**Ques.** What is k-means algorithm? Explain with an example.

## Ans. Introduction to K-Means Algorithm

K-means clustering algorithm computes the centroids and iterates until we it finds optimal centroid. It assumes that the number of clusters are already known. It is also called **flat clustering** algorithm. The number of clusters identified from data by algorithm is represented by 'K' in K-means.

## Working of K-Means Algorithm

We can understand the working of K-Means clustering algorithm with the help of following steps −

**Step 1** − First, we need to specify the number of clusters, K, need to be generated by this algorithm.

**Step 2** − Next, randomly select K data points and assign each data point to a cluster. In simple words, classify the data based on the number of data points.

**Step 3** − Now it will compute the cluster centroids.

**Step 4** − Next, keep iterating the following until we find optimal centroid which is the assignment of data points to the clusters that are not changing any more

- **4.1** − First, the sum of squared distance between data points and centroids would be computed.
- **4.2** − Now, we have to assign each data point to the cluster that is closer than other cluster (centroid).
- **4.3** − At last compute the centroids for the clusters by taking the average of all data points of that cluster.

K-means follows **Expectation-Maximization** approach to solve the problem. The Expectation-step is used for assigning the data points to the closest cluster and the Maximization-step is used for computing the centroid of each cluster.

The following two examples of implementing K-Means clustering algorithm will help us in its better understanding −

### Example 1

Let us move to another example in which we are going to apply K-means clustering on simple digits dataset. K-means will try to identify similar digits without using the original label information.

First, we will start by importing the necessary packages −

```
%matplotlib inline
import matplotlib.pyplot as plt
import seaborn as sns; sns.set()
import numpy as np
```

```
from sklearn.cluster import KMeans
```

Next, load the digit dataset from sklearn and make an object of it. We can also find number of rows and columns in this dataset as follows −

```
from sklearn.datasets import load_digits
digits = load_digits()
digits.data.shape
```

**Output**

```
(1797, 64)
```

The above output shows that this dataset is having 1797 samples with 64 features.

We can perform the clustering as we did in Example 1 above −

```
kmeans = KMeans(n_clusters = 10, random_state = 0)
clusters = kmeans.fit_predict(digits.data)
kmeans.cluster_centers_.shape
```

**Output**

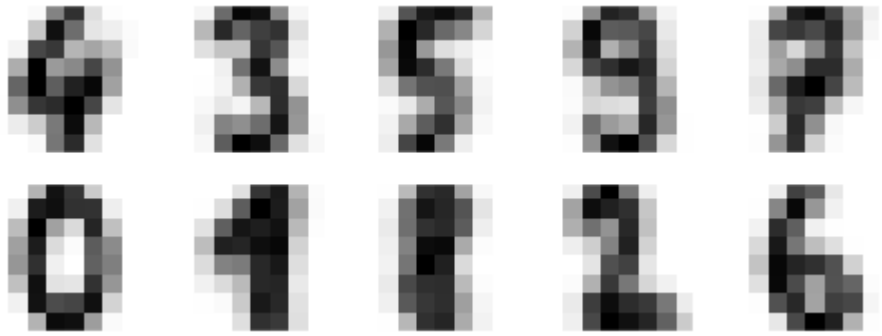
```
(10, 64)
```

The above output shows that K-means created 10 clusters with 64 features.

```
fig, ax = plt.subplots(2, 5, figsize=(8, 3))
centers = kmeans.cluster_centers_.reshape(10, 8, 8)
for axi, center in zip(ax.flat, centers):
axi.set(xticks=[], yticks=[])
axi.imshow(center, interpolation='nearest', cmap=plt.cm.binary)
```

**Output**

As output, we will get following image showing clusters centers learned by k-means.



The following lines of code will match the learned cluster labels with the true labels found in them −

```
from scipy.stats import mode
labels = np.zeros_like(clusters)
for i in range(10):
   mask = (clusters == i)
   labels[mask] = mode(digits.target[mask])[0]
```

Next, we can check the accuracy as follows −

```
from sklearn.metrics import accuracy_score
accuracy_score(digits.target, labels)
```

**Output**

```
0.7935447968836951
```

The above output shows that the accuracy is around 80%.