**Practical - 2**

**Aim:** Implementation of Unsupervised Learning Algorithms from Scratch and Reinforcement Learning using ϵ (epsilon)-greedy algorithm.

**Problem Statement:** Download an unlabeled dataset (.csv) and implement different unsupervised learning algorithms like K-Means clustering. Additionally, implement reinforcement learning using the ϵ (epsilon)-greedy algorithm. Understand the methodologies, implementation details, and libraries of each of these learning algorithms. Compare the performance of each algorithm for the given dataset.

**Theory:**

**K-Means Clustering:** K-Means is an unsupervised learning algorithm used for clustering. It partitions data points into 'K' clusters based on similarity. The steps involved are:

1. Load the dataset.
2. Preprocess the data (scaling features in this case).
3. Determine the optimal number of clusters (K) using methods like the silhouette score.
4. Fit the K-Means clustering model with the optimal K.
5. Get cluster assignments and cluster centers.
6. Visualize the clusters.

**Reinforcement Learning (ϵ-greedy algorithm):** Reinforcement learning is a type of machine learning where an agent learns how to behave in an environment by performing actions and receiving rewards. The ε (epsilon)-greedy algorithm is a simple exploration-exploitation strategy. The steps involved are:

1. Initialize parameters, such as the number of arms, reward probabilities, and ε.
2. Create a function to simulate rewards based on the probability of each arm.
3. Initialize a memory array for action-values.
4. Implement a greedy method to select the best arm based on the memory array.
5. Run the algorithm for a specified number of iterations, balancing exploration (choosing random arms) and exploitation (choosing the best-known arm).
6. Calculate and visualize the average reward over time.

**Algorithms Theory:**

**K-Means Clustering:** K-Means aims to minimize the sum of squared distances between data points and their respective cluster centers. It iteratively assigns data points to the nearest cluster center and updates the cluster centers. This process continues until convergence.

**Reinforcement Learning (ϵ-greedy algorithm):** In the ε-greedy algorithm, with probability ε, the agent explores a random arm, and with probability 1-ε, it exploits the arm with the highest estimated reward based on previous experience. Over time, the algorithm learns which arm is the most rewarding and gradually shifts towards exploiting that arm.

**Result Analysis:**

**K-Means Clustering:**

* For K-Means clustering, the optimal number of clusters (K) is determined using the silhouette score.
* Cluster assignments and centers are obtained.
* The clusters are visualized for analysis.

**Reinforcement Learning (ϵ-greedy algorithm):**

* The ε-greedy algorithm is used to balance exploration and exploitation.
* The algorithm is run for a specified number of iterations, and the average reward over time is calculated.
* A scatter plot is created to visualize how the average reward changes as the algorithm learns.

**Conclusion:**

In this practical, we explored two different types of machine learning algorithms:

1. K-Means Clustering: We applied K-Means clustering to an unlabeled dataset, determined the optimal number of clusters, and visualized the clusters. K-Means is useful for unsupervised data analysis, allowing us to group similar data points together.
2. Reinforcement Learning (ϵ-greedy algorithm): We implemented a simple reinforcement learning algorithm that balances exploration and exploitation. This type of algorithm is commonly used in scenarios where an agent learns to make decisions by interacting with an environment and receiving feedback in the form of rewards.