sutton-barto-reinforcement-ch-2

August 26, 2018

In [146]:
```
import numpy as np
import random
import numpy.random
import matplotlib.pyplot as plt

# EXERCISE 2.5

steps = 10000
runs = 2000

"""
returns data in the format

{
    "rewards": np.array([1.5, .2, ...]),
    "optimal": np.array([1, 0, ...])
}
"""
def ten_armed_bandit(sample_average = False):
    q = np.zeros(10)
    Q = np.zeros(10)

    rewards = []
    optimal = []

    for i in range(steps):
        arg_max_reward = None
        arg_max_actions = []

        for j in range(len(Q)):
            estimated_reward = Q[j]

            if arg_max_reward == None or estimated_reward > arg_max_reward:
                arg_max_reward = estimated_reward
                arg_max_actions = [j]

            elif estimated_reward == arg_max_reward:
                arg_max_actions.append(j)

        if random.uniform(0, 1) < .1:
            selected_action = random.choice(range(10))
        else:
            selected_action = random.choice(arg_max_actions)

        actual_reward = q[selected_action]
        alpha = 1/(i + 1) if sample_average else .1
        Q[selected_action] = Q[selected_action] + alpha * (actual_reward -
Q[selected_action])

        was_action_optimal = 1 if actual_reward == max(q) else 0

        rewards.append(actual_reward)
        optimal.append(was_action_optimal)
```

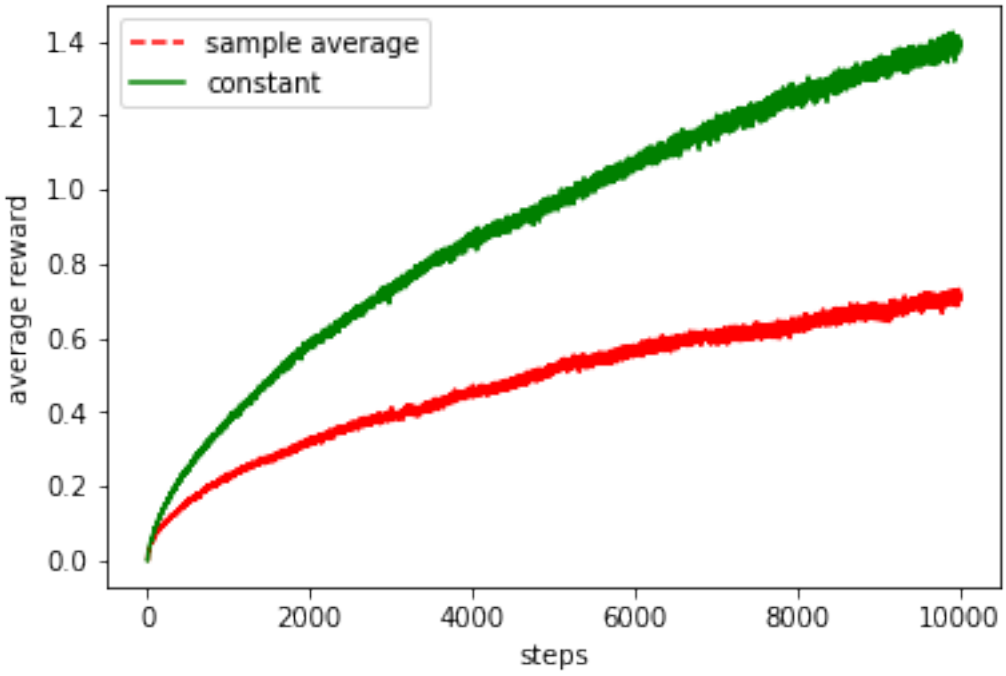
```
            random_walk_values = np.random.normal(0, .01, len(q))

            for j in range(len(q)):
                q[j] = q[j] + random_walk_values[j]

        return {
            "rewards": np.array(rewards),
            "optimal": np.array(optimal)
        }


    def average_bandit_results(sample_average = False):
        rewards = np.zeros(steps)
        optimal = np.zeros(steps)

        for i in range(runs):
            results = ten_armed_bandit(sample_average)
            rewards = rewards + (results["rewards"] / runs)
            optimal = optimal + (results["optimal"] / runs)

        return {
            "rewards": rewards,
            "optimal": optimal
        }

    def plot_average_rewards(with_sample_average, without_sample_average):
        plt.plot(with_sample_average, "r--", label = "sample average")
        plt.plot(without_sample_average, "g", label = "constant")
        plt.xlabel("steps")
        plt.ylabel("average reward")
        plt.legend()
        plt.show()

    def plot_average_optimality(with_sample_average, without_sample_average):
        plt.plot(with_sample_average, "r--", label = "sample average")
        plt.plot(without_sample_average, "g", label = "constant")
        plt.xlabel("steps")
        plt.ylabel("percent optimal")
        plt.legend()
        plt.show()
```

```
In [78]: %matplotlib inline
```

```
In [147]: with_sample_average = average_bandit_results(True)
```

```
In [148]: without_sample_average = average_bandit_results()
```

```
In [149]: plot_average_rewards(with_sample_average["rewards"], without_sample_average["rewards"])
```



In [150]:
```
plot_average_optimality(with_sample_average["optimal"],
without_sample_average["optimal"])
```