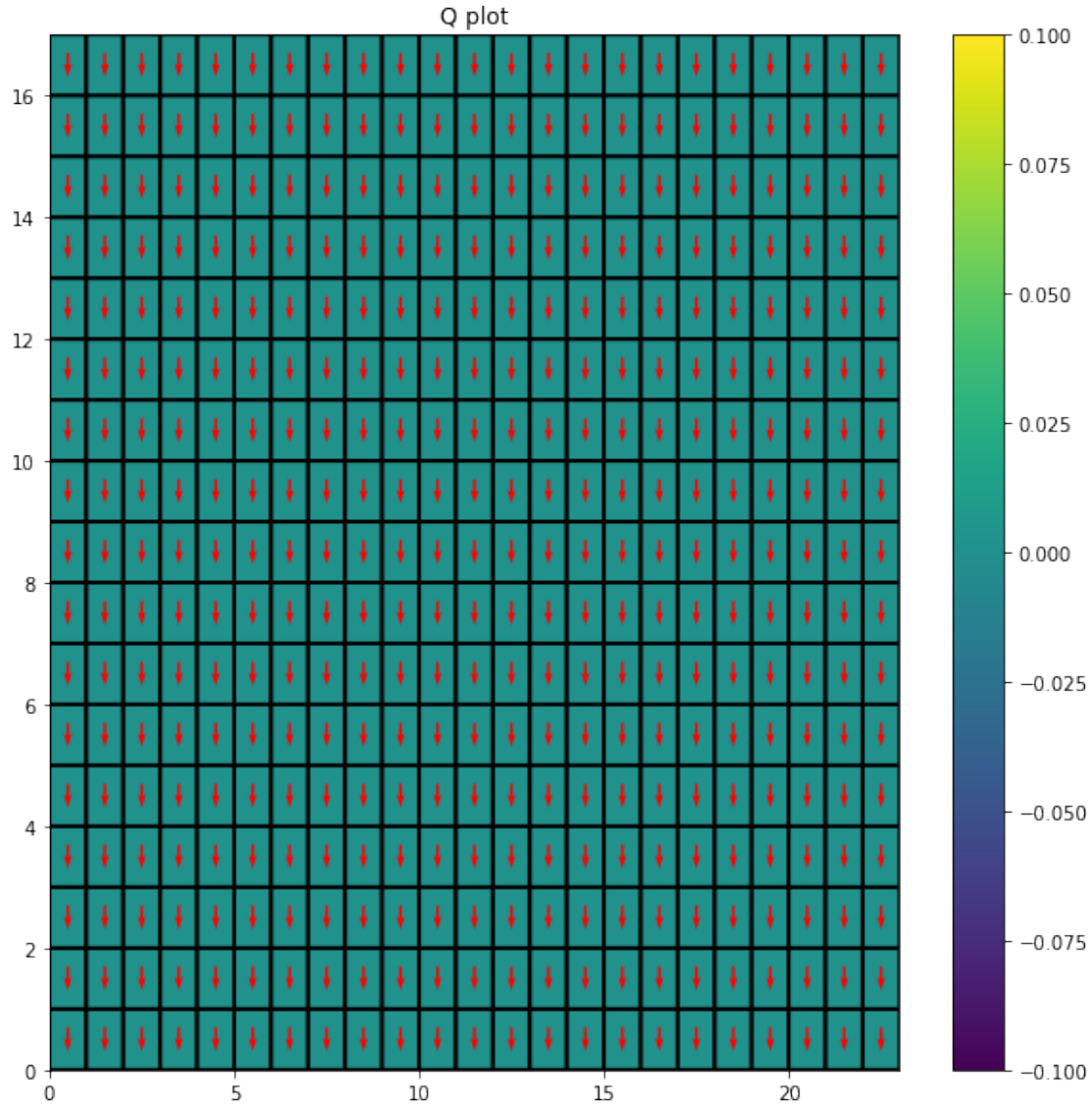
- *Blue* is the **start state**.
- *Green* is the **goal state**.
- *Yellow* is current **state of the agent**.
- *Redness* denotes the extent of **negative reward**.

1.1.2 Q values

We can use a 3D array to represent Q values. The first two indices are X, Y coordinates and last index is the action.

[ ]:
```
from grid_world import plot_Q

Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))
```

```
plot_Q(Q)

Q.shape
```



[ ]: (17, 23, 4)

1.1.3 Exploration strategies

1. Epsilon-greedy
2. Softmax

[ ]:
```
from scipy.special import softmax

seed = 42
rg = np.random.RandomState(seed)

# Epsilon greedy
def choose_action_epsilon(Q, state, epsilon, rg=rg):
    if not Q[state[0], state[1]].any() or rg.rand() < epsilon:
        return rg.choice(Q.shape[-1])
    else:
        return np.argmax(Q[state[0], state[1]])

# Softmax
def choose_action_softmax(Q, state, rg=rg):
    return rg.choice(Q.shape[-1], p = softmax(Q[state[0], state[1]]))
```

1.2 SARSA

Now we implement the SARSA algorithm.

Recall the update rule for SARSA:

$$Q(s_t, a_t) \leftarrow Q(s_t, a_t) + \alpha[r_t + \gamma Q(s_{t+1}, a_{t+1}) - Q(s_t, a_t)] \tag{1}$$

1.2.1 Hyperparameters

So we have som hyperparameters for the algorithm: - α - number of *episodes*. - ϵ: For epsilon greedy exploration

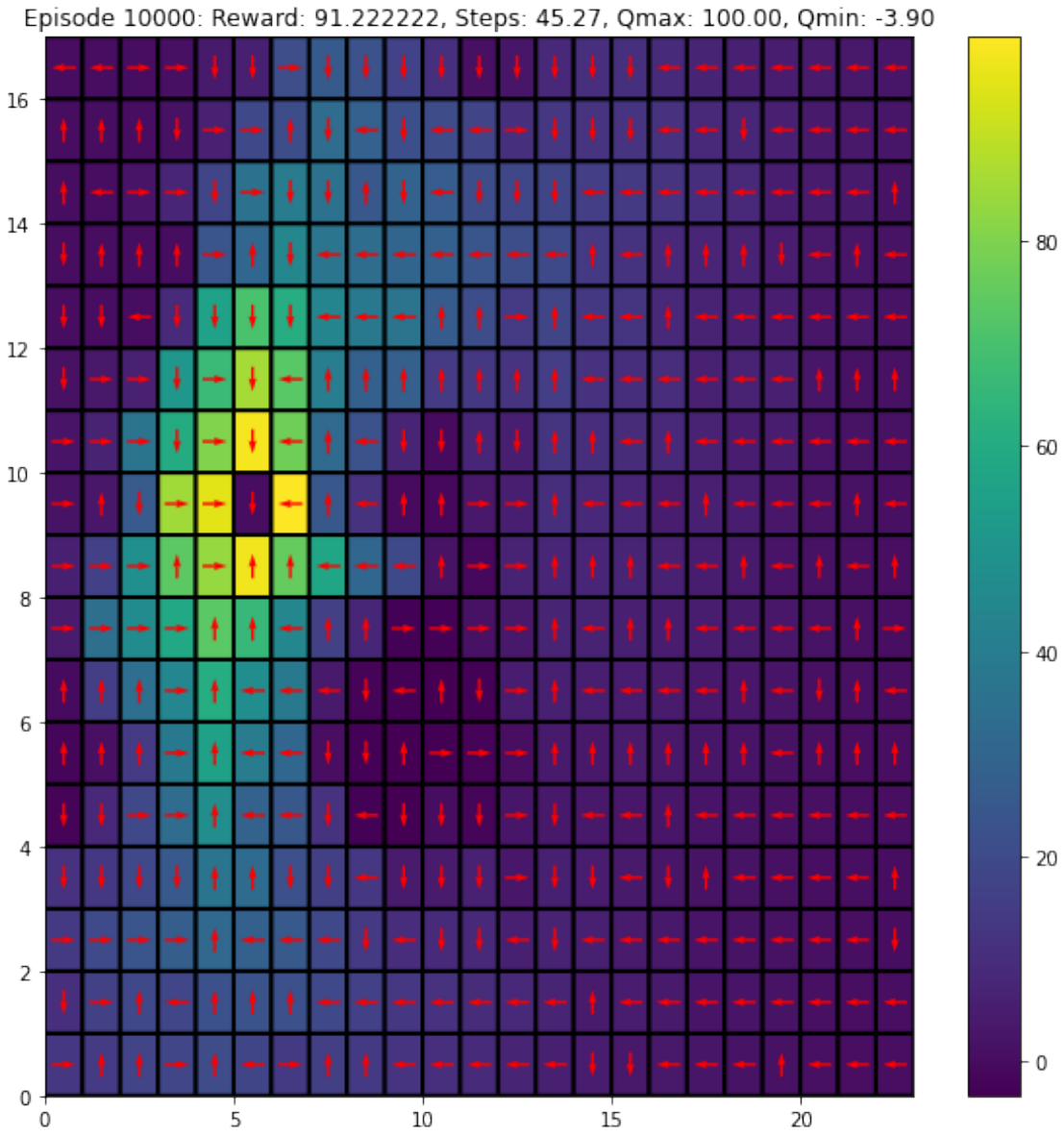
[ ]:
```
# initialize Q-value
Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))

alpha0 = 0.4
gamma = 0.9
episodes = 10000
epsilon0 = 0.1
```

Let's implement SARSA

[ ]:
```
print_freq = 100

def sarsa(env, Q, gamma = 0.9, plot_heat = False, choose_action =␣
 ↪choose_action_softmax):

    episode_rewards = np.zeros(episodes)
    steps_to_completion = np.zeros(episodes)
    if plot_heat:
        clear_output(wait=True)
        plot_Q(Q)
    epsilon = epsilon0
```

```
    alpha = alpha0
    for ep in tqdm(range(episodes)):
        tot_reward, steps = 0, 0

        # Reset environment
        state = env.reset()
        action = choose_action(Q, state)
        done = False
        while not done:
            state_next, reward, done = env.step(action)
            action_next = choose_action(Q, state_next)

            # update equation
            Q[state[0], state[1], action] += alpha*(reward +␣
↪gamma*Q[state_next[0], state_next[1], action_next] - Q[state[0], state[1],␣
↪action])

            tot_reward += reward
            steps += 1

            state, action = state_next, action_next

        episode_rewards[ep] = tot_reward
        steps_to_completion[ep] = steps

        if (ep+1)%print_freq == 0 and plot_heat:
            clear_output(wait=True)
            plot_Q(Q, message = "Episode %d: Reward: %f, Steps: %.2f, Qmax: %.
↪2f, Qmin: %.2f"%(ep+1, np.mean(episode_rewards[ep-print_freq+1:ep]),
                                                                        np.
↪mean(steps_to_completion[ep-print_freq+1:ep]),
                                                                        Q.
↪max(), Q.min()))

    return Q, episode_rewards, steps_to_completion
```

[ ]:
```
Q, rewards, steps = sarsa(env, Q, gamma = gamma, plot_heat=True, choose_action=␣
↪choose_action_softmax)
```



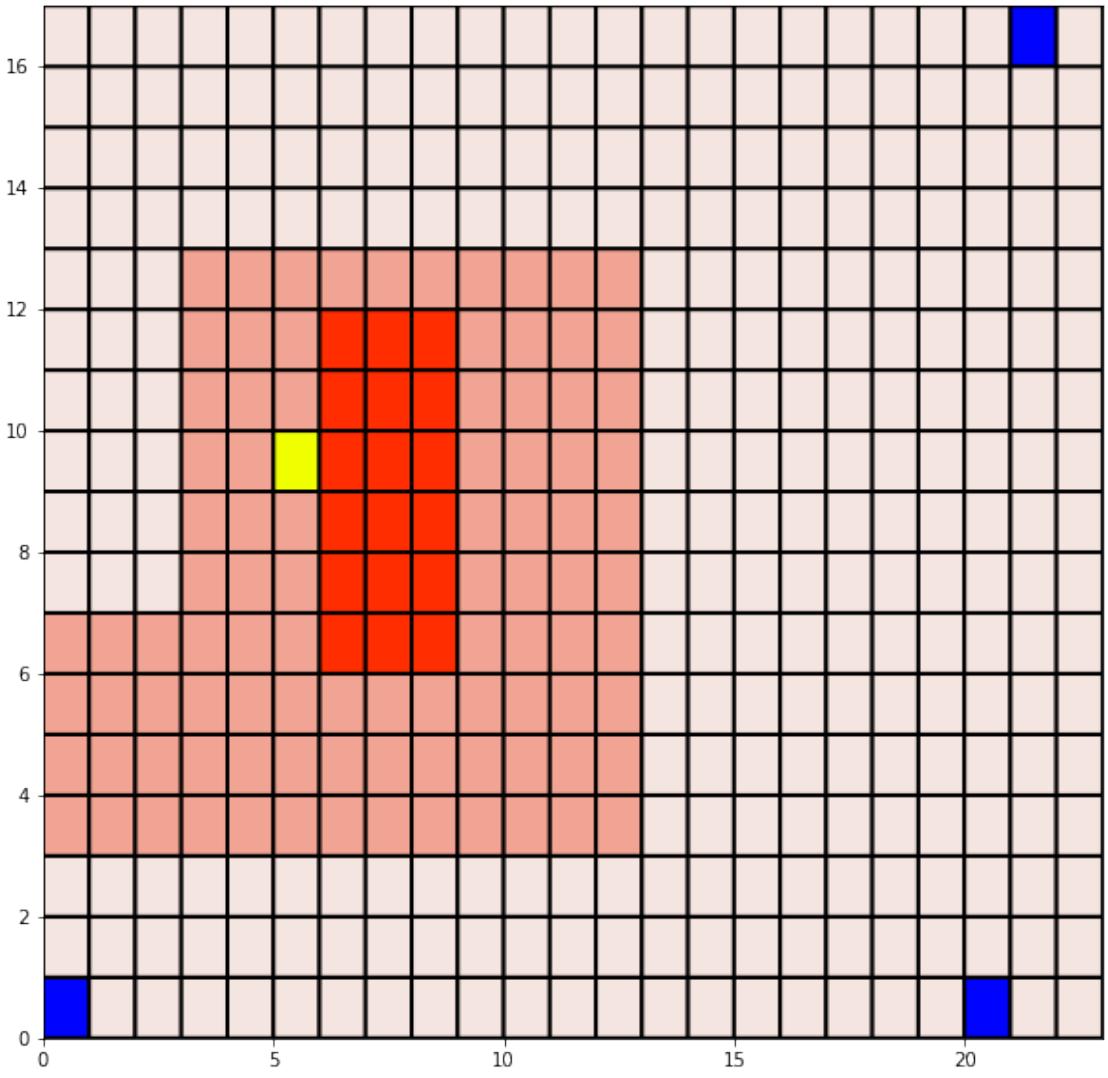

```
100%|| 10000/10000 [01:37<00:00, 102.43it/s]
```

1.2.2 Visualizing the policy

Now let's see the agent in action. Run the below cell (as many times) to render the policy;

[ ]:
```
from time import sleep

state = env.reset()
done = False
steps = 0
tot_reward = 0
```

```
while not done:
    clear_output(wait=True)
    state, reward, done = env.step(Q[state[0], state[1]].argmax())
    plt.figure(figsize=(10, 10))
    env.render(ax=plt, render_agent=True)
    plt.show()
    steps += 1
    tot_reward += reward
    sleep(0.2)
print("Steps: %d, Total Reward: %d"%(steps, tot_reward))
```




```
Steps: 25, Total Reward: 94
```

1.2.3 Analyzing performance of the policy

We use two metrics to analyze the policies:

1. Average steps to reach the goal
2. Total rewards from the episode

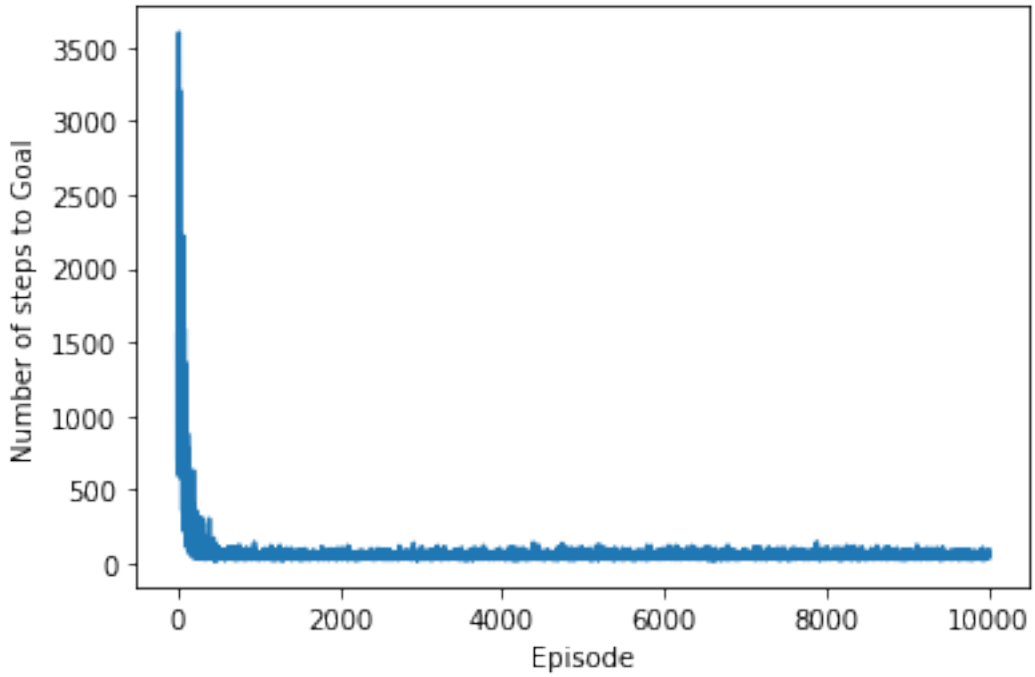
To ensure, we account for randomness in environment and algorithm (say when using epsilon-greedy exploration), we run the algorithm for multiple times and use the average of values over all runs.

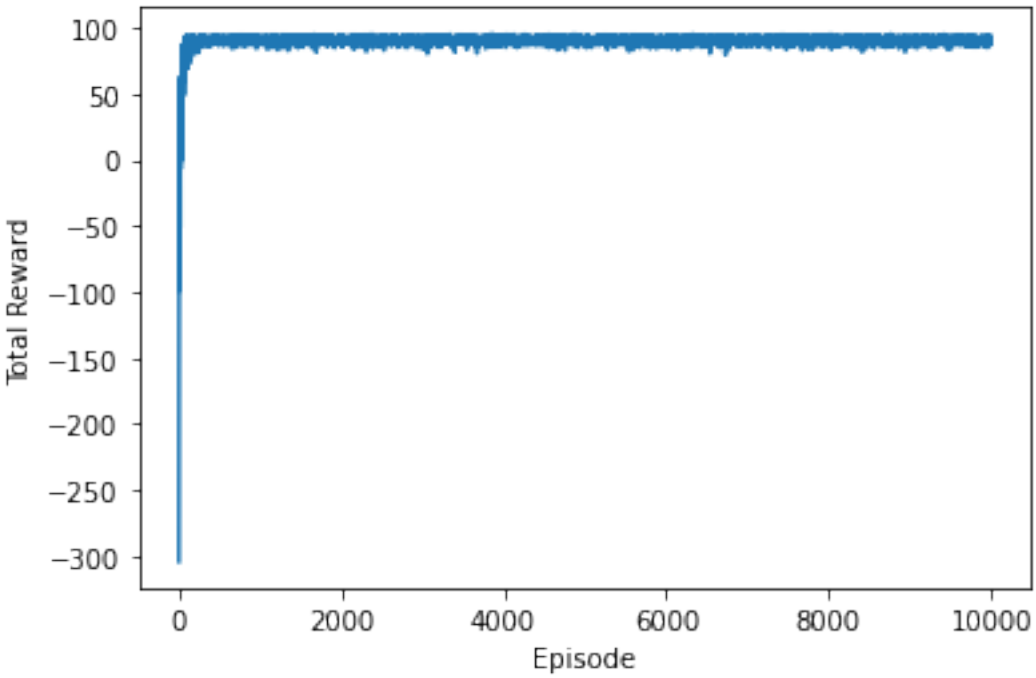
[ ]:
```
Q_avgs, reward_avgs, steps_avgs = [], [], []
num_expts = 5

for i in range(num_expts):
    print("Experiment: %d"%(i+1))
    Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))
    rg = np.random.RandomState(i)
    Q, rewards, steps = sarsa(env, Q)
    Q_avgs.append(Q.copy())
    reward_avgs.append(rewards)
    steps_avgs.append(steps)
```

```
Experiment: 1

100%|| 10000/10000 [00:42<00:00, 234.40it/s]

Experiment: 2

100%|| 10000/10000 [00:53<00:00, 187.23it/s]

Experiment: 3

100%|| 10000/10000 [01:07<00:00, 147.33it/s]

Experiment: 4

100%|| 10000/10000 [01:45<00:00, 94.98it/s]

Experiment: 5

100%|| 10000/10000 [01:12<00:00, 137.73it/s]
```

[ ]:
```
plt.xlabel('Episode')
plt.ylabel('Number of steps to Goal')
plt.plot(np.arange(episodes),np.average(steps_avgs, 0))
plt.show()
plt.xlabel('Episode')
plt.ylabel('Total Reward')
plt.plot(np.arange(episodes),np.average(reward_avgs, 0))
```

```
plt.show()
```


Number of steps to Goal
3500
3000
2500
2000
1500
1000
500
0
0
2000
4000
6000
8000
10000
Episode


Total Reward
100
50
0
−50
−100
−150
−200
−250
−300
0
2000
4000
6000
8000
10000
Episode

1.3 Q-Learning

Now, implement the Q-Learning algorithm as an exercise.

Recall the update rule for Q-Learning:

$$Q(s_t, a_t) \leftarrow Q(s_t, a_t) + \alpha[r_t + \gamma \max_a Q(s_{t+1}, a) - Q(s_t, a_t)] \tag{2}$$

Visualize and compare results with SARSA.

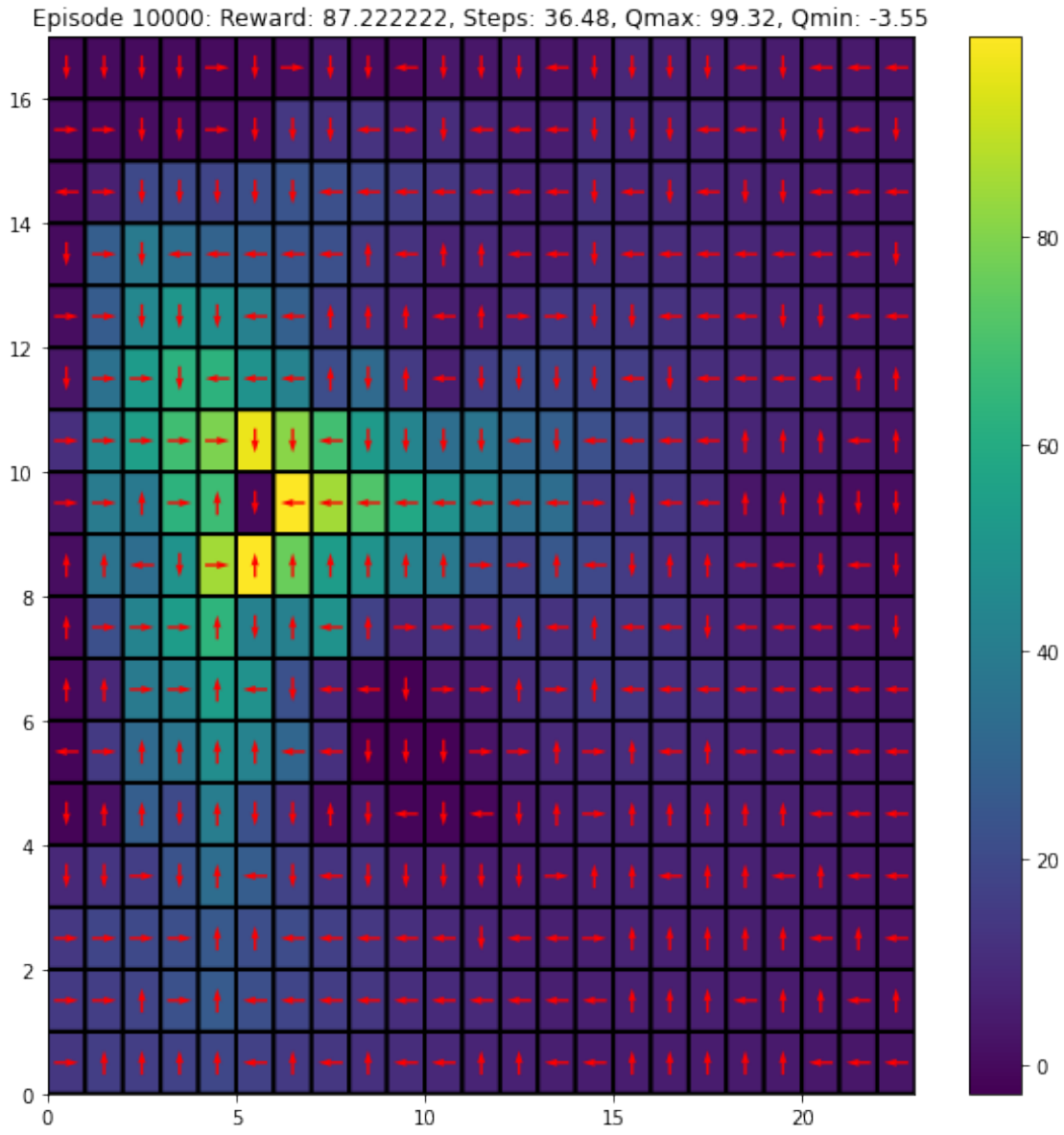
[ ]:
```
# initialize Q-value
Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))

alpha0 = 0.4
gamma = 0.9
episodes = 10000
epsilon0 = 0.1
```

Implementing Q Learning

[ ]:
```
print_freq = 100

def q_learning(env, Q, gamma = 0.9, plot_heat = False, choose_action =␣
 ↪choose_action_softmax):

    episode_rewards = np.zeros(episodes)
    steps_to_completion = np.zeros(episodes)
    if plot_heat:
        clear_output(wait=True)
        plot_Q(Q)
    epsilon = epsilon0
    alpha = alpha0
    for ep in tqdm(range(episodes)):
        tot_reward, steps = 0, 0

        # Reset environment
        state = env.reset()
        #action = choose_action(Q, state)
        done = False
        while not done:
            action = choose_action(Q, state)
            state_next, reward, done = env.step(action)
            #action_next = choose_action(Q, state_next)
            action_next = np.argmax(Q[state_next[0], state_next[1]])
            # update equation
            Q[state[0], state[1], action] += alpha*(reward +␣
 ↪gamma*Q[state_next[0], state_next[1], action_next] - Q[state[0], state[1],␣
 ↪action])

            tot_reward += reward
            steps += 1
```

```
            state, action = state_next, action_next

        episode_rewards[ep] = tot_reward
        steps_to_completion[ep] = steps

        if (ep+1)%print_freq == 0 and plot_heat:
            clear_output(wait=True)
            plot_Q(Q, message = "Episode %d: Reward: %f, Steps: %.2f, Qmax: %.
↪2f, Qmin: %.2f"%(ep+1, np.mean(episode_rewards[ep-print_freq+1:ep]),
                                                                        np.
↪mean(steps_to_completion[ep-print_freq+1:ep]),
                                                                        Q.
↪max(), Q.min()))

    return Q, episode_rewards, steps_to_completion
```

[ ]:
```
Q, rewards, steps = q_learning(env, Q, gamma = gamma, plot_heat=True,␣
↪choose_action= choose_action_softmax)
```

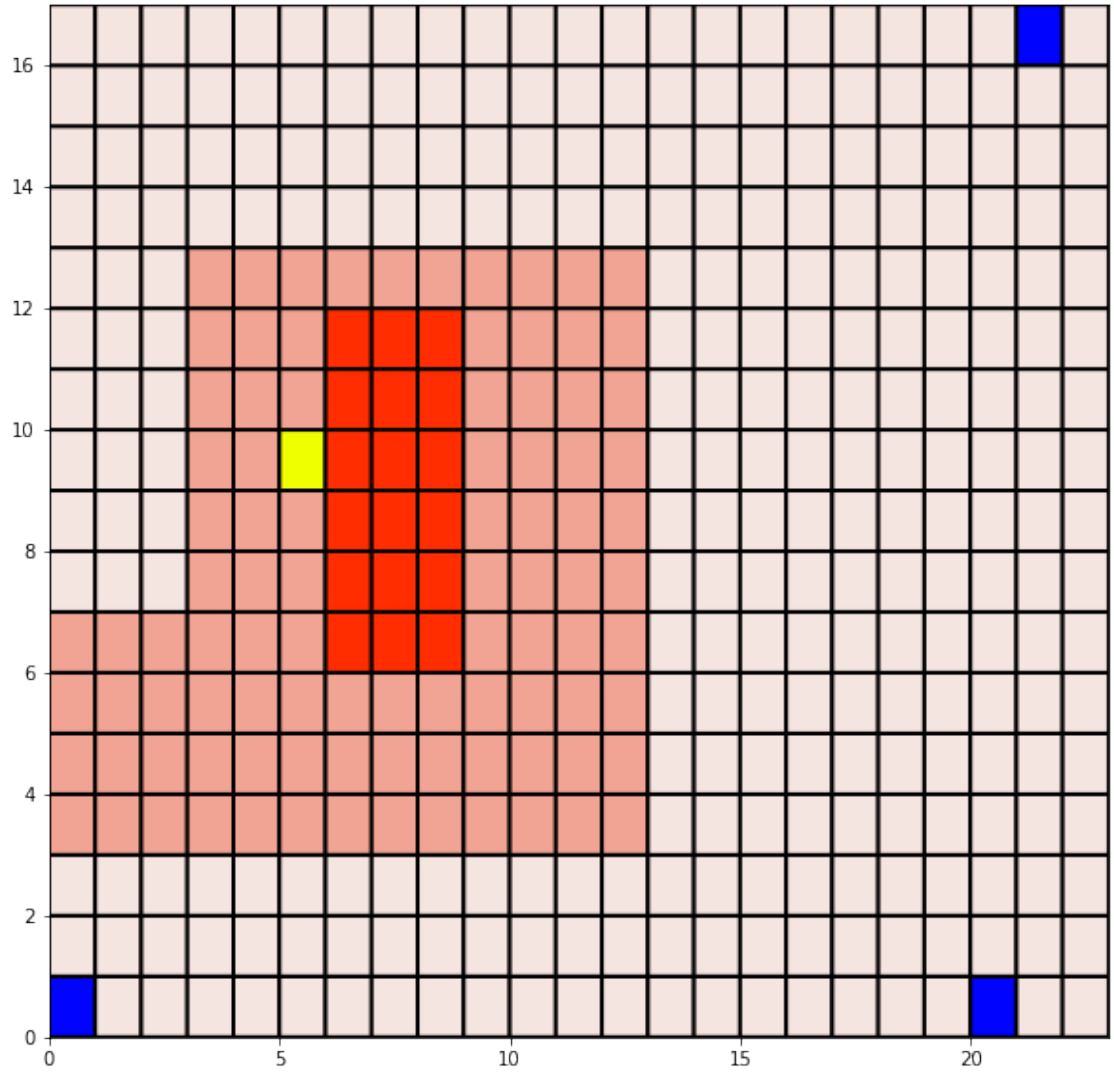



```
100%|| 10000/10000 [02:04<00:00, 80.46it/s]
```

1.3.1 Visualizing Q learning

[ ]:
```
from time import sleep

state = env.reset()
done = False
steps = 0
tot_reward = 0
while not done:
```

```
    clear_output(wait=True)
    state, reward, done = env.step(Q[state[0], state[1]].argmax())
    plt.figure(figsize=(10, 10))
    env.render(ax=plt, render_agent=True)
    plt.show()
    steps += 1
    tot_reward += reward
    sleep(0.2)
print("Steps: %d, Total Reward: %d"%(steps, tot_reward))
```



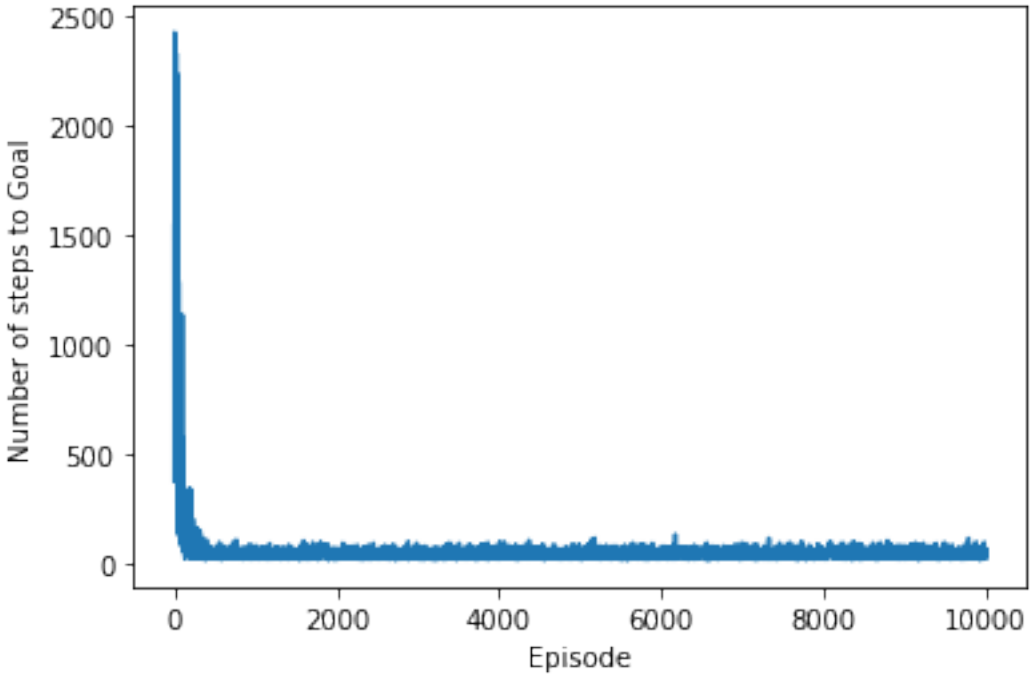

```
Steps: 28, Total Reward: 89
```

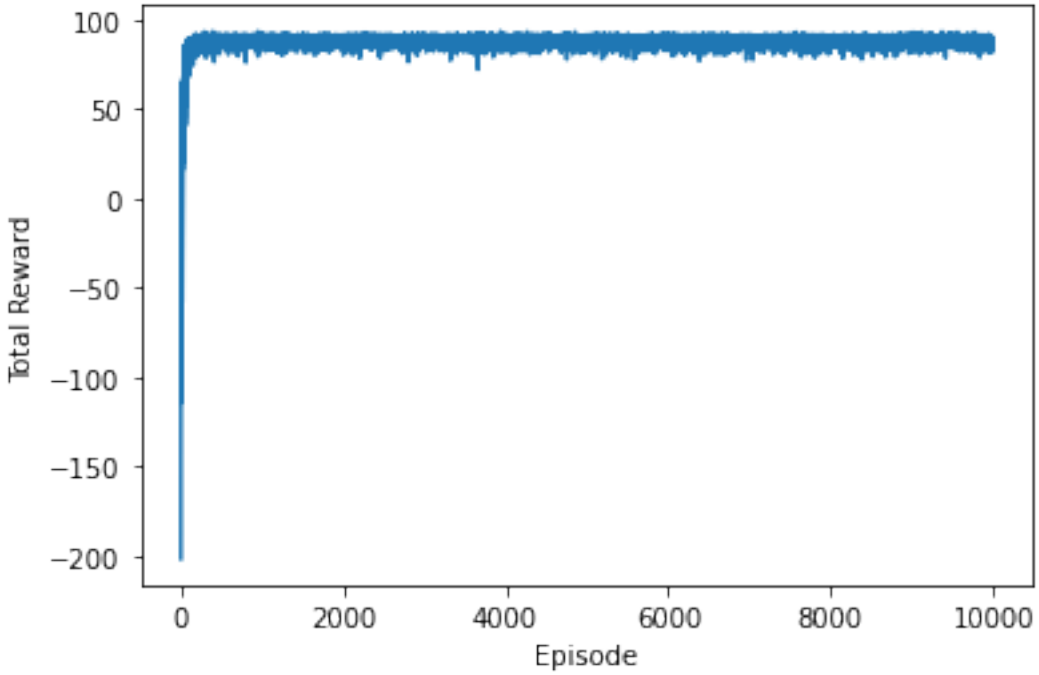
1.3.2 Analyzing performance of the policy

[ ]:
```
Q_avgs, reward_avgs, steps_avgs = [], [], []
num_expts = 5

for i in range(num_expts):
    print("Experiment: %d"%(i+1))
    Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))
    rg = np.random.RandomState(i)
    Q, rewards, steps = q_learning(env, Q)
    Q_avgs.append(Q.copy())
    reward_avgs.append(rewards)
    steps_avgs.append(steps)
```

```
Experiment: 1

100%|| 10000/10000 [01:17<00:00, 129.00it/s]

Experiment: 2

100%|| 10000/10000 [01:35<00:00, 105.21it/s]

Experiment: 3

100%|| 10000/10000 [01:51<00:00, 90.02it/s]

Experiment: 4

100%|| 10000/10000 [01:25<00:00, 116.54it/s]

Experiment: 5

100%|| 10000/10000 [00:54<00:00, 185.16it/s]
```

[ ]:
```
plt.xlabel('Episode')
plt.ylabel('Number of steps to Goal')
plt.plot(np.arange(episodes),np.average(steps_avgs, 0))
plt.show()
plt.xlabel('Episode')
plt.ylabel('Total Reward')
plt.plot(np.arange(episodes),np.average(reward_avgs, 0))
plt.show()
```


Number of steps to Goal
2500
2000
1500
1000
500
0
0
2000
4000
6000
8000
10000
Episode


Total Reward
100
50
0
−50
−100
−150
−200
0
2000
4000
6000
8000
10000
Episode

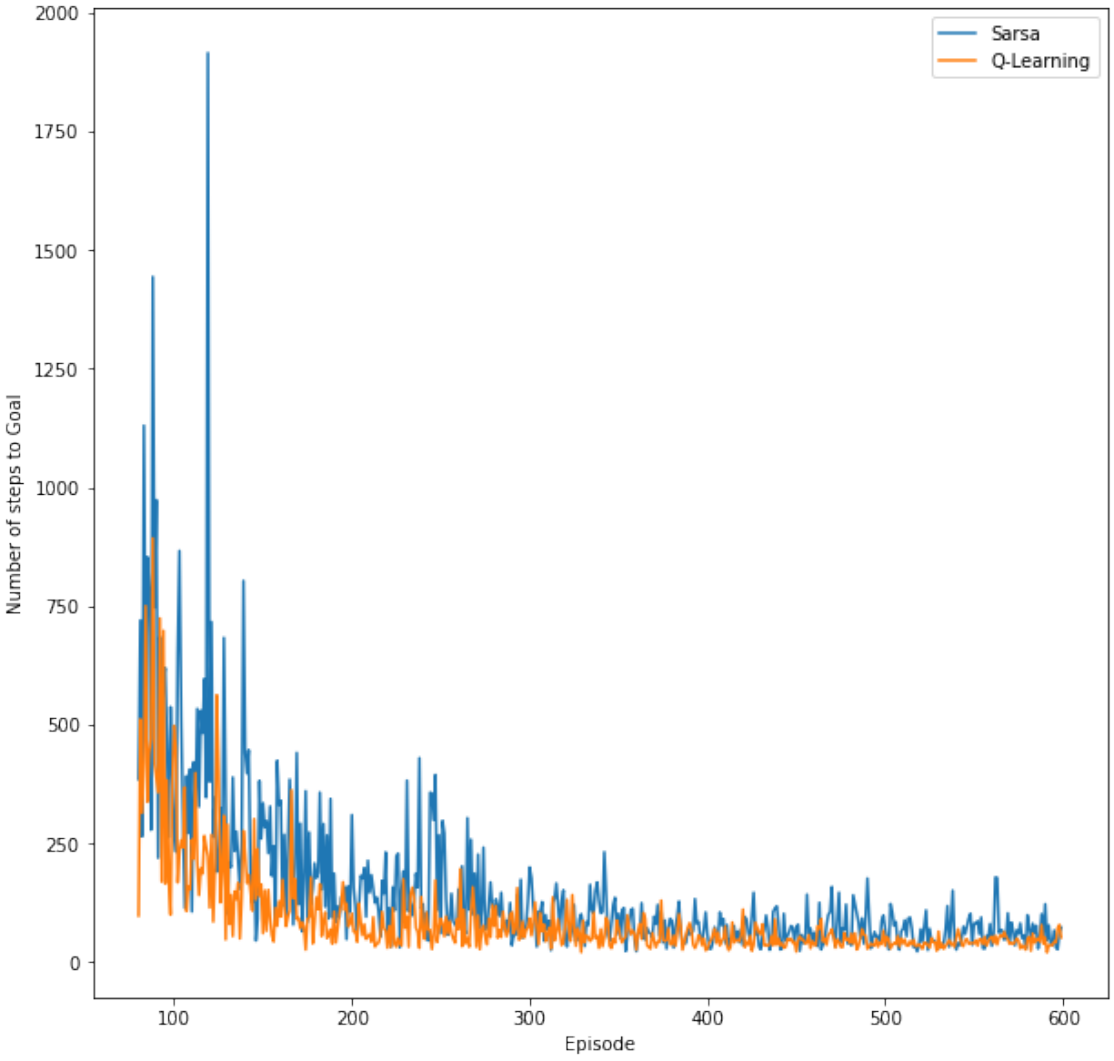
1.3.3 q_learning vs SARSA

[ ]:
```
# sarsa
Q_avgs_sarsa, reward_avgs_sarsa, steps_avgs_sarsa = [], [], []
num_expts = 5

for i in range(num_expts):
    print("Experiment: %d"%(i+1))
    Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))
    rg = np.random.RandomState(i)
    Q, rewards, steps = sarsa(env, Q)
    Q_avgs_sarsa.append(Q.copy())
    reward_avgs_sarsa.append(rewards)
    steps_avgs_sarsa.append(steps)


# Q learning

Q_avgs_q, reward_avgs_q, steps_avgs_q = [], [], []
num_expts = 5

for i in range(num_expts):
    print("Experiment: %d"%(i+1))
    Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))
    rg = np.random.RandomState(i)
    Q, rewards, steps = q_learning(env, Q)
    Q_avgs_q.append(Q.copy())
    reward_avgs_q.append(rewards)
    steps_avgs_q.append(steps)
```

```
Experiment: 1

100%|| 10000/10000 [01:05<00:00, 152.92it/s]

Experiment: 2

100%|| 10000/10000 [01:17<00:00, 128.83it/s]

Experiment: 3

100%|| 10000/10000 [01:02<00:00, 160.93it/s]

Experiment: 4

100%|| 10000/10000 [01:01<00:00, 161.81it/s]

Experiment: 5

100%|| 10000/10000 [01:01<00:00, 161.37it/s]
```

```
Experiment: 1

100%|| 10000/10000 [01:12<00:00, 138.04it/s]

Experiment: 2

100%|| 10000/10000 [02:08<00:00, 77.97it/s]

Experiment: 3

100%|| 10000/10000 [01:45<00:00, 95.18it/s]

Experiment: 4

100%|| 10000/10000 [01:36<00:00, 103.47it/s]

Experiment: 5

100%|| 10000/10000 [01:02<00:00, 160.51it/s]
```

[ ]:
```
# inititial episodes
start_epi = 80
end_epi = 600

plt.xlabel('Episode')
plt.ylabel('Number of steps to Goal')

plt.plot(np.arange(episodes)[start_epi:end_epi] ,np.average(steps_avgs_sarsa,␣
 ↪0)[start_epi:end_epi] , label = "Sarsa")
plt.plot(np.arange(episodes)[start_epi:end_epi],np.average(steps_avgs_q,␣
 ↪0)[start_epi:end_epi] , label = "Q-Learning")
plt.legend()

fig = plt.gcf()
fig.set_size_inches(10, 10)
plt.show()
```

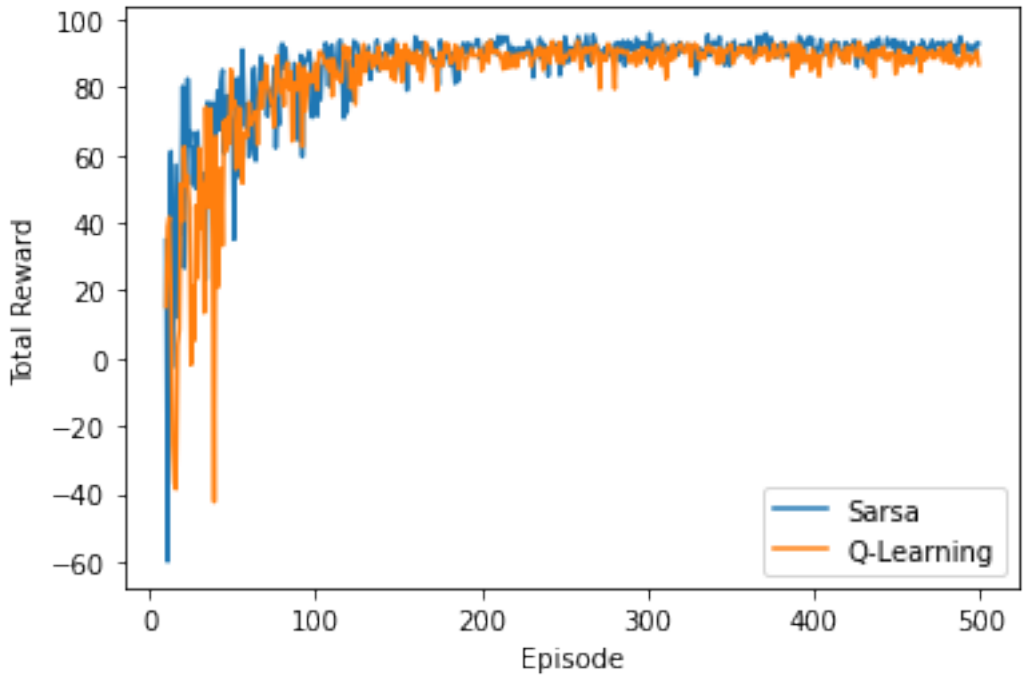


From the above figure it is clear that Q-learning converges faster than SARSA. Observe that the orange curve is below the blue curve in the figure for the most of the time.

Orange curve (Q learning) stabilized faster than the blue curve(SARSA)

[ ]:
```
# inititial episodes
start_epi = 10
end_epi = 500

plt.xlabel('Episode')
plt.ylabel('Total Reward')
plt.plot(np.arange(episodes)[start_epi:end_epi],np.average(reward_avgs_sarsa,␣
↪0)[start_epi:end_epi] , label = "Sarsa")
plt.plot(np.arange(episodes)[start_epi:end_epi],np.average(reward_avgs_q,␣
↪0)[start_epi:end_epi] , label = "Q-Learning")
plt.legend()
```

```
# fig = plt.gcf()
# fig.set_size_inches(10, 10)

plt.show()
```



Not a lot of difference can be obseved in the figure.
But intrestingly the blue curve is a little higher than the orange curve.

1.4 Code for converting to pdf file (IGNORE)

[1]:
```
!sudo apt-get install texlive-xetex texlive-fonts-recommended␣
↪texlive-plain-generic
```

```
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  cuda-command-line-tools-10-0 cuda-command-line-tools-10-1
  cuda-command-line-tools-11-0 cuda-compiler-10-0 cuda-compiler-10-1
  cuda-compiler-11-0 cuda-cuobjdump-10-0 cuda-cuobjdump-10-1
  cuda-cuobjdump-11-0 cuda-cupti-10-0 cuda-cupti-10-1 cuda-cupti-11-0
  cuda-cupti-dev-11-0 cuda-documentation-10-0 cuda-documentation-10-1
  cuda-documentation-11-0 cuda-documentation-11-1 cuda-gdb-10-0 cuda-gdb-10-1
  cuda-gdb-11-0 cuda-gpu-library-advisor-10-0 cuda-gpu-library-advisor-10-1
```

```
  cuda-libraries-10-0 cuda-libraries-10-1 cuda-libraries-11-0
  cuda-memcheck-10-0 cuda-memcheck-10-1 cuda-memcheck-11-0 cuda-nsight-10-0
  cuda-nsight-10-1 cuda-nsight-11-0 cuda-nsight-11-1 cuda-nsight-compute-10-0
  cuda-nsight-compute-10-1 cuda-nsight-compute-11-0 cuda-nsight-compute-11-1
  cuda-nsight-systems-10-1 cuda-nsight-systems-11-0 cuda-nsight-systems-11-1
  cuda-nvcc-10-0 cuda-nvcc-10-1 cuda-nvcc-11-0 cuda-nvdisasm-10-0
  cuda-nvdisasm-10-1 cuda-nvdisasm-11-0 cuda-nvml-dev-10-0 cuda-nvml-dev-10-1
  cuda-nvml-dev-11-0 cuda-nvprof-10-0 cuda-nvprof-10-1 cuda-nvprof-11-0
  cuda-nvprune-10-0 cuda-nvprune-10-1 cuda-nvprune-11-0 cuda-nvtx-10-0
  cuda-nvtx-10-1 cuda-nvtx-11-0 cuda-nvvp-10-0 cuda-nvvp-10-1 cuda-nvvp-11-0
  cuda-nvvp-11-1 cuda-samples-10-0 cuda-samples-10-1 cuda-samples-11-0
  cuda-samples-11-1 cuda-sanitizer-11-0 cuda-sanitizer-api-10-1
  cuda-toolkit-10-0 cuda-toolkit-10-1 cuda-toolkit-11-0 cuda-toolkit-11-1
  cuda-tools-10-0 cuda-tools-10-1 cuda-tools-11-0 cuda-tools-11-1
  cuda-visual-tools-10-0 cuda-visual-tools-10-1 cuda-visual-tools-11-0
  cuda-visual-tools-11-1 default-jre dkms freeglut3 freeglut3-dev
  keyboard-configuration libargon2-0 libcap2 libcryptsetup12
  libdevmapper1.02.1 libfontenc1 libip4tc0 libjansson4 libnvidia-cfg1-510
  libnvidia-common-460 libnvidia-common-510 libnvidia-extra-510
  libnvidia-fbc1-510 libnvidia-gl-510 libpam-systemd libpolkit-agent-1-0
  libpolkit-backend-1-0 libpolkit-gobject-1-0 libxfont2 libxi-dev libxkbfile1
  libxmu-dev libxmu-headers libxnvctrl0 libxtst6 nsight-compute-2020.2.1
  nsight-compute-2022.1.0 nsight-systems-2020.3.2 nsight-systems-2020.3.4
  nsight-systems-2021.5.2 nvidia-dkms-510 nvidia-kernel-common-510
  nvidia-kernel-source-510 nvidia-modprobe nvidia-settings openjdk-11-jre
  policykit-1 policykit-1-gnome python3-xkit screen-resolution-extra systemd
  systemd-sysv udev x11-xkb-utils xserver-common xserver-xorg-core-hwe-18.04
  xserver-xorg-video-nvidia-510
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono fonts-texgyre
  javascript-common libcupsfilters1 libcupsimage2 libgs9 libgs9-common
  libijs-0.35 libjbig2dec0 libjs-jquery libkpathsea6 libpotrace0 libptexenc1
  libruby2.5 libsynctex1 libtexlua52 libtexluajit2 libzzip-0-13 lmodern
  poppler-data preview-latex-style rake ruby ruby-did-you-mean ruby-minitest
  ruby-net-telnet ruby-power-assert ruby-test-unit ruby2.5
  rubygems-integration t1utils tex-common tex-gyre texlive-base
  texlive-binaries texlive-latex-base texlive-latex-extra
  texlive-latex-recommended texlive-pictures tipa
Suggested packages:
  fonts-noto apache2 | lighttpd | httpd poppler-utils ghostscript
  fonts-japanese-mincho | fonts-ipafont-mincho fonts-japanese-gothic
  | fonts-ipafont-gothic fonts-arphic-ukai fonts-arphic-uming fonts-nanum ri
  ruby-dev bundler debhelper gv | postscript-viewer perl-tk xpdf-reader
  | pdf-viewer texlive-fonts-recommended-doc texlive-latex-base-doc
  python-pygments icc-profiles libfile-which-perl
  libspreadsheet-parseexcel-perl texlive-latex-extra-doc
  texlive-latex-recommended-doc texlive-pstricks dot2tex prerex ruby-tcltk
```

```
  | libtcltk-ruby texlive-pictures-doc vprerex
The following NEW packages will be installed:
  fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono fonts-texgyre
  javascript-common libcupsfilters1 libcupsimage2 libgs9 libgs9-common
  libijs-0.35 libjbig2dec0 libjs-jquery libkpathsea6 libpotrace0 libptexenc1
  libruby2.5 libsynctex1 libtexlua52 libtexluajit2 libzzip-0-13 lmodern
  poppler-data preview-latex-style rake ruby ruby-did-you-mean ruby-minitest
  ruby-net-telnet ruby-power-assert ruby-test-unit ruby2.5
  rubygems-integration t1utils tex-common tex-gyre texlive-base
  texlive-binaries texlive-fonts-recommended texlive-latex-base
  texlive-latex-extra texlive-latex-recommended texlive-pictures
  texlive-plain-generic texlive-xetex tipa
0 upgraded, 46 newly installed, 0 to remove and 39 not upgraded.
Need to get 146 MB of archives.
After this operation, 460 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu bionic/main amd64 fonts-droid-fallback
all 1:6.0.1r16-1.1 [1,805 kB]
Get:2 http://archive.ubuntu.com/ubuntu bionic/main amd64 fonts-lato all 2.0-2
[2,698 kB]
Get:3 http://archive.ubuntu.com/ubuntu bionic/main amd64 poppler-data all
0.4.8-2 [1,479 kB]
Get:4 http://archive.ubuntu.com/ubuntu bionic/main amd64 tex-common all 6.09
[33.0 kB]
Get:5 http://archive.ubuntu.com/ubuntu bionic/main amd64 fonts-lmodern all
2.004.5-3 [4,551 kB]
Get:6 http://archive.ubuntu.com/ubuntu bionic/main amd64 fonts-noto-mono all
20171026-2 [75.5 kB]
Get:7 http://archive.ubuntu.com/ubuntu bionic/universe amd64 fonts-texgyre all
20160520-1 [8,761 kB]
Get:8 http://archive.ubuntu.com/ubuntu bionic/main amd64 javascript-common all
11 [6,066 B]
Get:9 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libcupsfilters1
amd64 1.20.2-0ubuntu3.1 [108 kB]
Get:10 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libcupsimage2
amd64 2.2.7-1ubuntu2.8 [18.6 kB]
Get:11 http://archive.ubuntu.com/ubuntu bionic/main amd64 libijs-0.35 amd64
0.35-13 [15.5 kB]
Get:12 http://archive.ubuntu.com/ubuntu bionic/main amd64 libjbig2dec0 amd64
0.13-6 [55.9 kB]
Get:13 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libgs9-common
all 9.26~dfsg+0-0ubuntu0.18.04.15 [5,092 kB]
Get:14 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libgs9 amd64
9.26~dfsg+0-0ubuntu0.18.04.15 [2,265 kB]
Get:15 http://archive.ubuntu.com/ubuntu bionic/main amd64 libjs-jquery all
3.2.1-1 [152 kB]
Get:16 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libkpathsea6
amd64 2017.20170613.44572-8ubuntu0.1 [54.9 kB]
Get:17 http://archive.ubuntu.com/ubuntu bionic/main amd64 libpotrace0 amd64
```

```
1.14-2 [17.4 kB]
Get:18 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libptexenc1
amd64 2017.20170613.44572-8ubuntu0.1 [34.5 kB]
Get:19 http://archive.ubuntu.com/ubuntu bionic/main amd64 rubygems-integration
all 1.11 [4,994 B]
Get:20 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 ruby2.5 amd64
2.5.1-1ubuntu1.11 [48.6 kB]
Get:21 http://archive.ubuntu.com/ubuntu bionic/main amd64 ruby amd64 1:2.5.1
[5,712 B]
Get:22 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 rake all
12.3.1-1ubuntu0.1 [44.9 kB]
Get:23 http://archive.ubuntu.com/ubuntu bionic/main amd64 ruby-did-you-mean all
1.2.0-2 [9,700 B]
Get:24 http://archive.ubuntu.com/ubuntu bionic/main amd64 ruby-minitest all
5.10.3-1 [38.6 kB]
Get:25 http://archive.ubuntu.com/ubuntu bionic/main amd64 ruby-net-telnet all
0.1.1-2 [12.6 kB]
Get:26 http://archive.ubuntu.com/ubuntu bionic/main amd64 ruby-power-assert all
0.3.0-1 [7,952 B]
Get:27 http://archive.ubuntu.com/ubuntu bionic/main amd64 ruby-test-unit all
3.2.5-1 [61.1 kB]
Get:28 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libruby2.5
amd64 2.5.1-1ubuntu1.11 [3,072 kB]
Get:29 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libsynctex1
amd64 2017.20170613.44572-8ubuntu0.1 [41.4 kB]
Get:30 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libtexlua52
amd64 2017.20170613.44572-8ubuntu0.1 [91.2 kB]
Get:31 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libtexluajit2
amd64 2017.20170613.44572-8ubuntu0.1 [230 kB]
Get:32 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 libzzip-0-13
amd64 0.13.62-3.1ubuntu0.18.04.1 [26.0 kB]
Get:33 http://archive.ubuntu.com/ubuntu bionic/main amd64 lmodern all 2.004.5-3
[9,631 kB]
Get:34 http://archive.ubuntu.com/ubuntu bionic/main amd64 preview-latex-style
all 11.91-1ubuntu1 [185 kB]
Get:35 http://archive.ubuntu.com/ubuntu bionic/main amd64 t1utils amd64 1.41-2
[56.0 kB]
Get:36 http://archive.ubuntu.com/ubuntu bionic/universe amd64 tex-gyre all
20160520-1 [4,998 kB]
Get:37 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 texlive-
binaries amd64 2017.20170613.44572-8ubuntu0.1 [8,179 kB]
Get:38 http://archive.ubuntu.com/ubuntu bionic/main amd64 texlive-base all
2017.20180305-1 [18.7 MB]
Get:39 http://archive.ubuntu.com/ubuntu bionic/universe amd64 texlive-fonts-
recommended all 2017.20180305-1 [5,262 kB]
Get:40 http://archive.ubuntu.com/ubuntu bionic/main amd64 texlive-latex-base all
2017.20180305-1 [951 kB]
Get:41 http://archive.ubuntu.com/ubuntu bionic/main amd64 texlive-latex-
```

```
recommended all 2017.20180305-1 [14.9 MB]
Get:42 http://archive.ubuntu.com/ubuntu bionic/universe amd64 texlive-pictures
all 2017.20180305-1 [4,026 kB]
Get:43 http://archive.ubuntu.com/ubuntu bionic/universe amd64 texlive-latex-
extra all 2017.20180305-2 [10.6 MB]
Get:44 http://archive.ubuntu.com/ubuntu bionic/universe amd64 texlive-plain-
generic all 2017.20180305-2 [23.6 MB]
Get:45 http://archive.ubuntu.com/ubuntu bionic/universe amd64 tipa all 2:1.3-20
[2,978 kB]
Get:46 http://archive.ubuntu.com/ubuntu bionic/universe amd64 texlive-xetex all
2017.20180305-1 [10.7 MB]
Fetched 146 MB in 7s (20.2 MB/s)
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based
frontend cannot be used. at /usr/share/perl5/Debconf/FrontEnd/Dialog.pm line 76,
<> line 46.)
debconf: falling back to frontend: Readline
debconf: unable to initialize frontend: Readline
debconf: (This frontend requires a controlling tty.)
debconf: falling back to frontend: Teletype
dpkg-preconfigure: unable to re-open stdin:
Selecting previously unselected package fonts-droid-fallback.
(Reading database ... 155113 files and directories currently installed.)
Preparing to unpack .../00-fonts-droid-fallback_1%3a6.0.1r16-1.1_all.deb ...
Unpacking fonts-droid-fallback (1:6.0.1r16-1.1) ...
Selecting previously unselected package fonts-lato.
Preparing to unpack .../01-fonts-lato_2.0-2_all.deb ...
Unpacking fonts-lato (2.0-2) ...
Selecting previously unselected package poppler-data.
Preparing to unpack .../02-poppler-data_0.4.8-2_all.deb ...
Unpacking poppler-data (0.4.8-2) ...
Selecting previously unselected package tex-common.
Preparing to unpack .../03-tex-common_6.09_all.deb ...
Unpacking tex-common (6.09) ...
Selecting previously unselected package fonts-lmodern.
Preparing to unpack .../04-fonts-lmodern_2.004.5-3_all.deb ...
Unpacking fonts-lmodern (2.004.5-3) ...
Selecting previously unselected package fonts-noto-mono.
Preparing to unpack .../05-fonts-noto-mono_20171026-2_all.deb ...
Unpacking fonts-noto-mono (20171026-2) ...
Selecting previously unselected package fonts-texgyre.
Preparing to unpack .../06-fonts-texgyre_20160520-1_all.deb ...
Unpacking fonts-texgyre (20160520-1) ...
Selecting previously unselected package javascript-common.
Preparing to unpack .../07-javascript-common_11_all.deb ...
Unpacking javascript-common (11) ...
Selecting previously unselected package libcupsfilters1:amd64.
Preparing to unpack .../08-libcupsfilters1_1.20.2-0ubuntu3.1_amd64.deb ...
```

```
Unpacking libcupsfilters1:amd64 (1.20.2-0ubuntu3.1) ...
Selecting previously unselected package libcupsimage2:amd64.
Preparing to unpack .../09-libcupsimage2_2.2.7-1ubuntu2.8_amd64.deb ...
Unpacking libcupsimage2:amd64 (2.2.7-1ubuntu2.8) ...
Selecting previously unselected package libijs-0.35:amd64.
Preparing to unpack .../10-libijs-0.35_0.35-13_amd64.deb ...
Unpacking libijs-0.35:amd64 (0.35-13) ...
Selecting previously unselected package libjbig2dec0:amd64.
Preparing to unpack .../11-libjbig2dec0_0.13-6_amd64.deb ...
Unpacking libjbig2dec0:amd64 (0.13-6) ...
Selecting previously unselected package libgs9-common.
Preparing to unpack .../12-libgs9-common_9.26~dfsg+0-0ubuntu0.18.04.15_all.deb
...
Unpacking libgs9-common (9.26~dfsg+0-0ubuntu0.18.04.15) ...
Selecting previously unselected package libgs9:amd64.
Preparing to unpack .../13-libgs9_9.26~dfsg+0-0ubuntu0.18.04.15_amd64.deb ...
Unpacking libgs9:amd64 (9.26~dfsg+0-0ubuntu0.18.04.15) ...
Selecting previously unselected package libjs-jquery.
Preparing to unpack .../14-libjs-jquery_3.2.1-1_all.deb ...
Unpacking libjs-jquery (3.2.1-1) ...
Selecting previously unselected package libkpathsea6:amd64.
Preparing to unpack .../15-libkpathsea6_2017.20170613.44572-8ubuntu0.1_amd64.deb
...
Unpacking libkpathsea6:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Selecting previously unselected package libpotrace0.
Preparing to unpack .../16-libpotrace0_1.14-2_amd64.deb ...
Unpacking libpotrace0 (1.14-2) ...
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack .../17-libptexenc1_2017.20170613.44572-8ubuntu0.1_amd64.deb
...
Unpacking libptexenc1:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Selecting previously unselected package rubygems-integration.
Preparing to unpack .../18-rubygems-integration_1.11_all.deb ...
Unpacking rubygems-integration (1.11) ...
Selecting previously unselected package ruby2.5.
Preparing to unpack .../19-ruby2.5_2.5.1-1ubuntu1.11_amd64.deb ...
Unpacking ruby2.5 (2.5.1-1ubuntu1.11) ...
Selecting previously unselected package ruby.
Preparing to unpack .../20-ruby_1%3a2.5.1_amd64.deb ...
Unpacking ruby (1:2.5.1) ...
Selecting previously unselected package rake.
Preparing to unpack .../21-rake_12.3.1-1ubuntu0.1_all.deb ...
Unpacking rake (12.3.1-1ubuntu0.1) ...
Selecting previously unselected package ruby-did-you-mean.
Preparing to unpack .../22-ruby-did-you-mean_1.2.0-2_all.deb ...
Unpacking ruby-did-you-mean (1.2.0-2) ...
Selecting previously unselected package ruby-minitest.
Preparing to unpack .../23-ruby-minitest_5.10.3-1_all.deb ...
```

```
Unpacking ruby-minitest (5.10.3-1) ...
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack .../24-ruby-net-telnet_0.1.1-2_all.deb ...
Unpacking ruby-net-telnet (0.1.1-2) ...
Selecting previously unselected package ruby-power-assert.
Preparing to unpack .../25-ruby-power-assert_0.3.0-1_all.deb ...
Unpacking ruby-power-assert (0.3.0-1) ...
Selecting previously unselected package ruby-test-unit.
Preparing to unpack .../26-ruby-test-unit_3.2.5-1_all.deb ...
Unpacking ruby-test-unit (3.2.5-1) ...
Selecting previously unselected package libruby2.5:amd64.
Preparing to unpack .../27-libruby2.5_2.5.1-1ubuntu1.11_amd64.deb ...
Unpacking libruby2.5:amd64 (2.5.1-1ubuntu1.11) ...
Selecting previously unselected package libsynctex1:amd64.
Preparing to unpack .../28-libsynctex1_2017.20170613.44572-8ubuntu0.1_amd64.deb
...
Unpacking libsynctex1:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Selecting previously unselected package libtexlua52:amd64.
Preparing to unpack .../29-libtexlua52_2017.20170613.44572-8ubuntu0.1_amd64.deb
...
Unpacking libtexlua52:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Selecting previously unselected package libtexluajit2:amd64.
Preparing to unpack
.../30-libtexluajit2_2017.20170613.44572-8ubuntu0.1_amd64.deb ...
Unpacking libtexluajit2:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Selecting previously unselected package libzzip-0-13:amd64.
Preparing to unpack .../31-libzzip-0-13_0.13.62-3.1ubuntu0.18.04.1_amd64.deb ...
Unpacking libzzip-0-13:amd64 (0.13.62-3.1ubuntu0.18.04.1) ...
Selecting previously unselected package lmodern.
Preparing to unpack .../32-lmodern_2.004.5-3_all.deb ...
Unpacking lmodern (2.004.5-3) ...
Selecting previously unselected package preview-latex-style.
Preparing to unpack .../33-preview-latex-style_11.91-1ubuntu1_all.deb ...
Unpacking preview-latex-style (11.91-1ubuntu1) ...
Selecting previously unselected package t1utils.
Preparing to unpack .../34-t1utils_1.41-2_amd64.deb ...
Unpacking t1utils (1.41-2) ...
Selecting previously unselected package tex-gyre.
Preparing to unpack .../35-tex-gyre_20160520-1_all.deb ...
Unpacking tex-gyre (20160520-1) ...
Selecting previously unselected package texlive-binaries.
Preparing to unpack .../36-texlive-
binaries_2017.20170613.44572-8ubuntu0.1_amd64.deb ...
Unpacking texlive-binaries (2017.20170613.44572-8ubuntu0.1) ...
Selecting previously unselected package texlive-base.
Preparing to unpack .../37-texlive-base_2017.20180305-1_all.deb ...
Unpacking texlive-base (2017.20180305-1) ...
Selecting previously unselected package texlive-fonts-recommended.
```

```
Preparing to unpack .../38-texlive-fonts-recommended_2017.20180305-1_all.deb ...
Unpacking texlive-fonts-recommended (2017.20180305-1) ...
Selecting previously unselected package texlive-latex-base.
Preparing to unpack .../39-texlive-latex-base_2017.20180305-1_all.deb ...
Unpacking texlive-latex-base (2017.20180305-1) ...
Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack .../40-texlive-latex-recommended_2017.20180305-1_all.deb ...
Unpacking texlive-latex-recommended (2017.20180305-1) ...
Selecting previously unselected package texlive-pictures.
Preparing to unpack .../41-texlive-pictures_2017.20180305-1_all.deb ...
Unpacking texlive-pictures (2017.20180305-1) ...
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack .../42-texlive-latex-extra_2017.20180305-2_all.deb ...
Unpacking texlive-latex-extra (2017.20180305-2) ...
Selecting previously unselected package texlive-plain-generic.
Preparing to unpack .../43-texlive-plain-generic_2017.20180305-2_all.deb ...
Unpacking texlive-plain-generic (2017.20180305-2) ...
Selecting previously unselected package tipa.
Preparing to unpack .../44-tipa_2%3a1.3-20_all.deb ...
Unpacking tipa (2:1.3-20) ...
Selecting previously unselected package texlive-xetex.
Preparing to unpack .../45-texlive-xetex_2017.20180305-1_all.deb ...
Unpacking texlive-xetex (2017.20180305-1) ...
Setting up libgs9-common (9.26~dfsg+0-0ubuntu0.18.04.15) ...
Setting up libkpathsea6:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Setting up libjs-jquery (3.2.1-1) ...
Setting up libtexlua52:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Setting up fonts-droid-fallback (1:6.0.1r16-1.1) ...
Setting up libsynctex1:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Setting up libptexenc1:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Setting up tex-common (6.09) ...
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based
frontend cannot be used. at /usr/share/perl5/Debconf/FrontEnd/Dialog.pm line
76.)
debconf: falling back to frontend: Readline
update-language: texlive-base not installed and configured, doing nothing!
Setting up poppler-data (0.4.8-2) ...
Setting up tex-gyre (20160520-1) ...
Setting up preview-latex-style (11.91-1ubuntu1) ...
Setting up fonts-texgyre (20160520-1) ...
Setting up fonts-noto-mono (20171026-2) ...
Setting up fonts-lato (2.0-2) ...
Setting up libcupsfilters1:amd64 (1.20.2-0ubuntu3.1) ...
Setting up libcupsimage2:amd64 (2.2.7-1ubuntu2.8) ...
Setting up libjbig2dec0:amd64 (0.13-6) ...
Setting up ruby-did-you-mean (1.2.0-2) ...
Setting up t1utils (1.41-2) ...
```

```
Setting up ruby-net-telnet (0.1.1-2) ...
Setting up libijs-0.35:amd64 (0.35-13) ...
Setting up rubygems-integration (1.11) ...
Setting up libpotrace0 (1.14-2) ...
Setting up javascript-common (11) ...
Setting up ruby-minitest (5.10.3-1) ...
Setting up libzzip-0-13:amd64 (0.13.62-3.1ubuntu0.18.04.1) ...
Setting up libgs9:amd64 (9.26~dfsg+0-0ubuntu0.18.04.15) ...
Setting up libtexluajit2:amd64 (2017.20170613.44572-8ubuntu0.1) ...
Setting up fonts-lmodern (2.004.5-3) ...
Setting up ruby-power-assert (0.3.0-1) ...
Setting up texlive-binaries (2017.20170613.44572-8ubuntu0.1) ...
update-alternatives: using /usr/bin/xdvi-xaw to provide /usr/bin/xdvi.bin
(xdvi.bin) in auto mode
update-alternatives: using /usr/bin/bibtex.original to provide /usr/bin/bibtex
(bibtex) in auto mode
Setting up texlive-base (2017.20180305-1) ...
mktexlsr: Updating /var/lib/texmf/ls-R-TEXLIVEDIST...
mktexlsr: Updating /var/lib/texmf/ls-R-TEXMFMAIN...
mktexlsr: Updating /var/lib/texmf/ls-R...
mktexlsr: Done.
tl-paper: setting paper size for dvips to a4: /var/lib/texmf/dvips/config
/config-paper.ps
tl-paper: setting paper size for dvipdfmx to a4: /var/lib/texmf/dvipdfmx
/dvipdfmx-paper.cfg
tl-paper: setting paper size for xdvi to a4: /var/lib/texmf/xdvi/XDvi-paper
tl-paper: setting paper size for pdftex to a4:
/var/lib/texmf/tex/generic/config/pdftexconfig.tex
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based
frontend cannot be used. at /usr/share/perl5/Debconf/FrontEnd/Dialog.pm line
76.)
debconf: falling back to frontend: Readline
Setting up texlive-fonts-recommended (2017.20180305-1) ...
Setting up texlive-plain-generic (2017.20180305-2) ...
Setting up texlive-latex-base (2017.20180305-1) ...
Setting up lmodern (2.004.5-3) ...
Setting up texlive-latex-recommended (2017.20180305-1) ...
Setting up texlive-pictures (2017.20180305-1) ...
Setting up tipa (2:1.3-20) ...
Regenerating '/var/lib/texmf/fmtutil.cnf-DEBIAN'... done.
Regenerating '/var/lib/texmf/fmtutil.cnf-TEXLIVEDIST'... done.
update-fmtutil has updated the following file(s):
        /var/lib/texmf/fmtutil.cnf-DEBIAN
        /var/lib/texmf/fmtutil.cnf-TEXLIVEDIST
If you want to activate the changes in the above file(s),
you should run fmtutil-sys or fmtutil.
Setting up texlive-latex-extra (2017.20180305-2) ...
```

```
Setting up texlive-xetex (2017.20180305-1) ...
Setting up ruby2.5 (2.5.1-1ubuntu1.11) ...
Setting up ruby (1:2.5.1) ...
Setting up ruby-test-unit (3.2.5-1) ...
Setting up rake (12.3.1-1ubuntu0.1) ...
Setting up libruby2.5:amd64 (2.5.1-1ubuntu1.11) ...
Processing triggers for mime-support (3.60ubuntu1) ...
Processing triggers for libc-bin (2.27-3ubuntu1.3) ...
/sbin/ldconfig.real: /usr/local/lib/python3.7/dist-
packages/ideep4py/lib/libmkldnn.so.0 is not a symbolic link

Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
Processing triggers for fontconfig (2.12.6-0ubuntu2) ...
Processing triggers for tex-common (6.09) ...
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based
frontend cannot be used. at /usr/share/perl5/Debconf/FrontEnd/Dialog.pm line
76.)
debconf: falling back to frontend: Readline
Running updmap-sys. This may take some time... done.
Running mktexlsr /var/lib/texmf ... done.
Building format(s) --all.
        This may take some time... done.
```

[ ]:
```
!jupyter nbconvert --to pdf
```