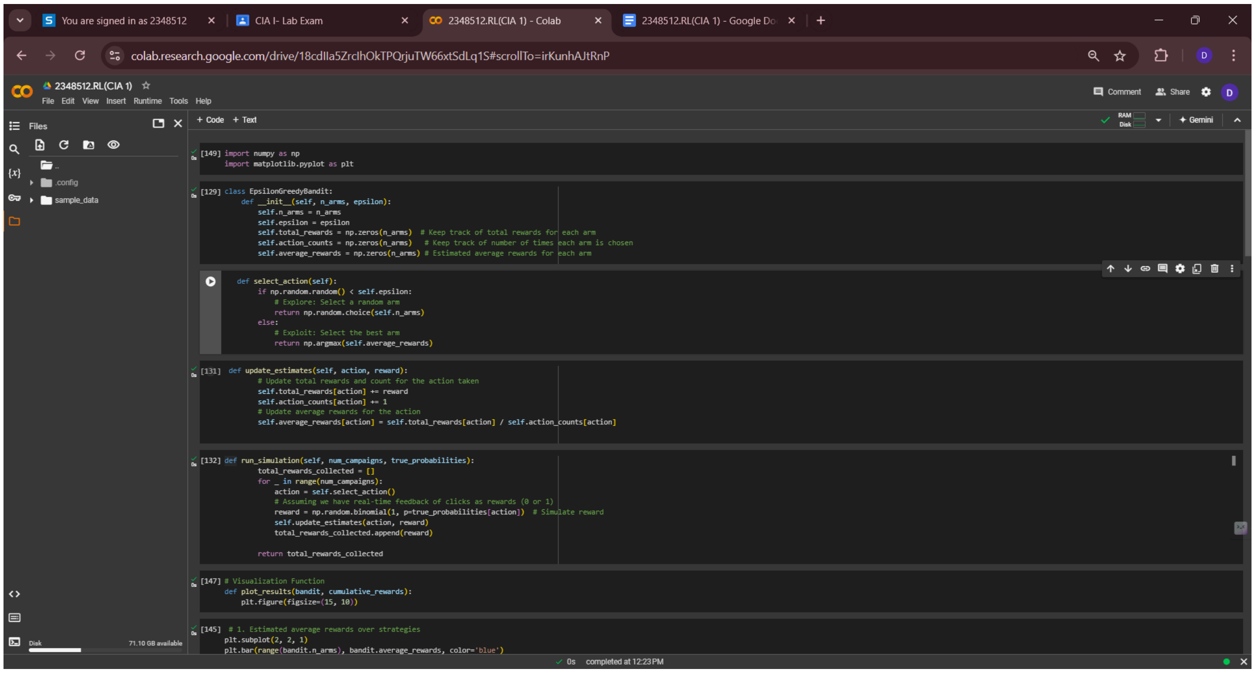
Question1:

Python implementation of the algorithm: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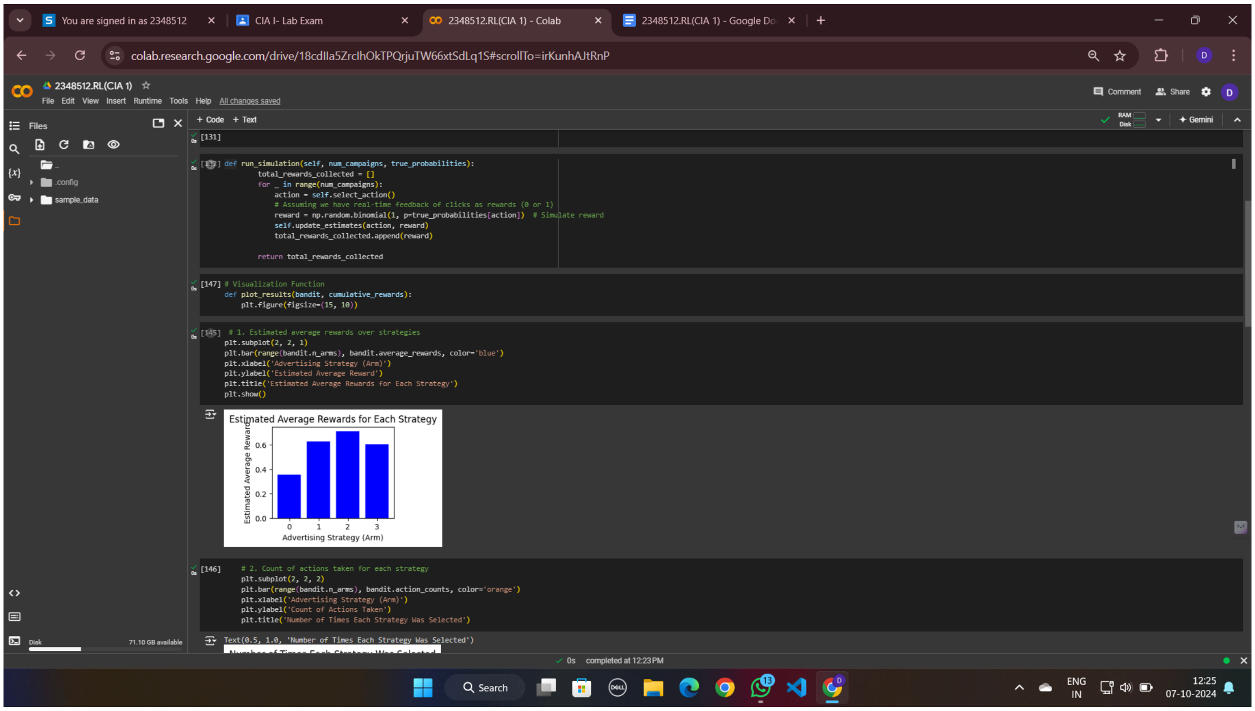
```
[149] import numpy as np
      import matplotlib.pyplot as plt

[129] class EpsilonGreedyBandit:
          def __init__(self, n_arms, epsilon):
              self.n_arms = n_arms
              self.epsilon = epsilon
              self.total_rewards = np.zeros(n_arms)  # Keep track of total rewards for each arm
              self.action_counts = np.zeros(n_arms)   # Keep track of number of times each arm is chosen
              self.average_rewards = np.zeros(n_arms) # Estimated average rewards for each arm

        def select_action(self):
            if np.random.random() < self.epsilon:
                # Explore: Select a random arm
                return np.random.choice(self.n_arms)
            else:
                # Exploit: Select the best arm
                return np.argmax(self.average_rewards)

[131]  def update_estimates(self, action, reward):
              # Update total rewards and count for the action taken
              self.total_rewards[action] += reward
              self.action_counts[action] += 1
              # Update average rewards for the action
              self.average_rewards[action] = self.total_rewards[action] / self.action_counts[action]

[132] def run_simulation(self, num_campaigns, true_probabilities):
              total_rewards_collected = []
              for _ in range(num_campaigns):
                  action = self.select_action()
                  # Assuming we have real-time feedback of clicks as rewards (0 or 1)
                  reward = np.random.binomial(1, p=true_probabilities[action])  # Simulate reward
                  self.update_estimates(action, reward)
                  total_rewards_collected.append(reward)

              return total_rewards_collected

[147] # Visualization Function
      def plot_results(bandit, cumulative_rewards):
          plt.figure(figsize=(15, 10))

[145]  # 1. Estimated average rewards over strategies
      plt.subplot(2, 2, 1)
      plt.bar(range(bandit.n_arms), bandit.average_rewards, color='blue')
```

Average Rewards over strategies: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Estimated Average Rewards for Each Strategy
Estimated Average Reward
0.0
0.2
0.4
0.6
0
1
2
3
Advertising Strategy (Arm)
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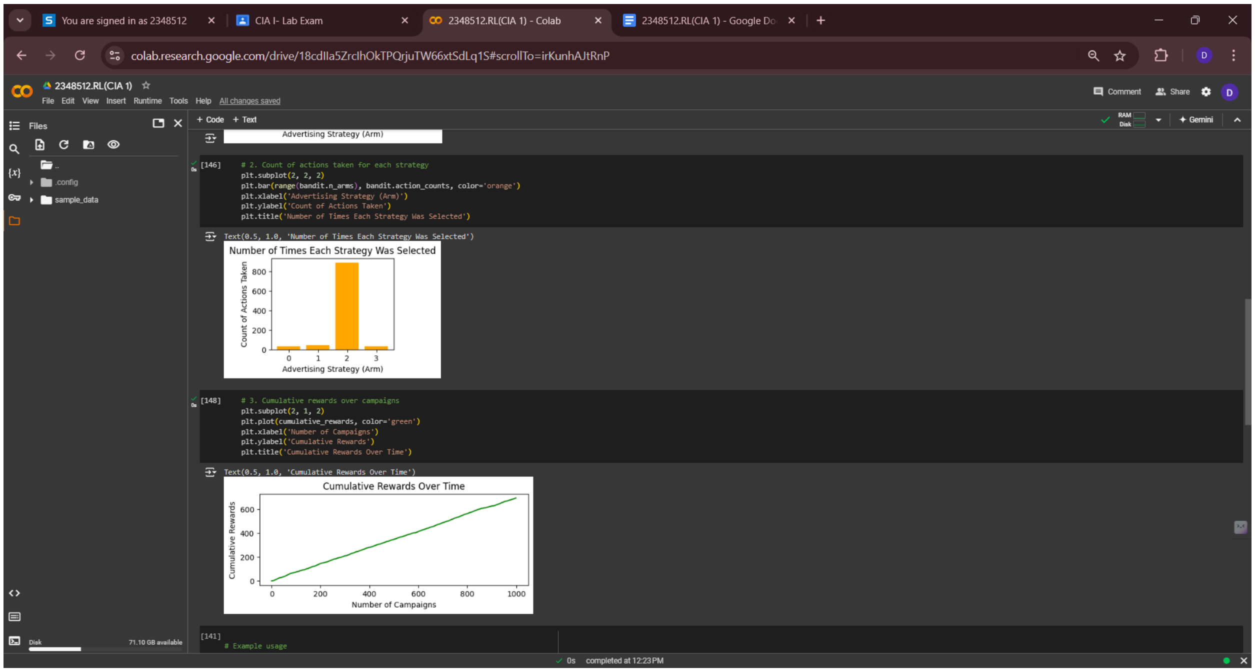
```
[131]

[132] def run_simulation(self, num_campaigns, true_probabilities):
              total_rewards_collected = []
              for _ in range(num_campaigns):
                  action = self.select_action()
                  # Assuming we have real-time feedback of clicks as rewards (0 or 1)
                  reward = np.random.binomial(1, p=true_probabilities[action])  # Simulate reward
                  self.update_estimates(action, reward)
                  total_rewards_collected.append(reward)

              return total_rewards_collected

[147] # Visualization Function
      def plot_results(bandit, cumulative_rewards):
          plt.figure(figsize=(15, 10))

[145]  # 1. Estimated average rewards over strategies
      plt.subplot(2, 2, 1)
      plt.bar(range(bandit.n_arms), bandit.average_rewards, color='blue')
      plt.xlabel('Advertising Strategy (Arm)')
      plt.ylabel('Estimated Average Reward')
      plt.title('Estimated Average Rewards for Each Strategy')
      plt.show()

[146]     # 2. Count of actions taken for each strategy
          plt.subplot(2, 2, 2)
          plt.bar(range(bandit.n_arms), bandit.action_counts, color='orange')
          plt.xlabel('Advertising Strategy (Arm)')
          plt.ylabel('Count of Actions Taken')
          plt.title('Number of Times Each Strategy Was Selected')

Text(0.5, 1.0, 'Number of Times Each Strategy Was Selected')
```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Gemini
Advertising Strategy (Arm)
Number of Times Each Strategy Was Selected
Count of Actions Taken
800
600
400
200
0
0
1
2
3
Advertising Strategy (Arm)
Cumulative Rewards Over Time
Cumulative Rewards
600
400
200
0
0
200
400
600
800
1000
Number of Campaigns
Disk
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```
[146]   # 2. Count of actions taken for each strategy
        plt.subplot(2, 2, 2)
        plt.bar(range(bandit.n_arms), bandit.action_counts, color='orange')
        plt.xlabel('Advertising Strategy (Arm)')
        plt.ylabel('Count of Actions Taken')
        plt.title('Number of Times Each Strategy Was Selected')
```

```
Text(0.5, 1.0, 'Number of Times Each Strategy Was Selected')
```

```
[148]   # 3. Cumulative rewards over campaigns
        plt.subplot(2, 1, 2)
        plt.plot(cumulative_rewards, color='green')
        plt.xlabel('Number of Campaigns')
        plt.ylabel('Cumulative Rewards')
        plt.title('Cumulative Rewards Over Time')
```

```
Text(0.5, 1.0, 'Cumulative Rewards Over Time')
```

```
[141]
    # Example usage
```

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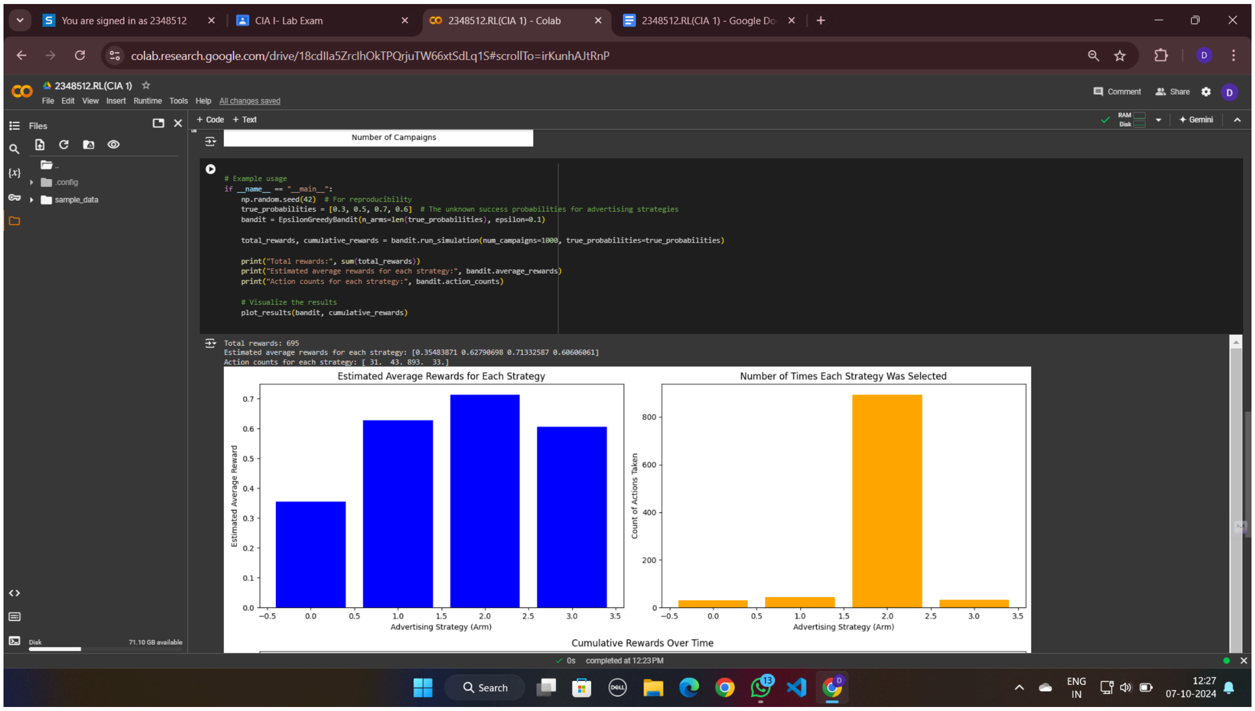
Show how the algorithm helps to choose the best-performing advertising strategy over time:



```
# Example usage
if __name__ == "__main__":
    np.random.seed(42)  # For reproducibility
    true_probabilities = [0.3, 0.5, 0.7, 0.6]  # The unknown success probabilities for advertising strategies
    bandit = EpsilonGreedyBandit(n_arms=len(true_probabilities), epsilon=0.1)

    total_rewards, cumulative_rewards = bandit.run_simulation(num_campaigns=1000, true_probabilities=true_probabilities)

    print("Total rewards:", sum(total_rewards))
    print("Estimated average rewards for each strategy:", bandit.average_rewards)
    print("Action counts for each strategy:", bandit.action_counts)

    # Visualize the results
    plot_results(bandit, cumulative_rewards)
```

```
Total rewards: 695
Estimated average rewards for each strategy: [0.35483871 0.62790698 0.71332587 0.60606061]
Action counts for each strategy: [ 31.  43. 893.  33.]
```

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Number of Campaigns
Estimated Average Rewards for Each Strategy
Estimated Average Reward
Advertising Strategy (Arm)
Number of Times Each Strategy Was Selected
Count of Actions Taken
Cumulative Rewards Over Time
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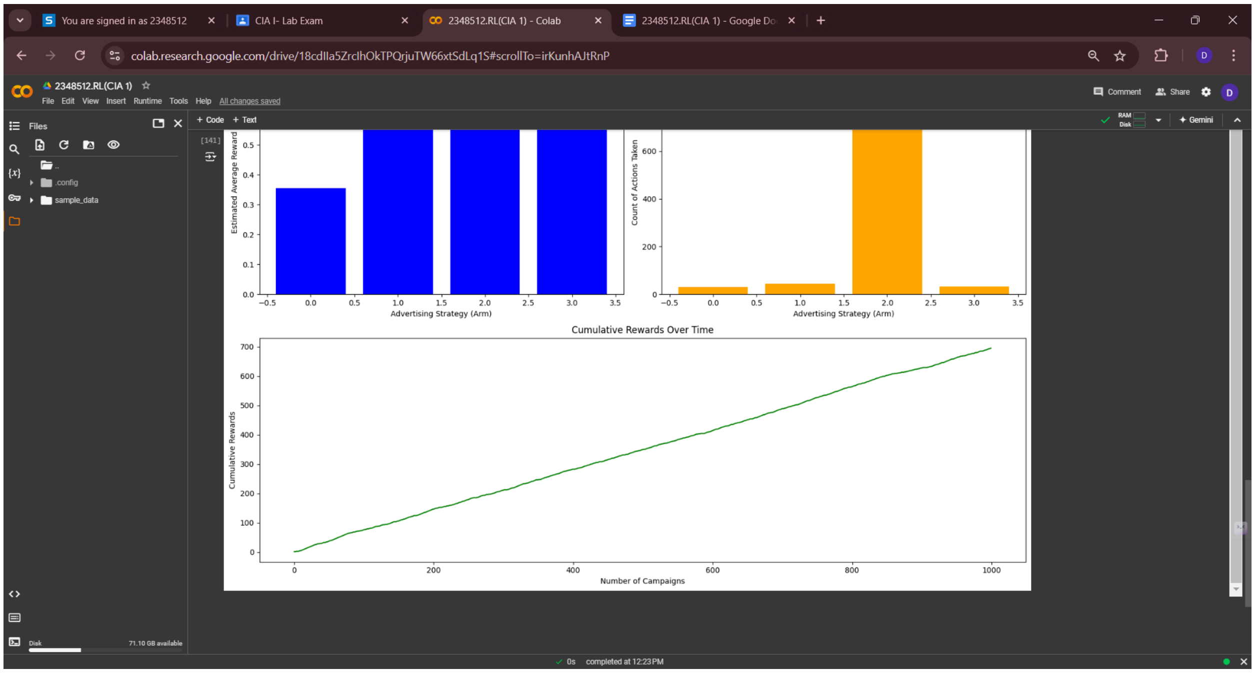

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[141]
Estimated Average Reward
0.0
0.1
0.2
0.3
0.4
0.5
−0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
Advertising Strategy (Arm)
Count of Actions Taken
0
200
400
600
Cumulative Rewards Over Time
Cumulative Rewards
0
100
200
300
400
500
600
700
0 200 400 600 800 1000
Number of Campaigns
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