In [2]:

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

In [3]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, c
all drive.mount("/content/drive", force_remount=True).
```

Problem Statement

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

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.

In [4]:

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

Let us construct a grid in a text file.

In [5]:

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

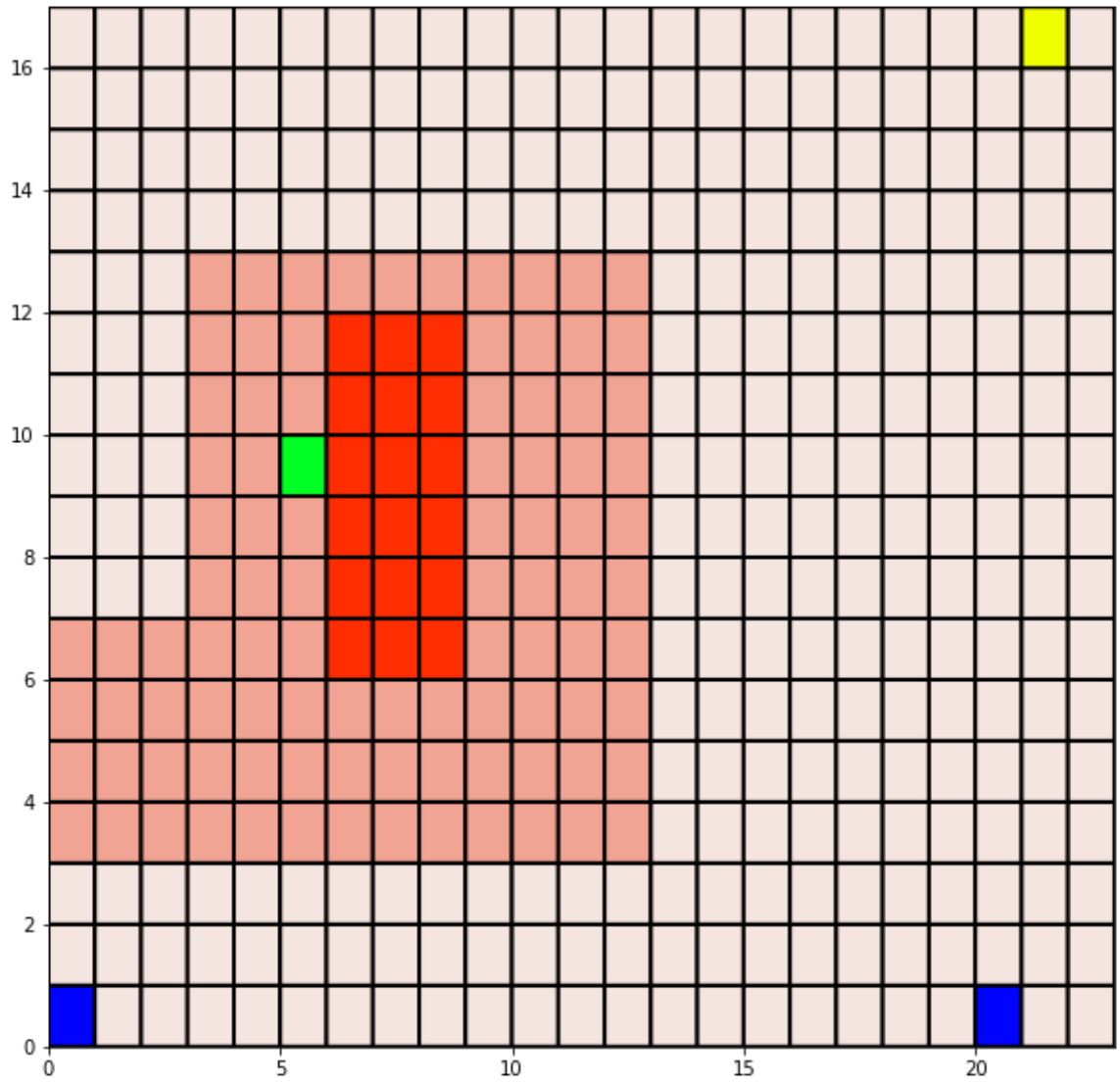
This is a 17×23 grid. The reward when an agent goes to a cell is negative of the value in that position in the text file (except if it is the goal cell). We will define the goal reward as 100. We will also fix the maximum episode length to 10000.

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.

In [6]:

```
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_stat
es=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)
```



Legend

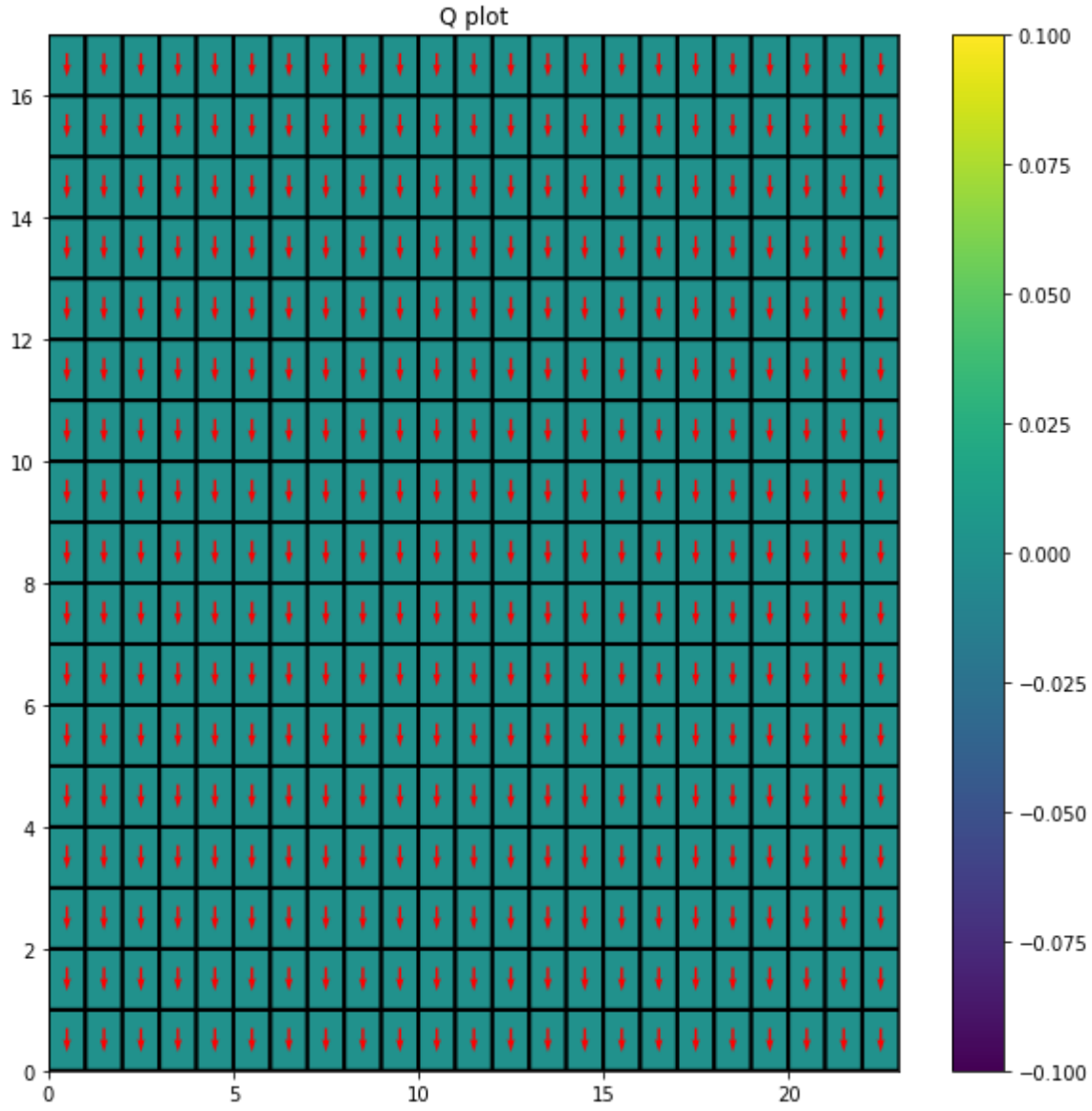
- *Blue* is the **start state**.
- *Green* is the **goal state**.
- *Yellow* is current **state of the agent**.
- *Redness* denotes the extent of **negative reward**.

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.

In [7]:

```
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
```



Out[7]:

```
(17, 23, 4)
```

Exploration strategies

1. Epsilon-greedy
2. Softmax

In [8]:

```
from scipy.special import softmax

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

# Epsilon greedy
def choose_action_epsilon(Q, state, epsilon, rg=rg):
    if rg.rand()<epsilon: # TODO: eps greedy condition
        return rg.randint(len(actions))# TODO: return random action
    else:
        return np.argmax(Q[state[0]][state[1]])# TODO: return best action

# Softmax
def choose_action_softmax(Q, state,tau=1, rg=rg):
    probs=softmax(Q[state[0]][state[1]]/tau)
    return actions.index(rg.choice(actions,p=probs))       # TODO: return random action
with selection probability
```

SARSA

Now we implement the SARSA algorithm.

Recall the update rule for SARSA:

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

Hyperparameters

So we have som hyperparameters for the algorithm:

- α
- number of *episodes*.
- ϵ: For epsilon greedy exploration

In [9]:

```
# 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
```

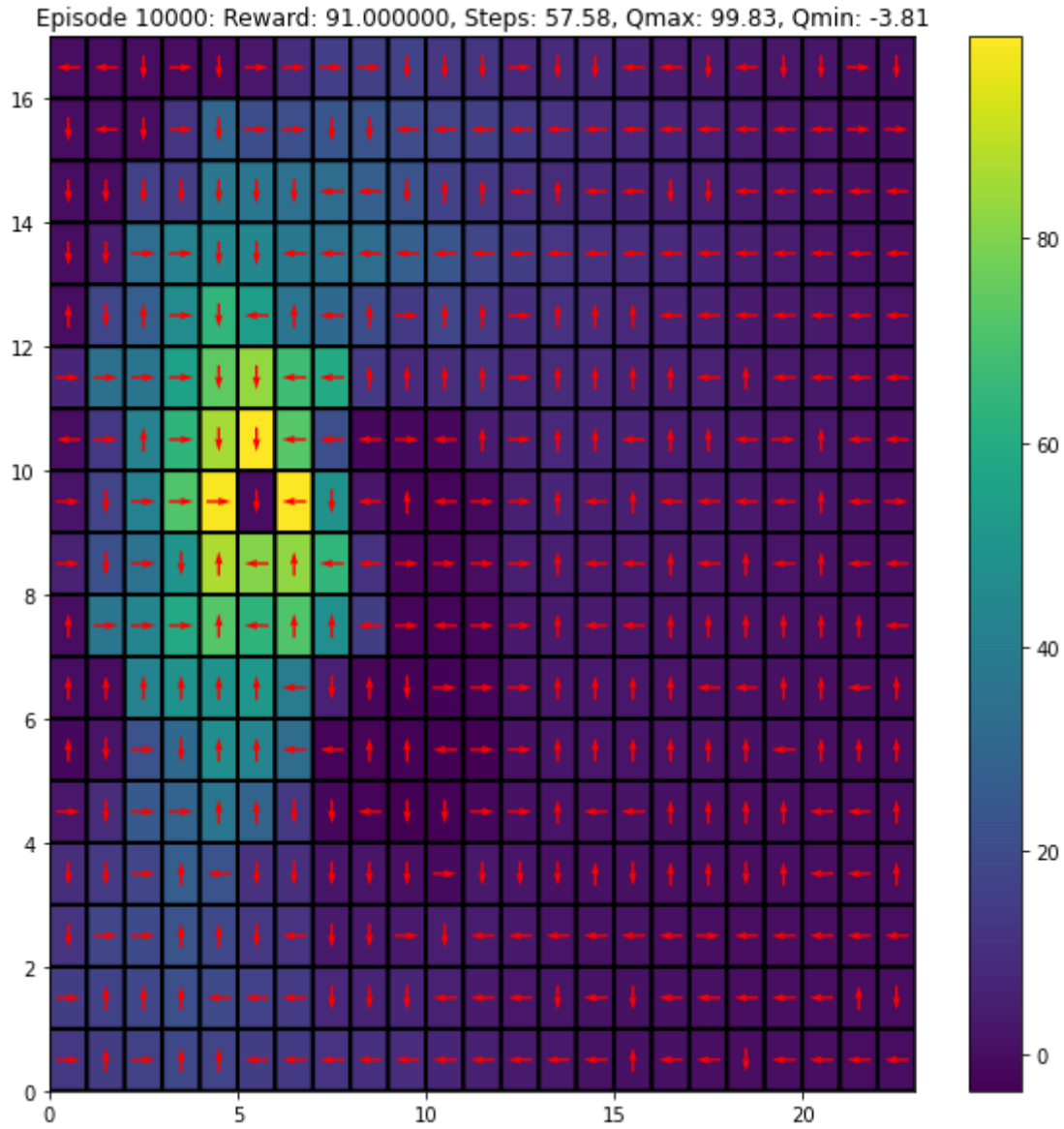
Let's implement SARSA

In [10]:

```
print_freq = 100

def sarsa(env, Q, gamma = 0.9, plot_heat = False, choose_action = choose_action_softma
x):

    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)

            # TODO: update equation
            Q[state[0]][state[1]][action]=Q[state[0]][state[1]][action]+alpha*(reward+g
amma*(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(step
s_to_completion[ep-print_freq+1:ep]),
                                                                        Q.max(), Q.m
in()))

    return Q, episode_rewards, steps_to_completion
```

In [11]:

```
Q, rewards, steps = sarsa(env, Q, gamma = gamma, plot_heat=True, choose_action= choose_
action_softmax)
```



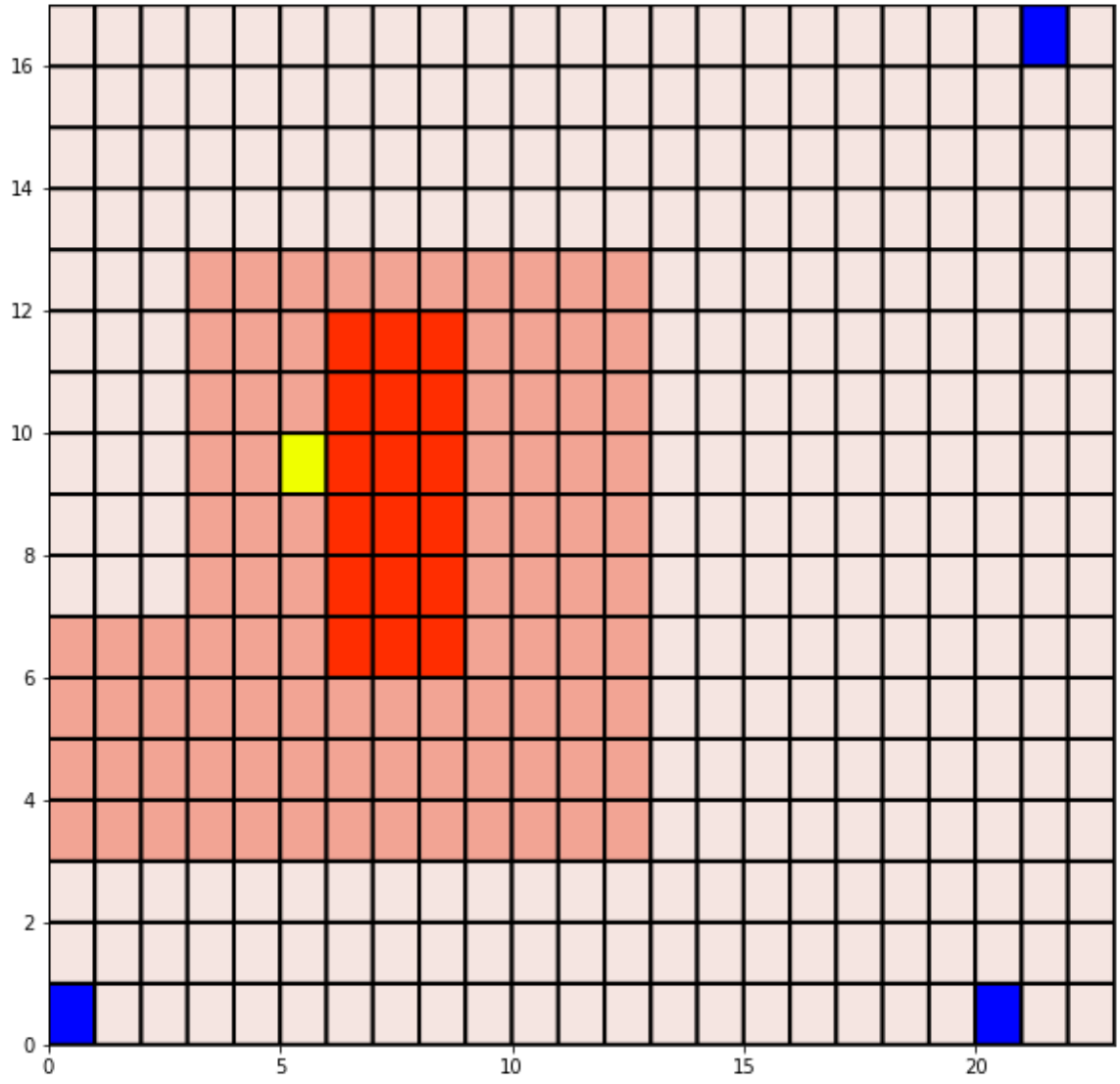
100%|██████████| 10000/10000 [01:49<00:00, 91.04it/s]

Visualizing the policy

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

In [12]:

```
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: 22, Total Reward: 88
```

Analyzing performance of the policy

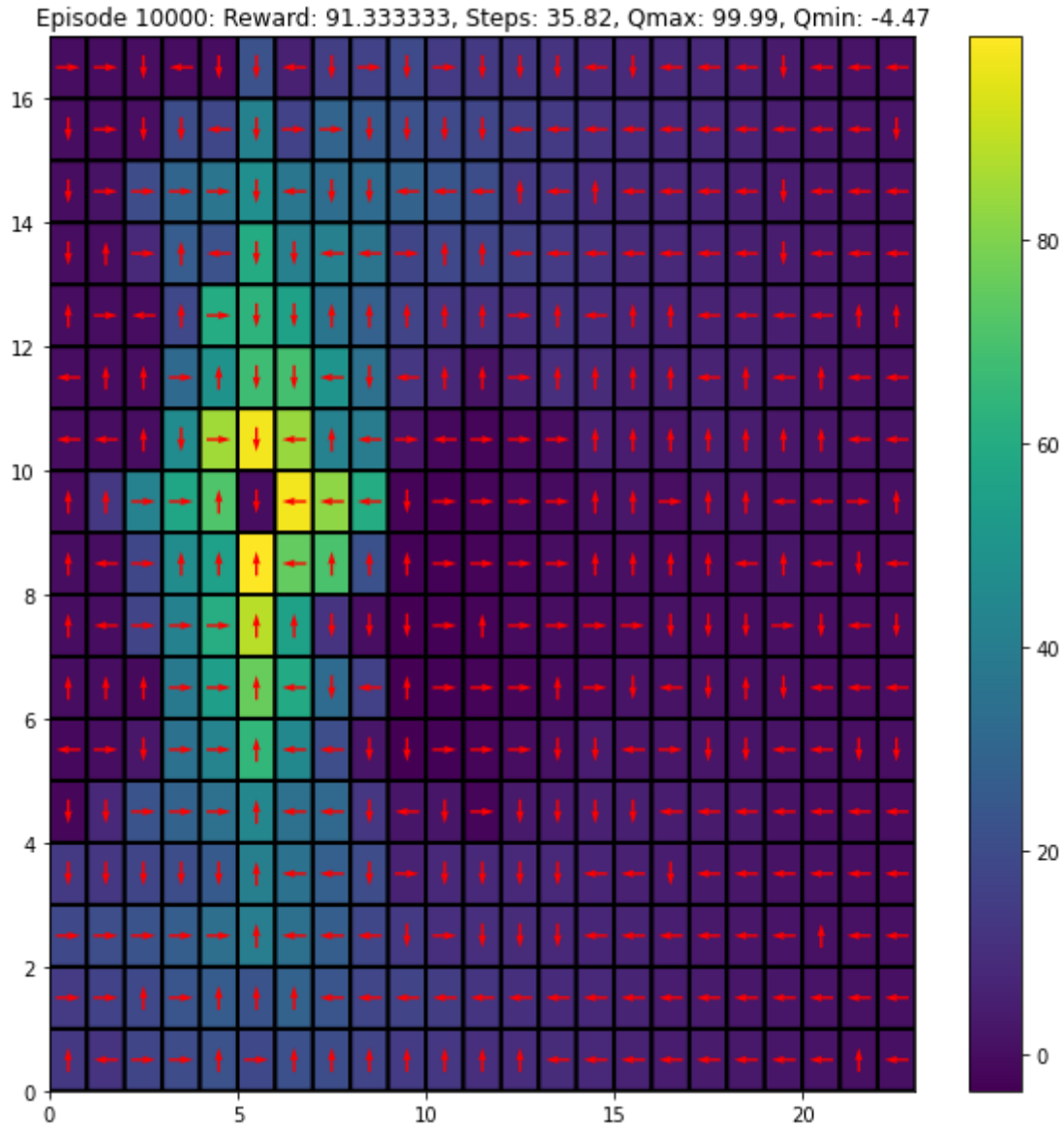
We use two metrics to analyze the policies:

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.

In [13]:

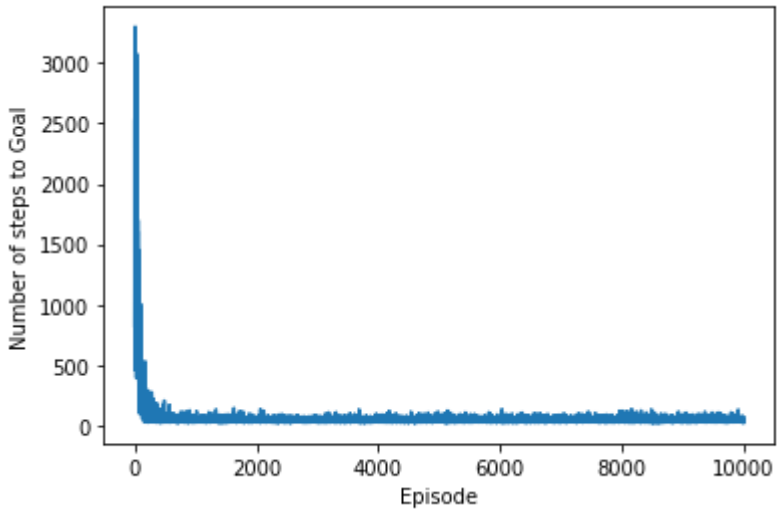
```
num_expts = 5
reward_avgs, steps_avgs = [], []

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, gamma = gamma, plot_heat=True, choose_action= cho
ose_action_softmax)
    steps_avgs.append(steps)
    reward_avgs.append(rewards)
avg_rewards=(np.mean(reward_avgs,axis=0))
avg_steps=np.mean(steps_avgs,axis=0)


    # TODO: run sarsa, store metrics
```

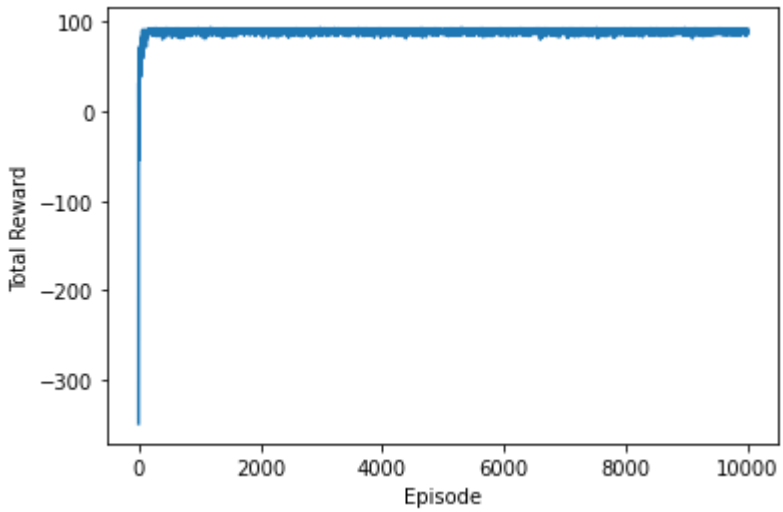


100%|██████████| 10000/10000 [01:28<00:00, 113.59it/s]

In [14]:

```
# TODO: visualize individual metrics vs episode count (averaged across multiple run(s))

plt.figure()
plt.xlabel('Episode')
plt.ylabel('Number of steps to Goal')
plt.plot([i+1 for i in range(len(avg_steps))],avg_steps)
plt.show()

plt.figure()
plt.xlabel('Episode')
plt.ylabel('Total Reward')
plt.plot([i+1 for i in range(len(avg_rewards))],avg_rewards)
plt.show()
```





Q-Learning

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

Recall the update rule for Q-Learning:

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

Visualize and compare results with SARSA.

In [15]:

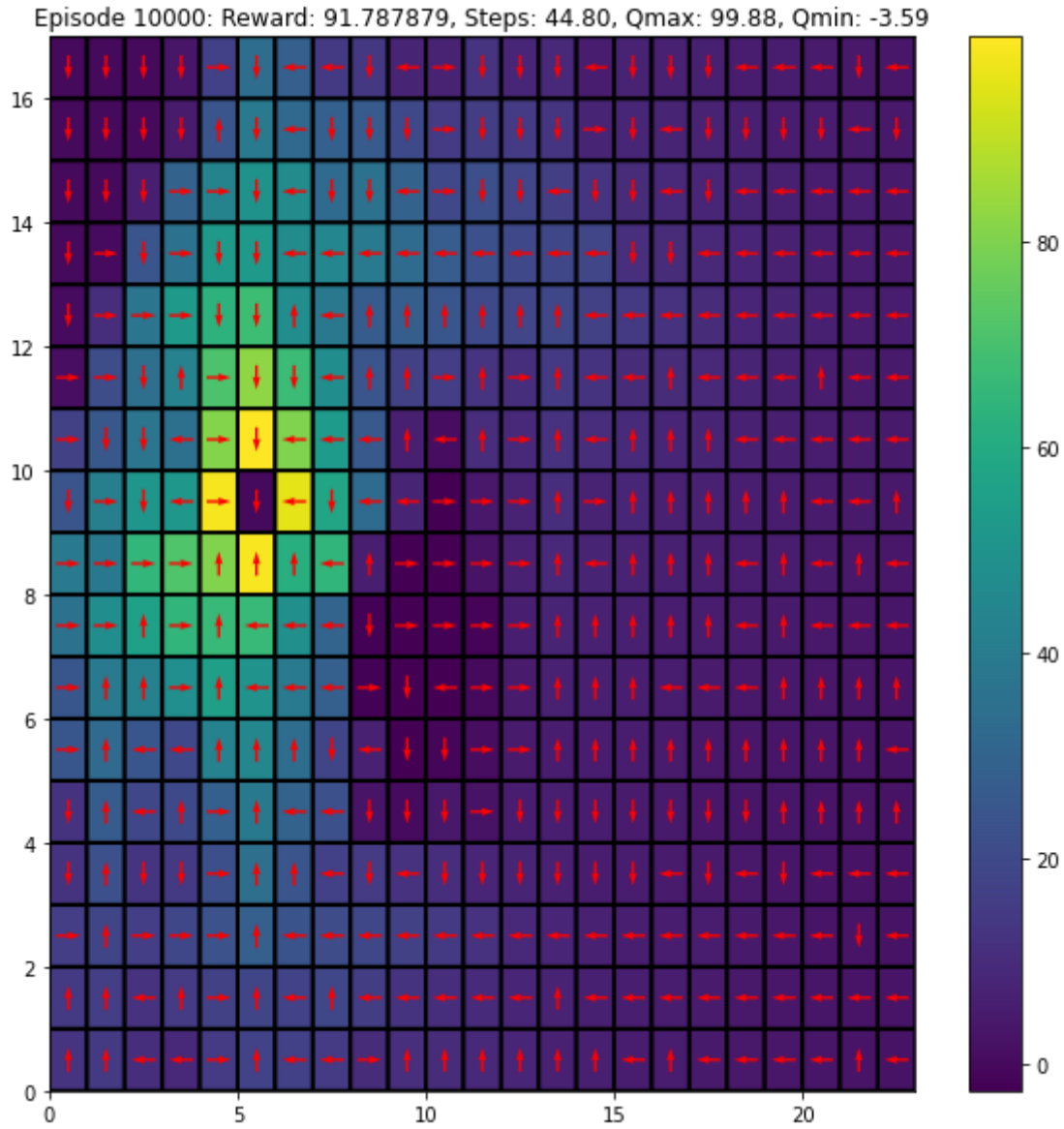
```
# initialize Q-value
Q = np.zeros((env.grid.shape[0], env.grid.shape[1], len(env.action_space)))

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

In [16]:

```
print_freq = 100

def qlearning(env, Q, gamma = 0.9, plot_heat = False, choose_action = choose_action_sof
tmax):

    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)

            # TODO: update equation
            Q[state[0]][state[1]][action]=Q[state[0]][state[1]][action]+alpha*(reward+g
amma*(np.max(Q[state_next[0]][state_next[1]]))-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(step
s_to_completion[ep-print_freq+1:ep]),
                                                                        Q.max(), Q.m
in()))

    return Q, episode_rewards, steps_to_completion
```

In [18]:

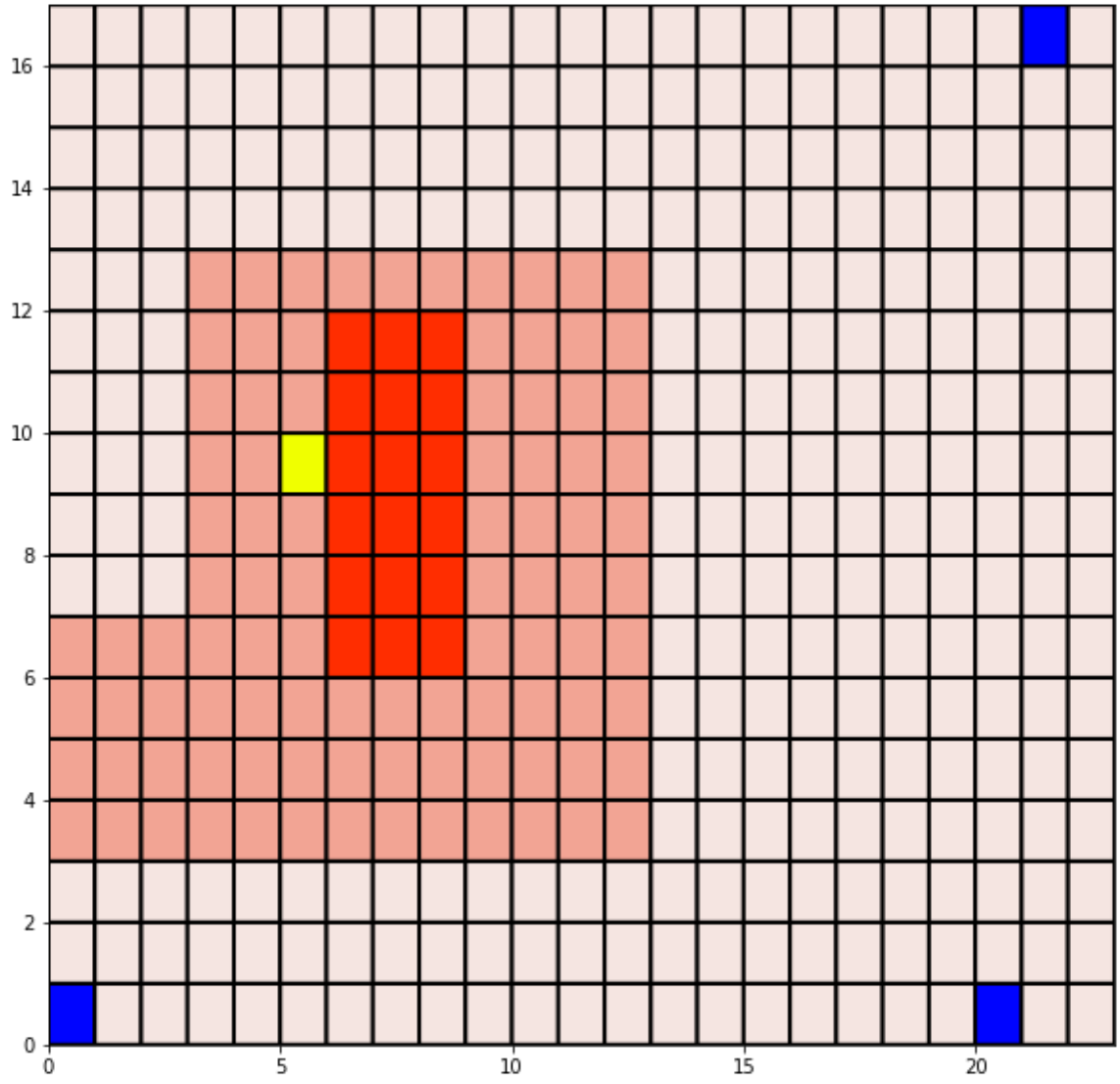
```
Q, rewards, steps = qlearning(env, Q, gamma = gamma, plot_heat=True, choose_action= cho
ose_action_softmax)
```



100%|██████████| 10000/10000 [01:28<00:00, 112.82it/s]

In [19]:

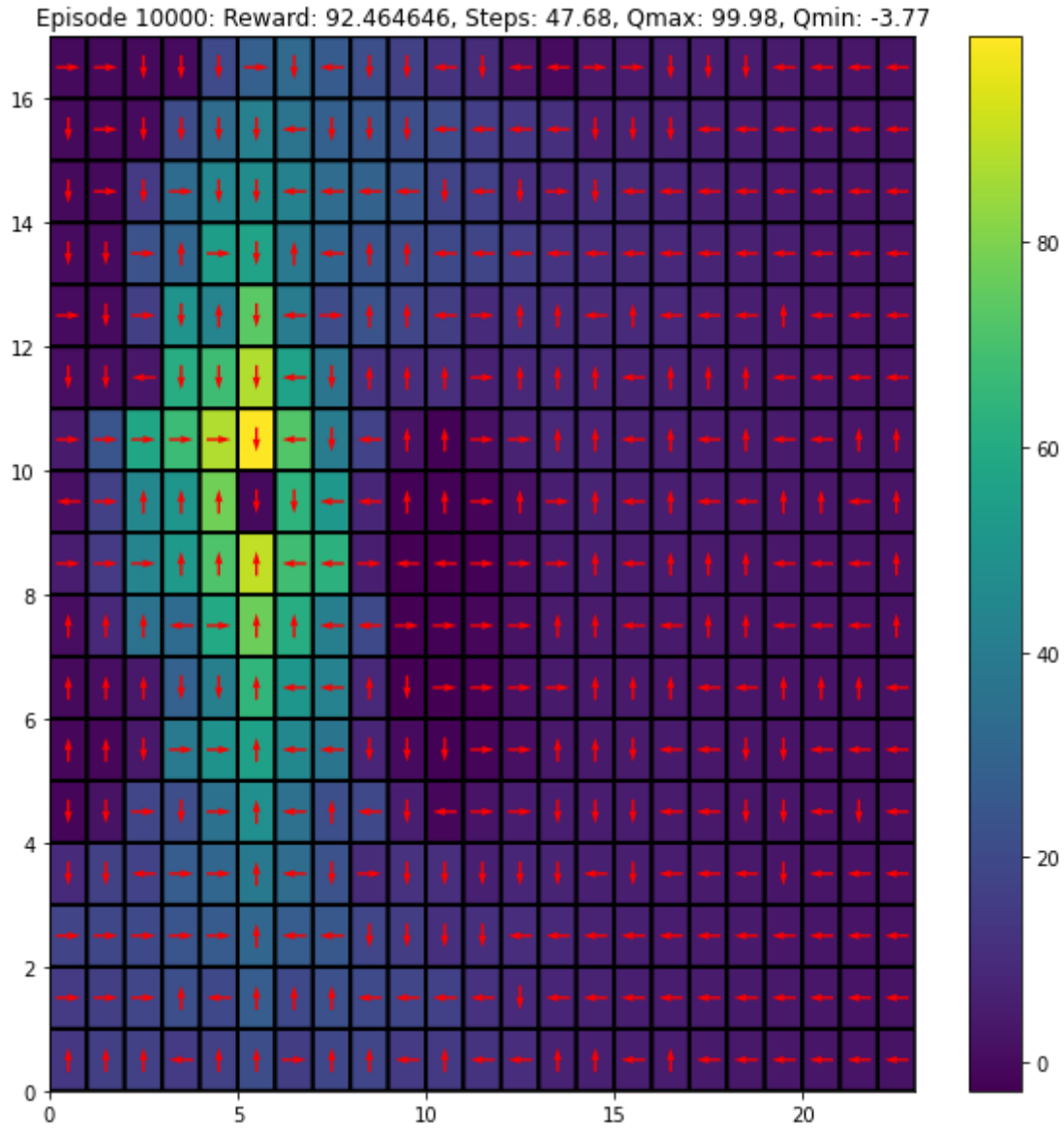
```
from time import sleep

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: 32, Total Reward: 90
```

In [20]:

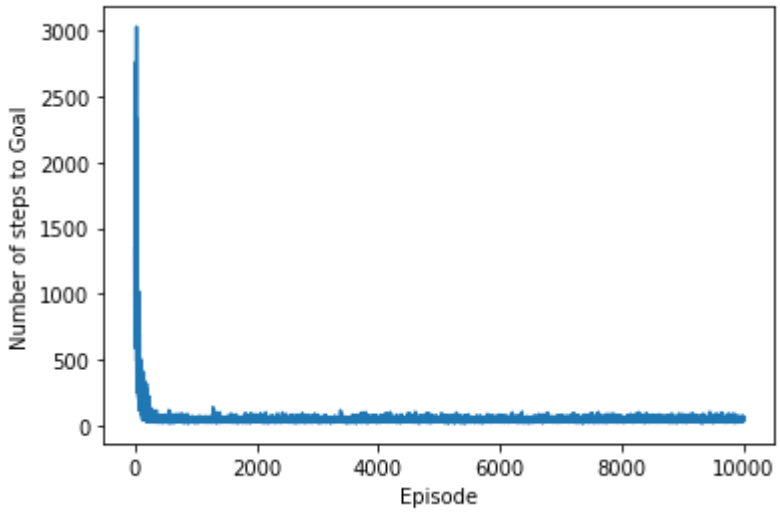
```
num_expts = 5
reward_avgs, steps_avgs = [], []

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 = qlearning(env, Q, gamma = gamma, plot_heat=True, choose_action=
choose_action_softmax)
    steps_avgs.append(steps)
    reward_avgs.append(rewards)
avg_rewards=(np.mean(reward_avgs,axis=0))
avg_steps=np.mean(steps_avgs,axis=0)

    # TODO: run qlearning, store metrics
```

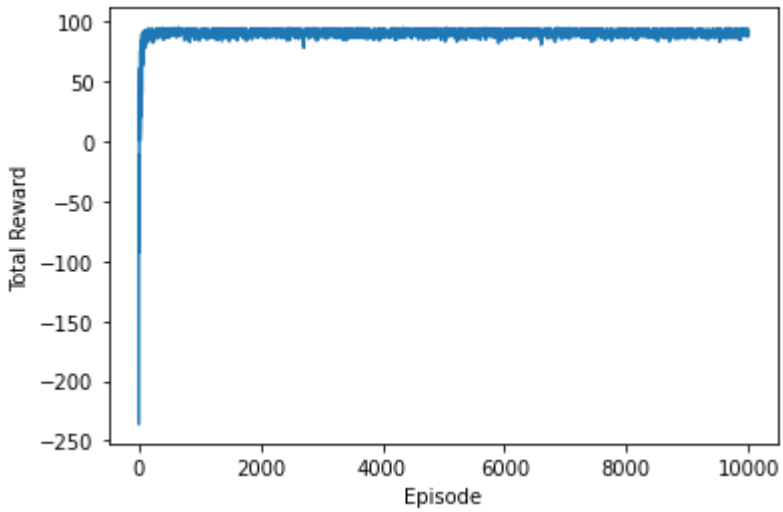


100%|██████████| 10000/10000 [01:30<00:00, 110.43it/s]

In [22]:

```
# TODO: visualize individual metrics vs episode count (averaged across multiple run(s))

plt.figure()
plt.xlabel('Episode')
plt.ylabel('Number of steps to Goal')
plt.plot([i+1 for i in range(len(avg_steps))],avg_steps)
plt.show()

plt.figure()
plt.xlabel('Episode')
plt.ylabel('Total Reward')
plt.plot([i+1 for i in range(len(avg_rewards))],avg_rewards)
plt.show()
```





TODO: What differences do you observe between the policies learnt by Q Learning and SARSA (if any).

Sarsa converges faster than Q-Learning in terms of the no of steps to reach the destination. We observe a difference in policies. The key difference is that in q-learning since it is off policy, it dosent mind going into the grid positions with -1 reward first and then moving in grid positions with zero rewards.

But Sarsa traverses through all positions with 0 rewards and then only moves into the grid space with negative rewards.

This is similar to the cliff-hanging explained by sir in class. Sarsa chooses a more safer route than q-learning.

In [23]:

```
!pip install nbconvert
!sudo apt-get install texlive-xetex texlive-fonts-recommended texlive-plain-generic
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/col
ab-wheels/public/simple/
Requirement already satisfied: nbconvert in /usr/local/lib/python3.8/dist-
packages (5.6.1)
Requirement already satisfied: nbformat>=4.4 in /usr/local/lib/python3.8/d
ist-packages (from nbconvert) (5.7.3)
Requirement already satisfied: mistune<2,>=0.8.1 in /usr/local/lib/python
3.8/dist-packages (from nbconvert) (0.8.4)
Requirement already satisfied: jinja2>=2.4 in /usr/local/lib/python3.8/dis
t-packages (from nbconvert) (2.11.3)
Requirement already satisfied: pandocfilters>=1.4.1 in /usr/local/lib/pyth
on3.8/dist-packages (from nbconvert) (1.5.0)
Requirement already satisfied: pygments in /usr/local/lib/python3.8/dist-p
ackages (from nbconvert) (2.6.1)
Requirement already satisfied: entrypoints>=0.2.2 in /usr/local/lib/python
3.8/dist-packages (from nbconvert) (0.4)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.8/dist
-packages (from nbconvert) (0.7.1)
Requirement already satisfied: bleach in /usr/local/lib/python3.8/dist-pac
kages (from nbconvert) (6.0.0)
Requirement already satisfied: jupyter-core in /usr/local/lib/python3.8/di
st-packages (from nbconvert) (5.2.0)
Requirement already satisfied: traitlets>=4.2 in /usr/local/lib/python3.8/
dist-packages (from nbconvert) (5.7.1)
Requirement already satisfied: testpath in /usr/local/lib/python3.8/dist-p
ackages (from nbconvert) (0.6.0)
Requirement already satisfied: MarkupSafe>=0.23 in /usr/local/lib/python3.
8/dist-packages (from jinja2>=2.4->nbconvert) (2.0.1)
Requirement already satisfied: fastjsonschema in /usr/local/lib/python3.8/
dist-packages (from nbformat>=4.4->nbconvert) (2.16.2)
Requirement already satisfied: jsonschema>=2.6 in /usr/local/lib/python3.
8/dist-packages (from nbformat>=4.4->nbconvert) (4.3.3)
Requirement already satisfied: webencodings in /usr/local/lib/python3.8/di
st-packages (from bleach->nbconvert) (0.5.1)
Requirement already satisfied: six>=1.9.0 in /usr/local/lib/python3.8/dist
-packages (from bleach->nbconvert) (1.15.0)
Requirement already satisfied: platformdirs>=2.5 in /usr/local/lib/python
3.8/dist-packages (from jupyter-core->nbconvert) (3.0.0)
Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.1
4.0 in /usr/local/lib/python3.8/dist-packages (from jsonschema>=2.6->nbfor
mat>=4.4->nbconvert) (0.19.3)
Requirement already satisfied: importlib-resources>=1.4.0 in /usr/local/li
b/python3.8/dist-packages (from jsonschema>=2.6->nbformat>=4.4->nbconvert)
(5.10.2)
Requirement already satisfied: attrs>=17.4.0 in /usr/local/lib/python3.8/d
ist-packages (from jsonschema>=2.6->nbformat>=4.4->nbconvert) (22.2.0)
Requirement already satisfied: zipp>=3.1.0 in /usr/local/lib/python3.8/dis
t-packages (from importlib-resources>=1.4.0->jsonschema>=2.6->nbformat>=4.
4->nbconvert) (3.13.0)
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer require
d:
  libnvidia-common-510
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 javascript-common libapache-pom-java
  libcommons-logging-java libcommons-parent-java libfontbox-java libgs9
  libgs9-common libidn11 libijs-0.35 libjbig2dec0 libjs-jquery libkpathsea
```

```
6
  libpdfbox-java libptexenc1 libruby2.7 libsynctex2 libteckit0 libtexlua53
  libtexluajit2 libzzip-0-13 lmodern poppler-data preview-latex-style rake
  ruby ruby-minitest ruby-net-telnet ruby-power-assert ruby-test-unit
  ruby-xmlrpc ruby2.7 rubygems-integration t1utils teckit tex-common tex-g
yre
  texlive-base texlive-binaries texlive-latex-base texlive-latex-extra
  texlive-latex-recommended texlive-pictures tipa xfonts-encodings
  xfonts-utils
Suggested packages:
  fonts-noto fonts-freefont-otf | fonts-freefont-ttf apache2 | lighttpd
  | httpd libavalon-framework-java libcommons-logging-java-doc
  libexcalibur-logkit-java liblog4j1.2-java 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 | pdf-vie
wer
  xzdec texlive-fonts-recommended-doc texlive-latex-base-doc python3-pygme
nts
  icc-profiles libfile-which-perl libspreadsheet-parseexcel-perl
  texlive-latex-extra-doc texlive-latex-recommended-doc texlive-luatex
  texlive-pstricks dot2tex prerex ruby-tcltk | libtcltk-ruby
  texlive-pictures-doc vprerex
The following NEW packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 javascript-common libapache-pom-java
  libcommons-logging-java libcommons-parent-java libfontbox-java libgs9
  libgs9-common libidn11 libijs-0.35 libjbig2dec0 libjs-jquery libkpathsea
6
  libpdfbox-java libptexenc1 libruby2.7 libsynctex2 libteckit0 libtexlua53
  libtexluajit2 libzzip-0-13 lmodern poppler-data preview-latex-style rake
  ruby ruby-minitest ruby-net-telnet ruby-power-assert ruby-test-unit
  ruby-xmlrpc ruby2.7 rubygems-integration t1utils teckit tex-common tex-g
yre
  texlive-base texlive-binaries texlive-fonts-recommended texlive-latex-ba
se
  texlive-latex-extra texlive-latex-recommended texlive-pictures
  texlive-plain-generic texlive-xetex tipa xfonts-encodings xfonts-utils
0 upgraded, 55 newly installed, 0 to remove and 21 not upgraded.
Need to get 169 MB of archives.
After this operation, 536 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu focal/main amd64 fonts-droid-fallba
ck all 1:6.0.1r16-1.1 [1,805 kB]
Get:2 http://archive.ubuntu.com/ubuntu focal/main amd64 fonts-lato all 2.0
-2 [2,698 kB]
Get:3 http://archive.ubuntu.com/ubuntu focal/main amd64 poppler-data all
0.4.9-2 [1,475 kB]
Get:4 http://archive.ubuntu.com/ubuntu focal/universe amd64 tex-common all
6.13 [32.7 kB]
Get:5 http://archive.ubuntu.com/ubuntu focal/main amd64 fonts-urw-base35 a
ll 20170801.1-3 [6,333 kB]
Get:6 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libgs9-com
mon all 9.50~dfsg-5ubuntu4.6 [681 kB]
Get:7 http://archive.ubuntu.com/ubuntu focal/main amd64 libidn11 amd64 1.3
3-2.2ubuntu2 [46.2 kB]
Get:8 http://archive.ubuntu.com/ubuntu focal/main amd64 libijs-0.35 amd64
0.35-15 [15.7 kB]
Get:9 http://archive.ubuntu.com/ubuntu focal/main amd64 libjbig2dec0 amd64
0.18-1ubuntu1 [60.0 kB]
Get:10 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libgs9 am
```

```
d64 9.50~dfsg-5ubuntu4.6 [2,173 kB]
Get:11 http://archive.ubuntu.com/ubuntu focal/main amd64 libkpathsea6 amd6
4 2019.20190605.51237-3build2 [57.0 kB]
Get:12 http://archive.ubuntu.com/ubuntu focal/universe amd64 dvisvgm amd64
2.8.1-1build1 [1,048 kB]
Get:13 http://archive.ubuntu.com/ubuntu focal/universe amd64 fonts-lmodern
all 2.004.5-6 [4,532 kB]
Get:14 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 fonts-not
o-mono all 20200323-1build1~ubuntu20.04.1 [80.6 kB]
Get:15 http://archive.ubuntu.com/ubuntu focal/universe amd64 fonts-texgyre
all 20180621-3 [10.2 MB]
Get:16 http://archive.ubuntu.com/ubuntu focal/main amd64 javascript-common
all 11 [6,066 B]
Get:17 http://archive.ubuntu.com/ubuntu focal/universe amd64 libapache-pom
-java all 18-1 [4,720 B]
Get:18 http://archive.ubuntu.com/ubuntu focal/universe amd64 libcommons-pa
rent-java all 43-1 [10.8 kB]
Get:19 http://archive.ubuntu.com/ubuntu focal/universe amd64 libcommons-lo
gging-java all 1.2-2 [60.3 kB]
Get:20 http://archive.ubuntu.com/ubuntu focal/main amd64 libjs-jquery all
3.3.1~dfsg-3 [329 kB]
Get:21 http://archive.ubuntu.com/ubuntu focal/main amd64 libptexenc1 amd64
2019.20190605.51237-3build2 [35.5 kB]
Get:22 http://archive.ubuntu.com/ubuntu focal/main amd64 rubygems-integrat
ion all 1.16 [5,092 B]
Get:23 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 ruby2.7 a
md64 2.7.0-5ubuntu1.7 [95.6 kB]
Get:24 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby amd64 1:2.7+
1 [5,412 B]
Get:25 http://archive.ubuntu.com/ubuntu focal/main amd64 rake all 13.0.1-4
[61.6 kB]
Get:26 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-minitest all
5.13.0-1 [40.9 kB]
Get:27 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-net-telnet a
ll 0.1.1-2 [12.6 kB]
Get:28 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-power-assert
all 1.1.7-1 [11.4 kB]
Get:29 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-test-unit al
l 3.3.5-1 [73.2 kB]
Get:30 http://archive.ubuntu.com/ubuntu focal/main amd64 ruby-xmlrpc all
0.3.0-2 [23.8 kB]
Get:31 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libruby2.
7 amd64 2.7.0-5ubuntu1.7 [3,533 kB]
Get:32 http://archive.ubuntu.com/ubuntu focal/main amd64 libsynctex2 amd64
2019.20190605.51237-3build2 [55.0 kB]
Get:33 http://archive.ubuntu.com/ubuntu focal/universe amd64 libteckit0 am
d64 2.5.8+ds2-5ubuntu2 [320 kB]
Get:34 http://archive.ubuntu.com/ubuntu focal/main amd64 libtexlua53 amd64
2019.20190605.51237-3build2 [105 kB]
Get:35 http://archive.ubuntu.com/ubuntu focal/main amd64 libtexluajit2 amd
64 2019.20190605.51237-3build2 [235 kB]
Get:36 http://archive.ubuntu.com/ubuntu focal/universe amd64 libzzip-0-13
amd64 0.13.62-3.2ubuntu1 [26.2 kB]
Get:37 http://archive.ubuntu.com/ubuntu focal/main amd64 xfonts-encodings
all 1:1.0.5-0ubuntu1 [573 kB]
Get:38 http://archive.ubuntu.com/ubuntu focal/main amd64 xfonts-utils amd6
4 1:7.7+6 [91.5 kB]
Get:39 http://archive.ubuntu.com/ubuntu focal/universe amd64 lmodern all
2.004.5-6 [9,474 kB]
Get:40 http://archive.ubuntu.com/ubuntu focal/universe amd64 preview-latex
-style all 11.91-2ubuntu2 [184 kB]
```

```
Get:41 http://archive.ubuntu.com/ubuntu focal/main amd64 t1utils amd64 1.4
1-3 [56.1 kB]
Get:42 http://archive.ubuntu.com/ubuntu focal/universe amd64 teckit amd64
2.5.8+ds2-5ubuntu2 [687 kB]
Get:43 http://archive.ubuntu.com/ubuntu focal/universe amd64 tex-gyre all
20180621-3 [6,209 kB]
Get:44 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-binar
ies amd64 2019.20190605.51237-3build2 [8,041 kB]
Get:45 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-base
all 2019.20200218-1 [20.8 MB]
Get:46 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-fonts
-recommended all 2019.20200218-1 [4,972 kB]
Get:47 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-latex
-base all 2019.20200218-1 [990 kB]
Get:48 http://archive.ubuntu.com/ubuntu focal/universe amd64 libfontbox-ja
va all 1:1.8.16-2 [207 kB]
Get:49 http://archive.ubuntu.com/ubuntu focal/universe amd64 libpdfbox-jav
a all 1:1.8.16-2 [5,199 kB]
Get:50 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-latex
-recommended all 2019.20200218-1 [15.7 MB]
Get:51 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-pictu
res all 2019.20200218-1 [4,492 kB]
Get:52 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-latex
-extra all 2019.202000218-1 [12.5 MB]
Get:53 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-plain
-generic all 2019.202000218-1 [24.6 MB]
Get:54 http://archive.ubuntu.com/ubuntu focal/universe amd64 tipa all 2:1.
3-20 [2,978 kB]
Get:55 http://archive.ubuntu.com/ubuntu focal/universe amd64 texlive-xetex
all 2019.20200218-1 [14.6 MB]
Fetched 169 MB in 25s (6,825 kB/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 li
ne 76, <> line 55.)
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 ... 128126 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_0.4.9-2_all.deb ...
Unpacking poppler-data (0.4.9-2) ...
Selecting previously unselected package tex-common.
Preparing to unpack .../03-tex-common_6.13_all.deb ...
Unpacking tex-common (6.13) ...
Selecting previously unselected package fonts-urw-base35.
Preparing to unpack .../04-fonts-urw-base35_20170801.1-3_all.deb ...
Unpacking fonts-urw-base35 (20170801.1-3) ...
Selecting previously unselected package libgs9-common.
Preparing to unpack .../05-libgs9-common_9.50~dfsg-5ubuntu4.6_all.deb ...
Unpacking libgs9-common (9.50~dfsg-5ubuntu4.6) ...
Selecting previously unselected package libidn11:amd64.
```

```
Preparing to unpack .../06-libidn11_1.33-2.2ubuntu2_amd64.deb ...
Unpacking libidn11:amd64 (1.33-2.2ubuntu2) ...
Selecting previously unselected package libijs-0.35:amd64.
Preparing to unpack .../07-libijs-0.35_0.35-15_amd64.deb ...
Unpacking libijs-0.35:amd64 (0.35-15) ...
Selecting previously unselected package libjbig2dec0:amd64.
Preparing to unpack .../08-libjbig2dec0_0.18-1ubuntu1_amd64.deb ...
Unpacking libjbig2dec0:amd64 (0.18-1ubuntu1) ...
Selecting previously unselected package libgs9:amd64.
Preparing to unpack .../09-libgs9_9.50~dfsg-5ubuntu4.6_amd64.deb ...
Unpacking libgs9:amd64 (9.50~dfsg-5ubuntu4.6) ...
Selecting previously unselected package libkpathsea6:amd64.
Preparing to unpack .../10-libkpathsea6_2019.20190605.51237-3build2_amd64.
deb ...
Unpacking libkpathsea6:amd64 (2019.20190605.51237-3build2) ...
Selecting previously unselected package dvisvgm.
Preparing to unpack .../11-dvisvgm_2.8.1-1build1_amd64.deb ...
Unpacking dvisvgm (2.8.1-1build1) ...
Selecting previously unselected package fonts-lmodern.
Preparing to unpack .../12-fonts-lmodern_2.004.5-6_all.deb ...
Unpacking fonts-lmodern (2.004.5-6) ...
Selecting previously unselected package fonts-noto-mono.
Preparing to unpack .../13-fonts-noto-mono_20200323-1build1~ubuntu20.04.1_
all.deb ...
Unpacking fonts-noto-mono (20200323-1build1~ubuntu20.04.1) ...
Selecting previously unselected package fonts-texgyre.
Preparing to unpack .../14-fonts-texgyre_20180621-3_all.deb ...
Unpacking fonts-texgyre (20180621-3) ...
Selecting previously unselected package javascript-common.
Preparing to unpack .../15-javascript-common_11_all.deb ...
Unpacking javascript-common (11) ...
Selecting previously unselected package libapache-pom-java.
Preparing to unpack .../16-libapache-pom-java_18-1_all.deb ...
Unpacking libapache-pom-java (18-1) ...
Selecting previously unselected package libcommons-parent-java.
Preparing to unpack .../17-libcommons-parent-java_43-1_all.deb ...
Unpacking libcommons-parent-java (43-1) ...
Selecting previously unselected package libcommons-logging-java.
Preparing to unpack .../18-libcommons-logging-java_1.2-2_all.deb ...
Unpacking libcommons-logging-java (1.2-2) ...
Selecting previously unselected package libjs-jquery.
Preparing to unpack .../19-libjs-jquery_3.3.1~dfsg-3_all.deb ...
Unpacking libjs-jquery (3.3.1~dfsg-3) ...
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack .../20-libptexenc1_2019.20190605.51237-3build2_amd64.d
eb ...
Unpacking libptexenc1:amd64 (2019.20190605.51237-3build2) ...
Selecting previously unselected package rubygems-integration.
Preparing to unpack .../21-rubygems-integration_1.16_all.deb ...
Unpacking rubygems-integration (1.16) ...
Selecting previously unselected package ruby2.7.
Preparing to unpack .../22-ruby2.7_2.7.0-5ubuntu1.7_amd64.deb ...
Unpacking ruby2.7 (2.7.0-5ubuntu1.7) ...
Selecting previously unselected package ruby.
Preparing to unpack .../23-ruby_1%3a2.7+1_amd64.deb ...
Unpacking ruby (1:2.7+1) ...
Selecting previously unselected package rake.
Preparing to unpack .../24-rake_13.0.1-4_all.deb ...
Unpacking rake (13.0.1-4) ...
Selecting previously unselected package ruby-minitest.
Preparing to unpack .../25-ruby-minitest_5.13.0-1_all.deb ...
```

```
Unpacking ruby-minitest (5.13.0-1) ...
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack .../26-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 .../27-ruby-power-assert_1.1.7-1_all.deb ...
Unpacking ruby-power-assert (1.1.7-1) ...
Selecting previously unselected package ruby-test-unit.
Preparing to unpack .../28-ruby-test-unit_3.3.5-1_all.deb ...
Unpacking ruby-test-unit (3.3.5-1) ...
Selecting previously unselected package ruby-xmlrpc.
Preparing to unpack .../29-ruby-xmlrpc_0.3.0-2_all.deb ...
Unpacking ruby-xmlrpc (0.3.0-2) ...
Selecting previously unselected package libruby2.7:amd64.
Preparing to unpack .../30-libruby2.7_2.7.0-5ubuntu1.7_amd64.deb ...
Unpacking libruby2.7:amd64 (2.7.0-5ubuntu1.7) ...
Selecting previously unselected package libsynctex2:amd64.
Preparing to unpack .../31-libsynctex2_2019.20190605.51237-3build2_amd64.d
eb ...
Unpacking libsynctex2:amd64 (2019.20190605.51237-3build2) ...
Selecting previously unselected package libteckit0:amd64.
Preparing to unpack .../32-libteckit0_2.5.8+ds2-5ubuntu2_amd64.deb ...
Unpacking libteckit0:amd64 (2.5.8+ds2-5ubuntu2) ...
Selecting previously unselected package libtexlua53:amd64.
Preparing to unpack .../33-libtexlua53_2019.20190605.51237-3build2_amd64.d
eb ...
Unpacking libtexlua53:amd64 (2019.20190605.51237-3build2) ...
Selecting previously unselected package libtexluajit2:amd64.
Preparing to unpack .../34-libtexluajit2_2019.20190605.51237-3build2_amd6
4.deb ...
Unpacking libtexluajit2:amd64 (2019.20190605.51237-3build2) ...
Selecting previously unselected package libzzip-0-13:amd64.
Preparing to unpack .../35-libzzip-0-13_0.13.62-3.2ubuntu1_amd64.deb ...
Unpacking libzzip-0-13:amd64 (0.13.62-3.2ubuntu1) ...
Selecting previously unselected package xfonts-encodings.
Preparing to unpack .../36-xfonts-encodings_1%3a1.0.5-0ubuntu1_all.deb ...
Unpacking xfonts-encodings (1:1.0.5-0ubuntu1) ...
Selecting previously unselected package xfonts-utils.
Preparing to unpack .../37-xfonts-utils_1%3a7.7+6_amd64.deb ...
Unpacking xfonts-utils (1:7.7+6) ...
Selecting previously unselected package lmodern.
Preparing to unpack .../38-lmodern_2.004.5-6_all.deb ...
Unpacking lmodern (2.004.5-6) ...
Selecting previously unselected package preview-latex-style.
Preparing to unpack .../39-preview-latex-style_11.91-2ubuntu2_all.deb ...
Unpacking preview-latex-style (11.91-2ubuntu2) ...
Selecting previously unselected package t1utils.
Preparing to unpack .../40-t1utils_1.41-3_amd64.deb ...
Unpacking t1utils (1.41-3) ...
Selecting previously unselected package teckit.
Preparing to unpack .../41-teckit_2.5.8+ds2-5ubuntu2_amd64.deb ...
Unpacking teckit (2.5.8+ds2-5ubuntu2) ...
Selecting previously unselected package tex-gyre.
Preparing to unpack .../42-tex-gyre_20180621-3_all.deb ...
Unpacking tex-gyre (20180621-3) ...
Selecting previously unselected package texlive-binaries.
Preparing to unpack .../43-texlive-binaries_2019.20190605.51237-3build2_am
d64.deb ...
Unpacking texlive-binaries (2019.20190605.51237-3build2) ...
Selecting previously unselected package texlive-base.
Preparing to unpack .../44-texlive-base_2019.20200218-1_all.deb ...
```

```
Unpacking texlive-base (2019.20200218-1) ...
Selecting previously unselected package texlive-fonts-recommended.
Preparing to unpack .../45-texlive-fonts-recommended_2019.20200218-1_all.d
eb ...
Unpacking texlive-fonts-recommended (2019.20200218-1) ...
Selecting previously unselected package texlive-latex-base.
Preparing to unpack .../46-texlive-latex-base_2019.20200218-1_all.deb ...
Unpacking texlive-latex-base (2019.20200218-1) ...
Selecting previously unselected package libfontbox-java.
Preparing to unpack .../47-libfontbox-java_1%3a1.8.16-2_all.deb ...
Unpacking libfontbox-java (1:1.8.16-2) ...
Selecting previously unselected package libpdfbox-java.
Preparing to unpack .../48-libpdfbox-java_1%3a1.8.16-2_all.deb ...
Unpacking libpdfbox-java (1:1.8.16-2) ...
Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack .../49-texlive-latex-recommended_2019.20200218-1_all.d
eb ...
Unpacking texlive-latex-recommended (2019.20200218-1) ...
Selecting previously unselected package texlive-pictures.
Preparing to unpack .../50-texlive-pictures_2019.20200218-1_all.deb ...
Unpacking texlive-pictures (2019.20200218-1) ...
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack .../51-texlive-latex-extra_2019.202000218-1_all.deb
...
Unpacking texlive-latex-extra (2019.202000218-1) ...
Selecting previously unselected package texlive-plain-generic.
Preparing to unpack .../52-texlive-plain-generic_2019.202000218-1_all.deb
...
Unpacking texlive-plain-generic (2019.202000218-1) ...
Selecting previously unselected package tipa.
Preparing to unpack .../53-tipa_2%3a1.3-20_all.deb ...
Unpacking tipa (2:1.3-20) ...
Selecting previously unselected package texlive-xetex.
Preparing to unpack .../54-texlive-xetex_2019.20200218-1_all.deb ...
Unpacking texlive-xetex (2019.20200218-1) ...
Setting up javascript-common (11) ...
Setting up fonts-lato (2.0-2) ...
Setting up fonts-noto-mono (20200323-1build1~ubuntu20.04.1) ...
Setting up ruby-power-assert (1.1.7-1) ...
Setting up libtexlua53:amd64 (2019.20190605.51237-3build2) ...
Setting up libijs-0.35:amd64 (0.35-15) ...
Setting up libtexluajit2:amd64 (2019.20190605.51237-3build2) ...
Setting up libfontbox-java (1:1.8.16-2) ...
Setting up rubygems-integration (1.16) ...
Setting up libzzip-0-13:amd64 (0.13.62-3.2ubuntu1) ...
Setting up fonts-urw-base35 (20170801.1-3) ...
Setting up poppler-data (0.4.9-2) ...
Setting up ruby-minitest (5.13.0-1) ...
Setting up tex-common (6.13) ...
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 li
ne 76.)
debconf: falling back to frontend: Readline
update-language: texlive-base not installed and configured, doing nothing!
Setting up ruby-test-unit (3.3.5-1) ...
Setting up libjbig2dec0:amd64 (0.18-1ubuntu1) ...
Setting up libidn11:amd64 (1.33-2.2ubuntu2) ...
Setting up libteckit0:amd64 (2.5.8+ds2-5ubuntu2) ...
Setting up libapache-pom-java (18-1) ...
Setting up ruby-net-telnet (0.1.1-2) ...
```

```
Setting up xfonts-encodings (1:1.0.5-0ubuntu1) ...
Setting up t1utils (1.41-3) ...
Setting up fonts-texgyre (20180621-3) ...
Setting up libkpathsea6:amd64 (2019.20190605.51237-3build2) ...
Setting up fonts-lmodern (2.004.5-6) ...
Setting up fonts-droid-fallback (1:6.0.1r16-1.1) ...
Setting up libjs-jquery (3.3.1~dfsg-3) ...
Setting up ruby-xmlrpc (0.3.0-2) ...
Setting up libsynctex2:amd64 (2019.20190605.51237-3build2) ...
Setting up libgs9-common (9.50~dfsg-5ubuntu4.6) ...
Setting up teckit (2.5.8+ds2-5ubuntu2) ...
Setting up libpdfbox-java (1:1.8.16-2) ...
Setting up libgs9:amd64 (9.50~dfsg-5ubuntu4.6) ...
Setting up preview-latex-style (11.91-2ubuntu2) ...
Setting up libcommons-parent-java (43-1) ...
Setting up dvisvgm (2.8.1-1build1) ...
Setting up libcommons-logging-java (1.2-2) ...
Setting up xfonts-utils (1:7.7+6) ...
Setting up libptexenc1:amd64 (2019.20190605.51237-3build2) ...
Setting up texlive-binaries (2019.20190605.51237-3build2) ...
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/bi
btex (bibtex) in auto mode
Setting up lmodern (2.004.5-6) ...
Setting up texlive-base (2019.20200218-1) ...
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/d
vipdfmx-paper.cfg
tl-paper: setting paper size for xdvi to a4: /var/lib/texmf/xdvi/XDvi-pape
r
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 li
ne 76.)
debconf: falling back to frontend: Readline
Setting up tex-gyre (20180621-3) ...
Setting up texlive-plain-generic (2019.202000218-1) ...
Setting up texlive-latex-base (2019.20200218-1) ...
Setting up texlive-latex-recommended (2019.20200218-1) ...
Setting up texlive-pictures (2019.20200218-1) ...
Setting up texlive-fonts-recommended (2019.20200218-1) ...
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 (2019.202000218-1) ...
Setting up texlive-xetex (2019.20200218-1) ...
Setting up rake (13.0.1-4) ...
Setting up libruby2.7:amd64 (2.7.0-5ubuntu1.7) ...
```

```
Setting up ruby2.7 (2.7.0-5ubuntu1.7) ...
Setting up ruby (1:2.7+1) ...
Processing triggers for fontconfig (2.13.1-2ubuntu3) ...
Processing triggers for mime-support (3.64ubuntu1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.9) ...
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for tex-common (6.13) ...
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 li
ne 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.
```

In [26]:

```
!jupyter nbconvert --to html "/content/drive/MyDrive/Colab Notebooks/CS6700_Tutorial_4_
QLearning_SARSA_ME19B118.ipynb"
```

```
[NbConvertApp] WARNING | pattern '/content/drive/MyDrive/Colab Notebooks/C
S6700_Tutorial_4_QLearning_SARSA_ME19B118.ipynb' matched no files
This application is used to convert notebook files (*.ipynb)
        to various other formats.

        WARNING: THE COMMANDLINE INTERFACE MAY CHANGE IN FUTURE RELEASES.

Options
=======
The options below are convenience aliases to configurable class-options,
as listed in the "Equivalent to" description-line of the aliases.
To see all configurable class-options for some <cmd>, use:
    <cmd> --help-all

--debug
    set log level to logging.DEBUG (maximize logging output)
    Equivalent to: [--Application.log_level=10]
--show-config
    Show the application's configuration (human-readable format)
    Equivalent to: [--Application.show_config=True]
--show-config-json
    Show the application's configuration (json format)
    Equivalent to: [--Application.show_config_json=True]
--generate-config
    generate default config file
    Equivalent to: [--JupyterApp.generate_config=True]
-y
    Answer yes to any questions instead of prompting.
    Equivalent to: [--JupyterApp.answer_yes=True]
--execute
    Execute the notebook prior to export.
    Equivalent to: [--ExecutePreprocessor.enabled=True]
--allow-errors
    Continue notebook execution even if one of the cells throws an error a
nd include the error message in the cell output (the default behaviour is
to abort conversion). This flag is only relevant if '--execute' was specif
ied, too.
    Equivalent to: [--ExecutePreprocessor.allow_errors=True]
--stdin
    read a single notebook file from stdin. Write the resulting notebook w
ith default basename 'notebook.*'
    Equivalent to: [--NbConvertApp.from_stdin=True]
--stdout
    Write notebook output to stdout instead of files.
    Equivalent to: [--NbConvertApp.writer_class=StdoutWriter]
--inplace
    Run nbconvert in place, overwriting the existing notebook (only
            relevant when converting to notebook format)
    Equivalent to: [--NbConvertApp.use_output_suffix=False --NbConvertApp.
export_format=notebook --FilesWriter.build_directory=]
--clear-output
    Clear output of current file and save in place,
            overwriting the existing notebook.
    Equivalent to: [--NbConvertApp.use_output_suffix=False --NbConvertApp.
export_format=notebook --FilesWriter.build_directory= --ClearOutputPreproc
essor.enabled=True]
--no-prompt
    Exclude input and output prompts from converted document.
    Equivalent to: [--TemplateExporter.exclude_input_prompt=True --Templat
eExporter.exclude_output_prompt=True]
--no-input
```

```
    Exclude input cells and output prompts from converted document.
            This mode is ideal for generating code-free reports.
    Equivalent to: [--TemplateExporter.exclude_output_prompt=True --Templa
teExporter.exclude_input=True]
--log-level=<Enum>
    Set the log level by value or name.
    Choices: any of [0, 10, 20, 30, 40, 50, 'DEBUG', 'INFO', 'WARN', 'ERRO
R', 'CRITICAL']
    Default: 30
    Equivalent to: [--Application.log_level]
--config=<Unicode>
    Full path of a config file.
    Default: ''
    Equivalent to: [--JupyterApp.config_file]
--to=<Unicode>
    The export format to be used, either one of the built-in formats
            ['asciidoc', 'custom', 'html', 'latex', 'markdown', 'noteboo
k', 'pdf', 'python', 'rst', 'script', 'slides']
            or a dotted object name that represents the import path for an
            `Exporter` class
    Default: 'html'
    Equivalent to: [--NbConvertApp.export_format]
--template=<Unicode>
    Name of the template file to use
    Default: ''
    Equivalent to: [--TemplateExporter.template_file]
--writer=<DottedObjectName>
    Writer class used to write the
                                        results of the conversion
    Default: 'FilesWriter'
    Equivalent to: [--NbConvertApp.writer_class]
--post=<DottedOrNone>
    PostProcessor class used to write the
                                        results of the conversion
    Default: ''
    Equivalent to: [--NbConvertApp.postprocessor_class]
--output=<Unicode>
    overwrite base name use for output files.
                can only be used when converting one notebook at a time.
    Default: ''
    Equivalent to: [--NbConvertApp.output_base]
--output-dir=<Unicode>
    Directory to write output(s) to. Defaults
                                    to output to the directory of each noteb
ook. To recover
                                    previous default behaviour (outputting t
o the current
                                    working directory) use . as the flag val
ue.
    Default: ''
    Equivalent to: [--FilesWriter.build_directory]
--reveal-prefix=<Unicode>
    The URL prefix for reveal.js (version 3.x).
            This defaults to the reveal CDN, but can be any url pointing t
o a copy
            of reveal.js.
            For speaker notes to work, this must be a relative path to a l
ocal
            copy of reveal.js: e.g., "reveal.js".
            If a relative path is given, it must be a subdirectory of the
            current directory (from which the server is run).
```

```
            See the usage documentation
            (https://nbconvert.readthedocs.io/en/latest/usage.html#reveal-
js-html-slideshow)
            for more details.
    Default: ''
    Equivalent to: [--SlidesExporter.reveal_url_prefix]
--nbformat=<Enum>
    The nbformat version to write.
            Use this to downgrade notebooks.
    Choices: any of [1, 2, 3, 4]
    Default: 4
    Equivalent to: [--NotebookExporter.nbformat_version]

Examples
--------

    The simplest way to use nbconvert is

            > jupyter nbconvert mynotebook.ipynb

            which will convert mynotebook.ipynb to the default format (pro
bably HTML).

            You can specify the export format with `--to`.
            Options include ['asciidoc', 'custom', 'html', 'latex', 'markd
own', 'notebook', 'pdf', 'python', 'rst', 'script', 'slides'].

            > jupyter nbconvert --to latex mynotebook.ipynb

            Both HTML and LaTeX support multiple output templates. LaTeX i
ncludes
            'base', 'article' and 'report'.  HTML includes 'basic' and 'fu
ll'. You
            can specify the flavor of the format used.

            > jupyter nbconvert --to html --template basic mynotebook.ipyn
b

            You can also pipe the output to stdout, rather than a file

            > jupyter nbconvert mynotebook.ipynb --stdout

            PDF is generated via latex

            > jupyter nbconvert mynotebook.ipynb --to pdf

            You can get (and serve) a Reveal.js-powered slideshow

            > jupyter nbconvert myslides.ipynb --to slides --post serve

            Multiple notebooks can be given at the command line in a coupl
e of
            different ways:

            > jupyter nbconvert notebook*.ipynb
            > jupyter nbconvert notebook1.ipynb notebook2.ipynb

            or you can specify the notebooks list in a config file, contai
ning::

                c.NbConvertApp.notebooks = ["my_notebook.ipynb"]
```

```
> jupyter nbconvert --config mycfg.py
```

To see all available configurables, use `--help-all`.

In [ ]: