k-Mean Clustering

Learning Type: Unsupervised, Task: Clustering, Algorithm: k-mean Clustering

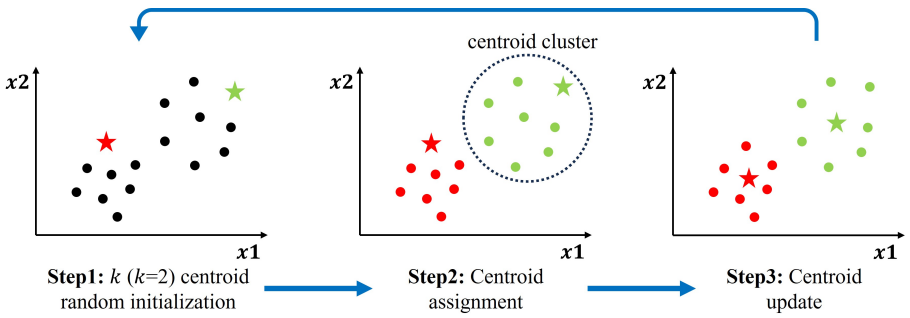
Definition:

It is a clustering algorithm where data points are assigned into k groups, based on the closest distance between each group's centroid(mean) to the data point. All data points assigned to the same centroid form a group which is called a cluster. For k groups, we will have k centroids and the corresponding k clusters.

Applications: it is used in pattern recognition, market segmentation, and image compression.

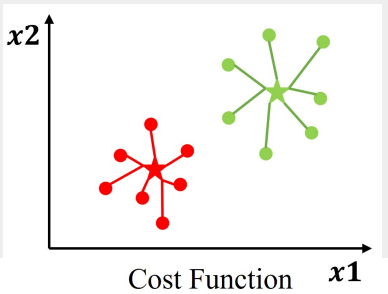
Algorithm of k-mean Clustering:

Step1: Specify k centroids (random datapoints) corresponding to k clusters.
Step2: Assign each data point to the closest centroid.
Step3: Compute the new centroid by taking the average (mean) of each data point assigned to the same cluster. Continue until the centroids do not change or the maximum number of iterations is reached.



Evaluation Criteria 1: Cost Function

It is the sum of the distance of each data point from the centroid in the assigned cluster.
$J = \sum_{j=1}^{k} \sum_{i=1}^{m} a_{ij} \left\| x_i - \mu_j \right\|_2^2$
where
$a_{ij} = 1$ if x_i belongs to j cluster and $a_{ij} = 0$ if x_i does not belong to j cluster



Evaluation Criteria 2: Silhouette Coefficient

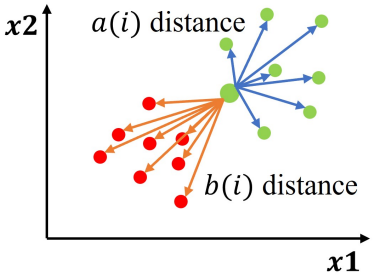
It is a measure of how similar a data point is within-cluster (cohesion) compared to other clusters (separation). The silhouette coefficient is between [-1, 1]. 1 means distinct clusters, 0 denotes overlapping and -1 means worst case.

$$S(i) = (b(i) - a(i))/max(a(i), b(i))$$

and for each cluster

$$AverageSilhouette = mean(S(i))$$

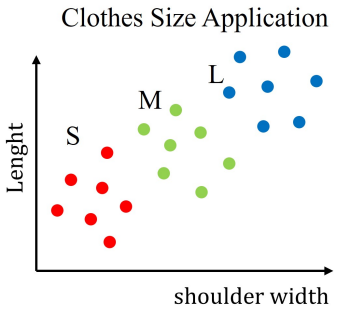
$S(i)$ is a silhouette score for datapoint i, $a(i)$ is the average distance between i and all data points belong to a cluster of i, $b(i)$ is the average distance between i and all other data points of neighboring clusters.

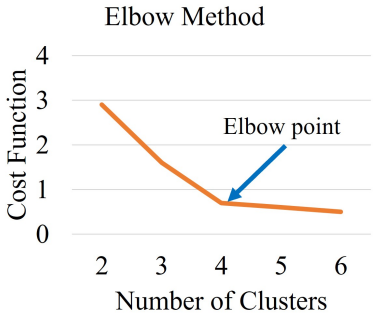


How to select the value of k:

1. Based on the Application: Number of clusters k can be decided based on an application like dress size will be small, medium, and large.

2. Based on Elbow Method: In this method, observe the end of sudden fall of the cost function in the plot of cost function vs k, that point is selected for k value and the point is called elbow point.





How to initialize the value of centroids:

1. Random data points: Initialize by randomly choosing k data points. This method is highly volatile.
2. The least Cost Value Cost function is computed with multiple random initializations. The specific initialization is selected which gives the lowest cost function value. This method is computationally expensive.
3. k-means++: The first centroid is selected randomly, and the other centroids are placed as far away from each other as possible, based on the squared distance from the existing centroids. k-means++.

For any mistake/query: alishafique3@gmail.com For references and updates: Website, Github