In [ ]:
```
# 1.1 Expected Reward
```

In [392]:
```
x1 = float(1+3)/2.0
x2 = float(8-3)/2.0
x3 = float(5+2)/2.0
x4 = float(6-2)/2.0
x5 = float(4-3)/2.0
x6 = float(2-2)/2.0

expected_reward = ( 1+3+8-3+5+2+6-2+4+3+2-2) /12.0
print('Expectated reward =',expected_reward)
```

```
Expectated reward = 2.25
```

In [393]:
```
# 1.2 Sample average reward for 10 actions
```

In [394]:
```
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline

def cumulative_mean(values):
    return np.cumsum(values) / np.arange(1, len(values) + 1)

from scipy.signal import convolve
def moving_average_over100_rows(values):
    return convolve(values, np.ones(100) / 100., mode="same")

def sample_reward(action):
    if action == 0:
        return np.random.uniform(1, 3)
    elif action == 1:
        return np.random.uniform(-3, 8)
    elif action == 2:
        return np.random.uniform(2, 5)
    elif action == 3:
        return np.random.uniform(-2, 6)
    elif action == 4:
        return np.random.uniform(3, 4)
    else:
        return np.random.uniform(-2, 2)


def sample_reward2(action):
    if action == 0:
        return np.random.uniform(1, 3)
    elif action == 1:
        return np.random.uniform(-3, 8)
    elif action == 2:
        return np.random.uniform(2, 5)
    elif action == 3:
        return np.random.uniform(5, 7)
    elif action == 4:
        return np.random.uniform(3, 4)
    else:
        return np.random.uniform(-2, 2)
```

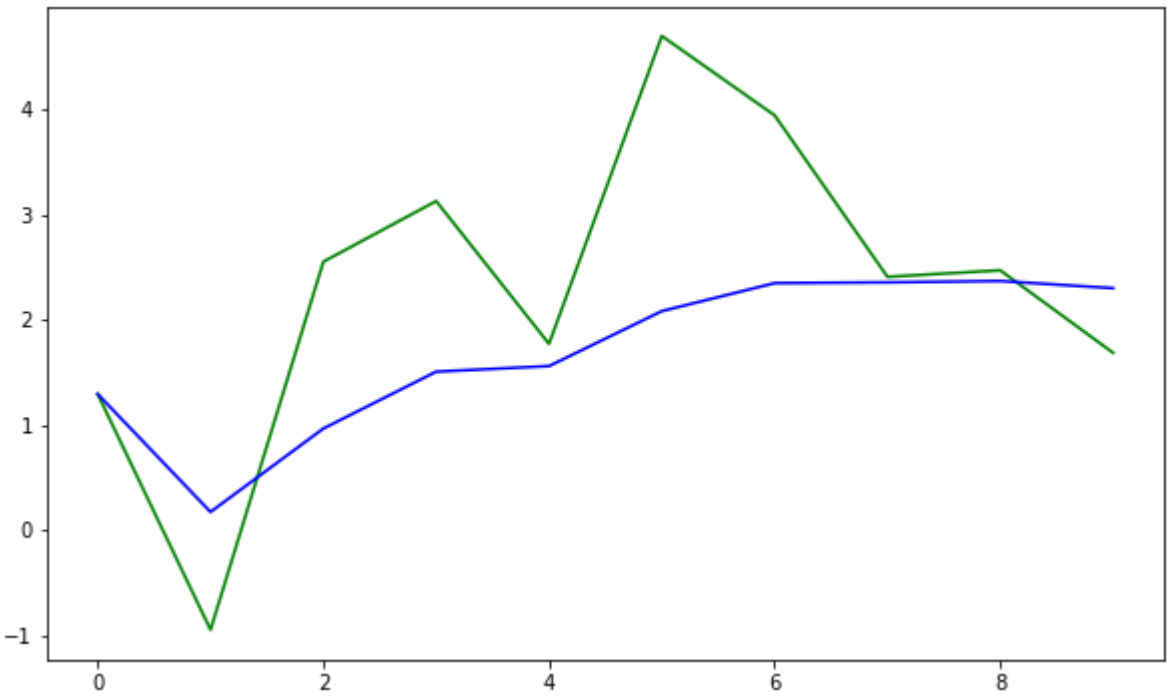
In [395]:
```
rewards = []
for i in range(10):
    action = np.random.randint(6)
    reward = sample_reward(action)
    rewards.append(reward)

print(expected_reward)
np.mean(rewards)
```

```
2.25
```

Out[395]:
```
2.3007049661689694
```

In [396]:
```
plt.figure(figsize=(10, 6))
plt.plot(rewards, color='green')
plt.plot(cumulative_mean(rewards), color='blue')
print(np.mean(rewards))
```

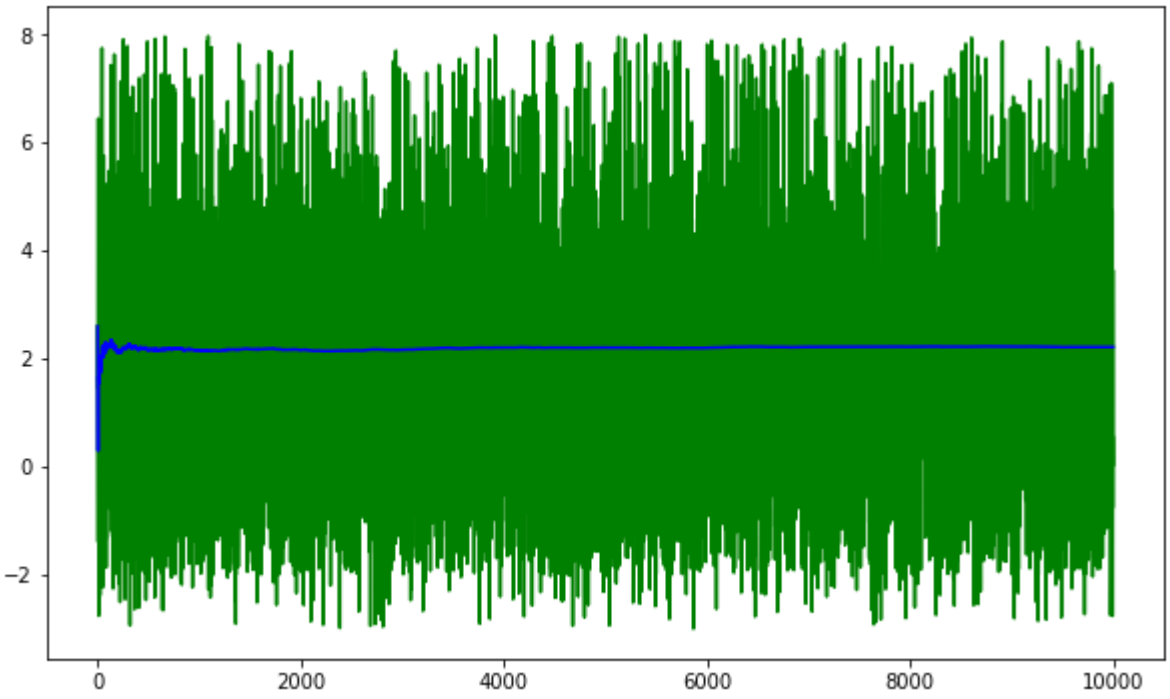
```
2.3007049661689694
```



In [397]:
```
# The expected reward ( when actions are chosen uniformly ) is 2.25 .  If we comp
# uniformly chosen actions we get a reward around that value. The more we increas
# converging to 2.25. We show it with 10000 sample spaces below instead of 10.
rewards = []
for i in range(10000):
    action = np.random.randint(6)
    reward = sample_reward(action)
    rewards.append(reward)

rewards1 = np.mean(rewards)

print("Average sample reward for 1000 sample spaces :: ",rewards1)
plt.figure(figsize=(10, 6))
plt.plot(rewards, color='green')

plt.plot(cumulative_mean(rewards), color='blue')
```

```
Average sample reward for 1000 sample spaces ::  2.2209328576272114
```

Out[397]:
```
[<matplotlib.lines.Line2D at 0x25acb5aa9b0>]
```

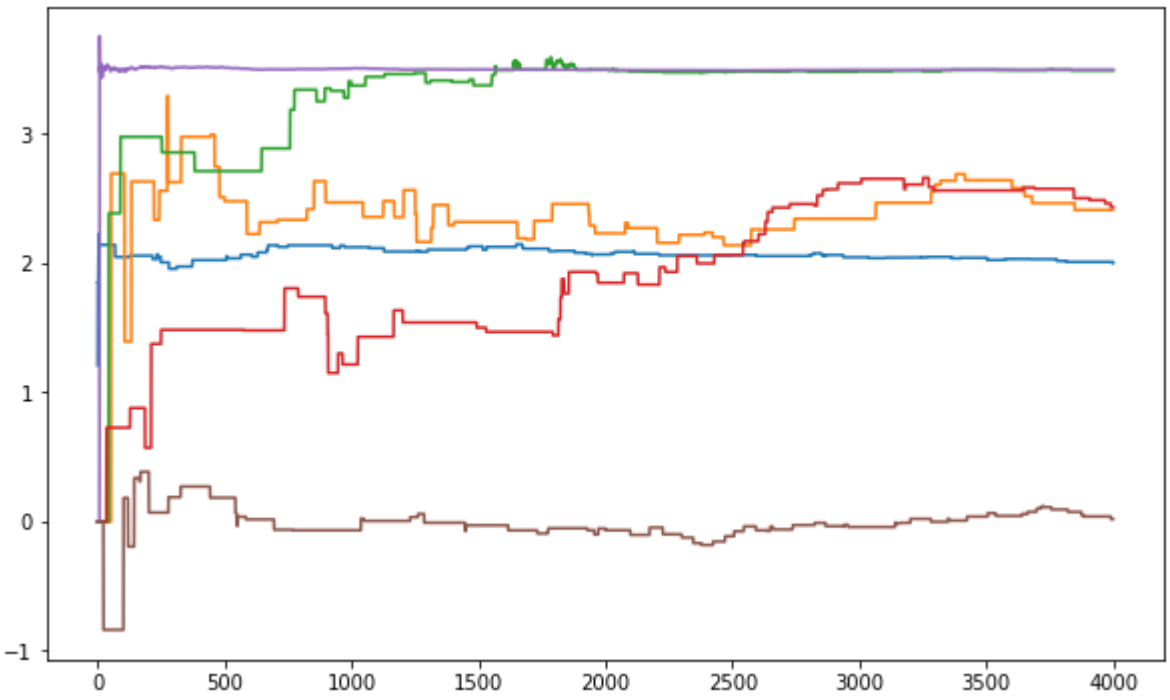


In [398]:
```
# 1.3 epsilon greedy method
```

In [399]:
```
epsilon = 0.1
k = 6
Q = np.zeros(k)
N = np.zeros(k)
R , A = [], []
Actions = np.empty((4000, k))
for steps in range(4000):
    if np.random.uniform() < epsilon:
        a = np.random.randint(k)
    else:
        a = np.argmax(Q)

    r = sample_reward(a)
    N[a] += 1
    Q[a] = Q[a] + (1.0 / (N[a])) * (r - Q[a])
    Actions[steps, :] = Q
    R.append(r)
    A.append(a)
```

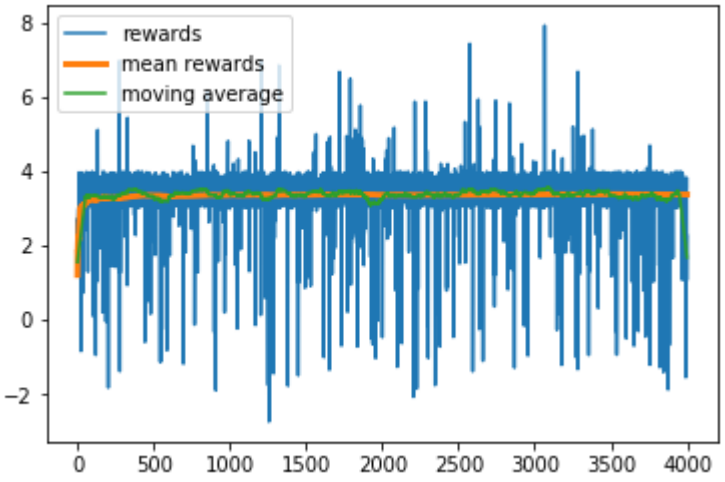
In [400]:
```
plt.figure(figsize=(10, 6))
plt.plot(Actions[:, 0])
plt.plot(Actions[:, 1])
plt.plot(Actions[:, 2])
plt.plot(Actions[:, 3])
plt.plot(Actions[:, 4])
plt.plot(Actions[:, 5])
```

Out[400]:
```
[<matplotlib.lines.Line2D at 0x25acbe12278>]
```



In [401]:
```
plt.plot(R, label='rewards')
plt.plot(cumulative_mean(R), linewidth=3, label='mean rewards')
from scipy.signal import convolve
plt.plot(moving_average_over100_rows(R), label='moving average')
plt.legend()
```

Out[401]:
```
<matplotlib.legend.Legend at 0x25acbe71828>
```

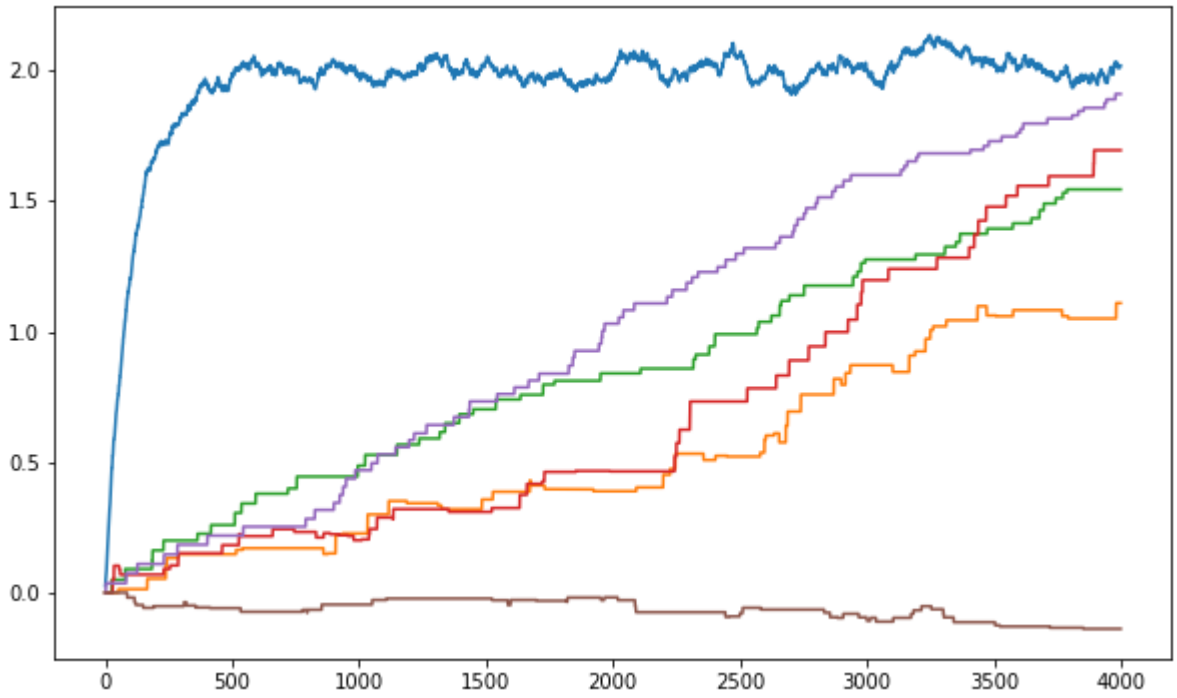


In [402]:
```
#1.4 Redo experiment with constant learning rate
```

In [403]:
```
epsilon = 0.1
k = 6
Q = np.zeros(k)
alpha = 0.01
R , A = [], []
Actions = np.empty((4000, k))
for steps in range(4000):
    if np.random.uniform() < epsilon:
        a = np.random.randint(k)
    else:
        a = np.argmax(Q)
    if steps > 2000:
        r = sample_reward2(a)
    else:
        r = sample_reward(a)
    Q[a] = Q[a] + alpha* (r - Q[a])
    Actions[steps, :] = Q
    R.append(r)
    A.append(a)
```

In [404]:
```
plt.figure(figsize=(10, 6))
plt.plot(Actions[:, 0])
plt.plot(Actions[:, 1])
plt.plot(Actions[:, 2])
plt.plot(Actions[:, 3])
plt.plot(Actions[:, 4])
plt.plot(Actions[:, 5])
```

Out[404]:
```
[<matplotlib.lines.Line2D at 0x25acc283240>]
```



In [405]:
```
plt.plot(R, label='rewards')
plt.plot(cumulative_mean(R), linewidth=3, label='mean rewards')
from scipy.signal import convolve
plt.plot(moving_average_over100_rows(R), label='moving average')
plt.legend()
```

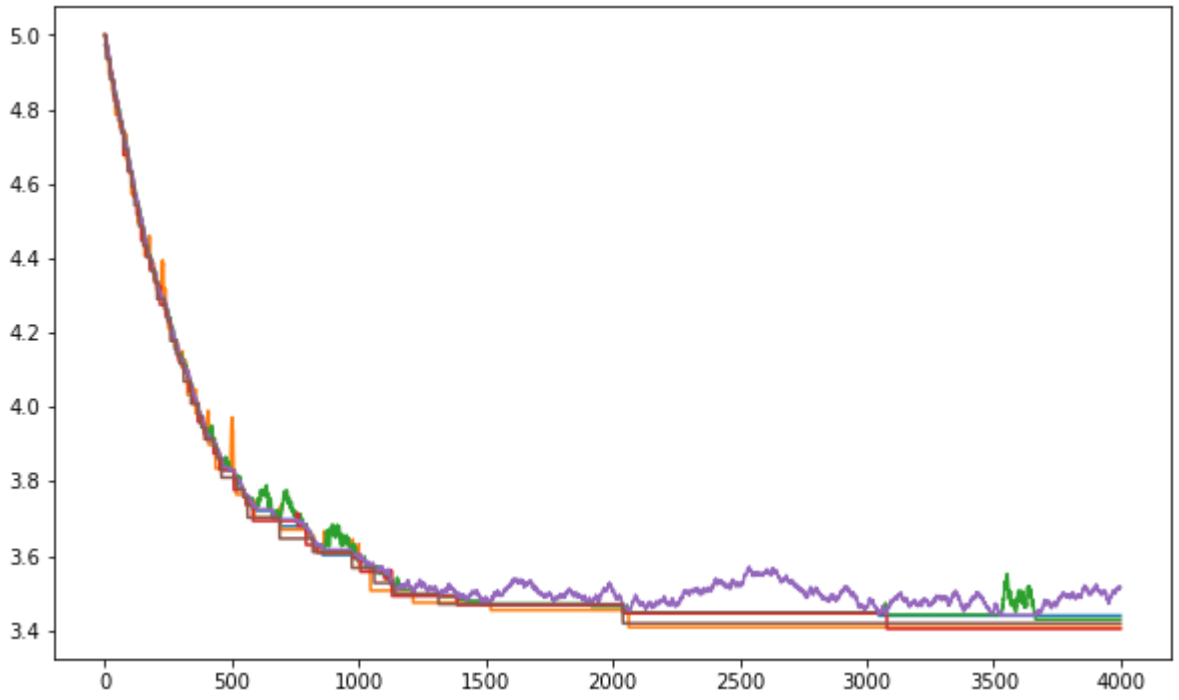
Out[405]:
```
<matplotlib.legend.Legend at 0x25acc2a1908>
```

In [406]:
```
#1.5 Greedy action
```

In [407]:
```
epsilon = 0.1
k = 6
Q = np.ones(k)*5
alpha = 0.01
R , A = [], []
Actions = np.empty((4000, k))
for steps in range(4000):
    a = np.argmax(Q)
    r = sample_reward(a)
    Q[a] = Q[a] + alpha* (r - Q[a])
    Actions[steps, :] = Q
    R.append(r)
    A.append(a)
```

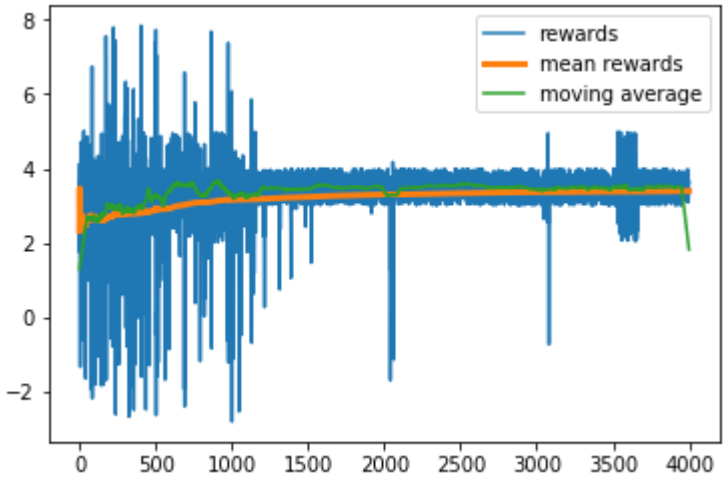
In [408]:
```
plt.figure(figsize=(10, 6))
plt.plot(Actions[:, 0])
plt.plot(Actions[:, 1])
plt.plot(Actions[:, 2])
plt.plot(Actions[:, 3])
plt.plot(Actions[:, 4])
plt.plot(Actions[:, 5])
```

Out[408]:
```
[<matplotlib.lines.Line2D at 0x25acc326240>]
```



In [409]:
```
plt.plot(R, label='rewards')
plt.plot(cumulative_mean(R), linewidth=3, label='mean rewards')
from scipy.signal import convolve
plt.plot(moving_average_over100_rows(R), label='moving average')
plt.legend()
```

Out[409]: <matplotlib.legend.Legend at 0x25acc38ccc0>



In [ ]:

In [ ]: