The following is the skeleton code for DynBandit env

In [1]:

```
# Gym Template for DynBandit Env Prepared by Kui Wu
# Since we do not publish the DynBandit Env, no need to register for it to

import numpy as np
import matplotlib.pyplot as plt
import gym
import random
import time

from gym import Env, spaces

class DynBandit(Env):
    def __init__(self):
        # Define the observation space, there are five arms, each having tw
        self.observation_space = spaces.Tuple((spaces.Discrete(2), spaces.D
                spaces.Discrete(2), spaces.Discrete(2)))

        # Define an action space ranging from 0 to 4, 0: the first arm, ...
        self.action_space = spaces.Discrete(5)

        # STUDENT CODE HERE
        # initialization with the given parameters specified in Assignment
        self.arm_pos = [0,0,0,0,0]
        self.mean_high = [2,4,6,8,10]
        self.mean_low = [0,1,2,3,1]

    def reset(self):
        # STUDENT CODE HERE
        # An episode is over, initialization for running next episode
        ## Important note: for each new episode, you must reset the random
        ## Otherwise, your episodes are not independent. This is a common e
        ## For example, you can use np.random.seed(time.time()) to avoid th
        self.arm_pos = [0,0,0,0,0]
        np.random.seed(int(time.time()))


    def _get_obs(self):
        pass # We assume the bandit does not disclose state information.

    def step(self, action):
        done = False
        reward = None
        # Assert that it is a valid action
        assert self.action_space.contains(action), "Invalid Action"

        # STUDENT CODE HERE:
        # apply the action, generate the corresponding reward, and update t
        if action == 0:
            reward = np.random.normal(self.mean_high[0], 1) if self.arm_pos
            prob = np.random.uniform(0,1)
            if prob>=0.6:
                self.arm_pos[0] = 1 - self.arm_pos[0]
        elif action == 1:
            reward = np.random.normal(self.mean_high[1], 1) if self.arm_pos
            prob = np.random.uniform(0,1)
            if prob>=0.6:
                self.arm_pos[1] = 1 - self.arm_pos[1]
        elif action == 2:
```

```
            if prob>=0.6:
                self.arm_pos[3] = 1 - self.arm_pos[3]
        elif action == 4:
            reward = np.random.normal(self.mean_high[4], 1) if self.arm_pos
            prob = np.random.uniform(0,1)
            if prob>=0.6:
                self.arm_pos[4] = 1 - self.arm_pos[4]

        return [], reward, done, []
```

The following is the template code of RL agent:

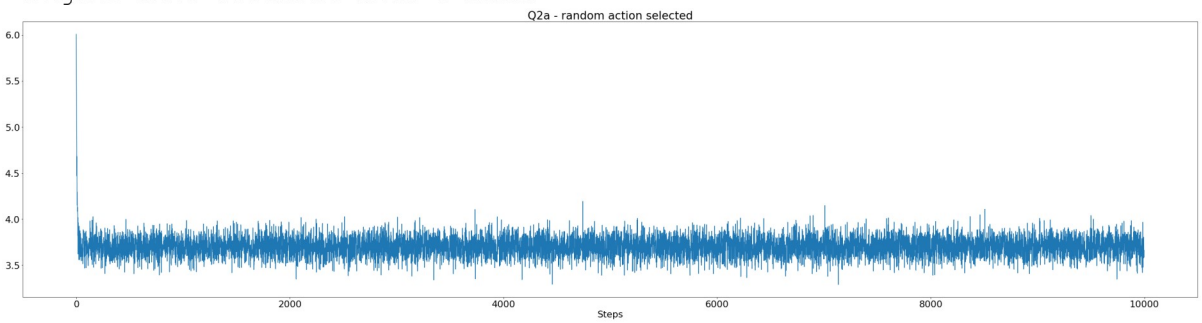
In [13]:

```
#Dynbandit RL agent, Template prepared by Kui Wu
# STUDENT CODE: FOLLOW THE TEMPLATE AND IMPLEMENT THE REQUIRED POLICY IN RL
# For simplicity, we do not write separate test code


if __name__ == '__main__':
    env = DynBandit()
    avg_reward = np.zeros(10000)

    plt.figure(figsize=(50,12))
    fig, ax1 = plt.subplots()
    fig.set_size_inches(50,12)
    #plt.rcParams.update({'font.size': 22})

    for _ in range(2000):
        env.reset()
        step_reward = np.zeros((10000,2))

        for i in range(10000):
            # Take a random action.

            action = env.action_space.sample()

        # Note that You will need to replace the random policy with your imp
        # write the code for other policies in the RL agent rather than the

            obs, reward, done, info = env.step(action)

            #print(action, reward) # print action, reward for TA to check i
            #print(type(reward))
        # Record reward, store historical rewards for calculation
            step_reward[i, :] = [i, reward]

        # reach 10000 steps. the end of this episode
        avg_reward += step_reward[:,1]
        #print(step_reward)
    # record/calculate the statistical result for the current episode
    #print(avg_reward)
    avg_reward /= 2000
    #print(avg_reward)
    #print(step_reward)
    ax1.plot(avg_reward)
    ax1.set_title("Q2a - random action selected")
    ax1.set_xlabel("Steps")
    env.close()

#calculate the final statistical result

# plot the final result by averaging the 100 episodes

    env1 = DynBandit()
    avg_reward_greedy = np.zeros(10000)
    plt.figure(figsize=(50,12))
    fig1, ax2 = plt.subplots()
    fig1.set_size_inches(50,12)

    for _ in range(2000):
        env1.reset()
```

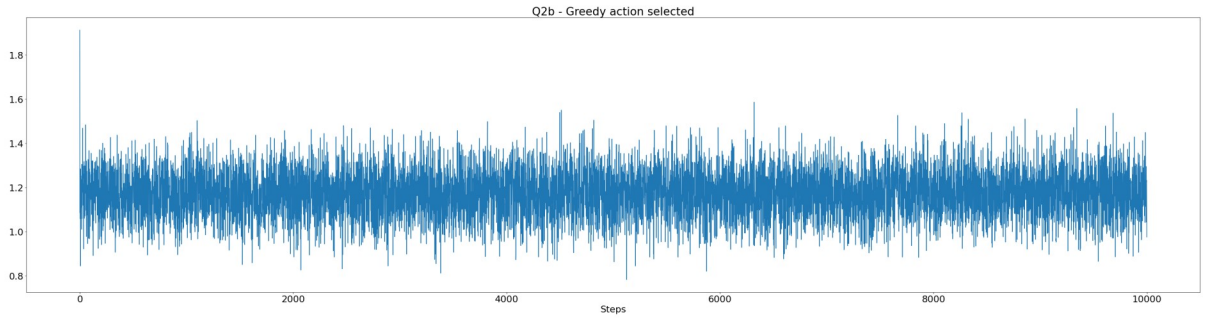
```
            #print(reward_estimates)
            obs, reward_greedy, done, info = env1.step(action_greedy)
            step_reward_greedy[j,:] = [j, reward_greedy]
            action_taken[action_greedy] += 1
            reward_estimates[action_greedy] += (reward_greedy - reward_estir

        avg_reward_greedy += step_reward_greedy[:,1]

    avg_reward_greedy /= 2000
    ax2.plot(avg_reward_greedy)
    ax2.set_title("Q2b - Greedy action selected")
    ax2.set_xlabel("Steps")

    env1.close()


    env2 = DynBandit()
    avg_reward_eps = np.zeros(10000)
    plt.figure(figsize=(50,12))
    fig2, ax3 = plt.subplots()
    fig2.set_size_inches(50,12)

    for _ in range(2000):
        env2.reset()
        reward_estimates_eps = np.zeros(5)
        action_taken1 = np.zeros(5)
        step_reward_eps = np.zeros((10000,2))
        epsilon = 0.1

        for k in range(10000):

            if np.random.random() < epsilon:
                action_epsilon = np.random.randint(5)
            else:
                action_epsilon = np.argmax(reward_estimates_eps)

            obs, reward_epsilon, done, info = env2.step(action_epsilon)
            step_reward_eps[k,:] = [k, reward_epsilon]
            action_taken1[action_epsilon] += 1
            reward_estimates_eps[action_epsilon] += (reward_epsilon - rewar

        avg_reward_eps += step_reward_eps[:,1]

    avg_reward_eps /= 2000
    ax3.plot(avg_reward_eps)
    ax3.set_title("Q2b - epsilon -greedy with epsilon=0.1")
    ax3.set_xlabel("Steps")
    env2.close()

    env3 = DynBandit()
    avg_reward_eps1 = np.zeros(10000)
    plt.figure(figsize=(50,12))
```

```
                action_epsilon1 = np.argmax(reward_estimates_eps)

            obs, reward_epsilon1, done, info = env3.step(action_epsilon1)
            step_reward_eps1[l,:] = [l, reward_epsilon1]
            action_taken2[action_epsilon1] += 1
            reward_estimates_eps1[action_epsilon1] += (reward_epsilon1 - rev

        avg_reward_eps1 += step_reward_eps1[:,1]

    avg_reward_eps1 /= 2000
    ax4.plot(avg_reward_eps1)
    ax4.set_title("Q2b - epsilon -greedy with epsilon=0.15")
    ax4.set_xlabel("Steps")
    env3.close()

    plt.figure(figsize=(50,12))
    fig4, ax5 = plt.subplots()
    fig4.set_size_inches(50,12)

    ax5.plot(avg_reward, label=r"random")
    ax5.plot(avg_reward_greedy, label=r"greedy")
    ax5.plot(avg_reward_eps, label=r"$\epsilon$=0.1")
    ax5.plot(avg_reward_eps1, label=r"$\epsilon$=0.15")
    ax5.set_title("Combined Q2")
    ax5.set_xlabel("Steps")
    ax5.legend()
```

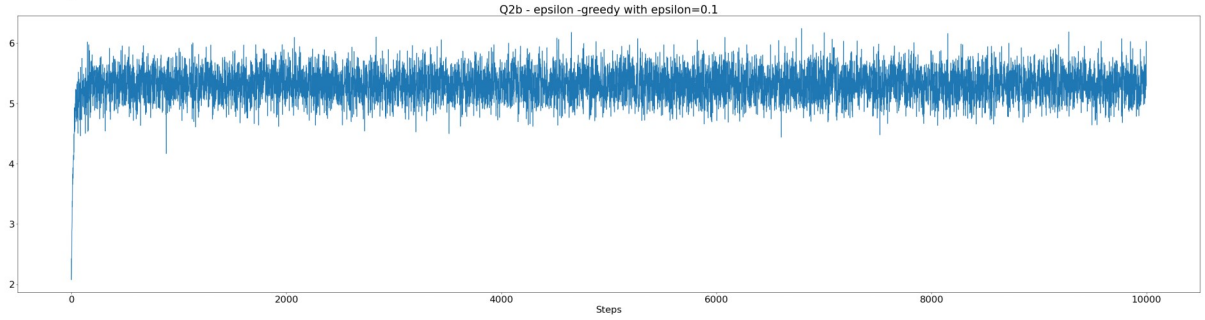
```
<Figure size 3600x864 with 0 Axes>
```



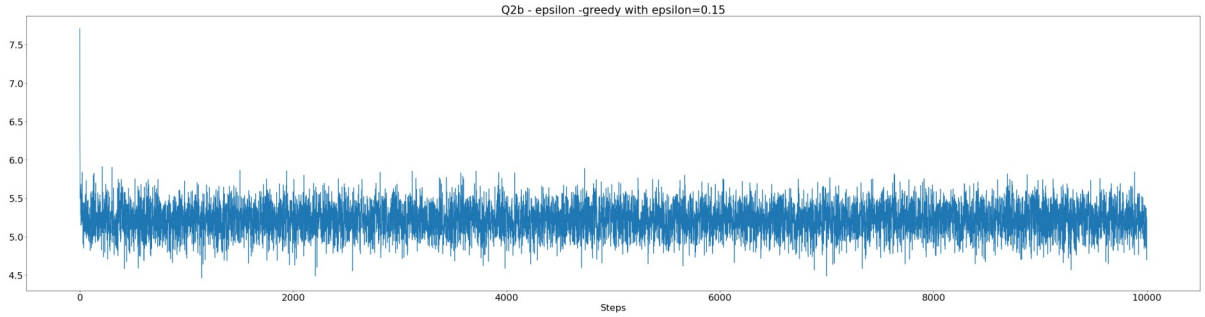

```
<Figure size 3600x864 with 0 Axes>
```



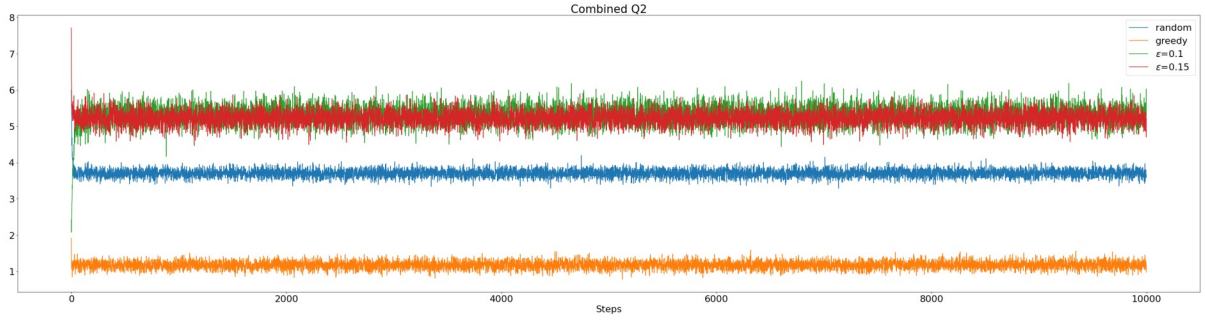

```
<Figure size 3600x864 with 0 Axes>
```




```
<Figure size 3600x864 with 0 Axes>
```




```
<Figure size 3600x864 with 0 Axes>
```



In [ ]:

In [ ]: