ML LAB ASSIGNMENT - 6

Name - Vivek Kamboj

Roll No - 2018IMT-109

You may use the appropriate python libraries do do the following assignments and make suitable assumptions. Note the assumptions without fail. Give Visual outputs wherever u deem necessary.

1. Considering the IRIS dataset discussed in previous assignment, apply EM algorithm to cluster the data (without considering the output labels) Use the same dataset for clustering using K-means algorithm. Compare the results of these two algorithms.

1. Apply PCA algorithm to obtain first two principal components and perform the clustering using both algorithms on the resultant data. Compare the results of these two algorithms.

In [63]:

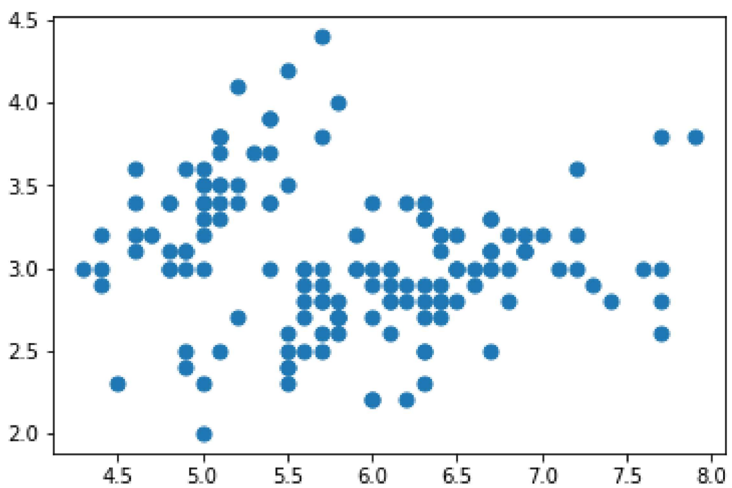
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from scipy import stats
```

In [64]:

```
from sklearn.datasets import load_iris
data = load_iris()
df = pd.DataFrame(data.data, columns=data.feature_names)
df.head()
X=data.data

Y=data.target
df = np.array(df)
```

In [65]:

```
plt.scatter(df[:, 0], df[:, 1], s=50);
```



In [66]:

```
pd.DataFrame(data.data, columns=data.feature_names).describe()
```

Out[66]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
count	150.000000	150.000000	150.000000	150.000000
mean	5.843333	3.057333	3.758000	1.199333
std	0.828066	0.435866	1.765298	0.762238
min	4.300000	2.000000	1.000000	0.100000
25%	5.100000	2.800000	1.600000	0.300000
50%	5.800000	3.000000	4.350000	1.300000

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
75%	6.400000	3.300000	5.100000	1.800000
max	7.900000	4.400000	6.900000	2.500000

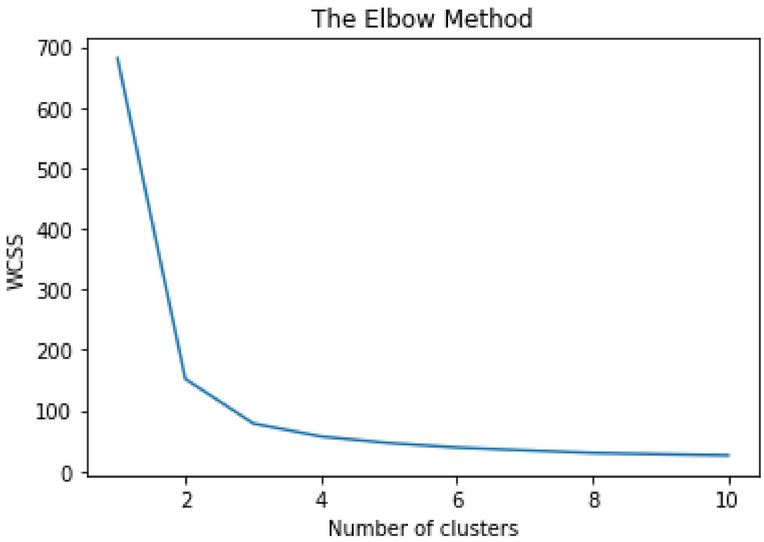
K-Means Clustering

Finding no of clusters on our dataset by Elbow method

In the Elbow method, we are actually varying the number of clusters (K) from 1 – 10. For each value of K, we are calculating WCSS (Within-Cluster Sum of Square). WCSS is the sum of squared distance between each point and the centroid in a cluster. When we plot the WCSS with the K value, the plot looks like an Elbow. As the number of clusters increases, the WCSS value will start to decrease. WCSS value is largest when K = 1. When we analyze the graph we can see that the graph will rapidly change at a point and thus creating an elbow shape. From this point, the graph starts to move almost parallel to the X-axis. The K value corresponding to this point is the optimal K value or an optimal number of clusters.

In [67]:

```
from sklearn.cluster import KMeans
wcss = []
for i in range(1, 11):
    kmeans = KMeans(n_clusters = i, init = 'k-means++', random_state = 42)
    kmeans.fit(df)
    wcss.append(kmeans.inertia_)
plt.plot(range(1, 11), wcss)
plt.title('The Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')
plt.show()
```



Since elbow lie at 3 on x-axis. We can conclude the no of clusters is 3.

In [68]:

```
kmeans = KMeans(n_clusters = 3, init = 'k-means++', random_state = 42)
y_kmeans = kmeans.fit_predict(df)

y_kmeans
```

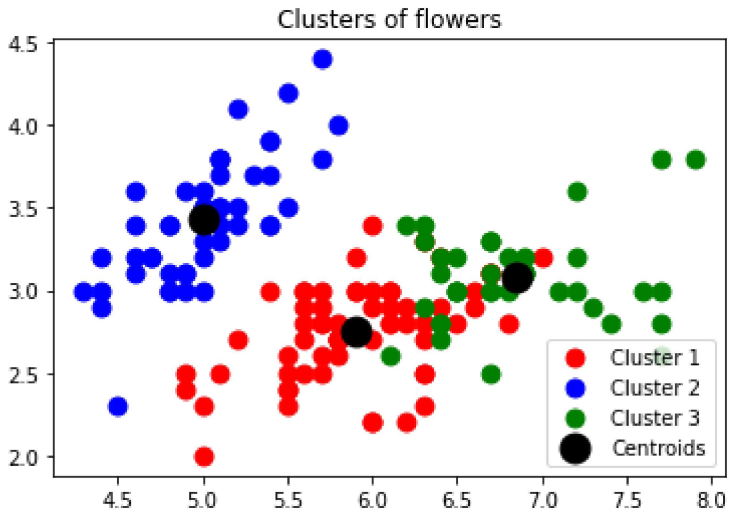
Out[68]:

```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 2, 2, 2, 2, 0, 2, 2, 2,
       2, 2, 2, 0, 0, 2, 2, 2, 2, 0, 2, 0, 2, 0, 2, 2, 0, 0, 2, 2, 2, 2,
       2, 0, 2, 2, 2, 2, 0, 2, 2, 2, 0, 2, 2, 2, 0, 2, 2, 0], dtype=int32)
```

In [70]:
```
from sklearn.metrics import accuracy_score

print('The accuracy of K-Mean model is: {}'.format(accuracy_score(Y,y_kmeans)))
```

```
The accuracy of K-Mean model is: 0.24
```

In [71]:
```
plt.scatter(df[y_kmeans == 0, 0], df[y_kmeans == 0, 1], s = 80, c = 'red', label = 'Cluster 1')
plt.scatter(df[y_kmeans == 1, 0], df[y_kmeans == 1, 1], s = 80, c = 'blue', label = 'Cluster 2'
plt.scatter(df[y_kmeans == 2, 0], df[y_kmeans == 2, 1], s = 80, c = 'green', label = 'Cluster 3

plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], s = 220, c = 'black',
plt.title('Clusters of flowers')

plt.legend()
plt.show()
```



An insight we can get from the scatterplot is the model's accuracy in determining Cluster 2 is comparatively more to Cluster 1 and Cluster 3.

PCA

In [72]:
```
from sklearn.decomposition import PCA
pca = PCA(n_components = 2)
dfs = pca.fit_transform(df)

explained_variance = pca.explained_variance_ratio_
```

In [73]:
```
explained_variance
```

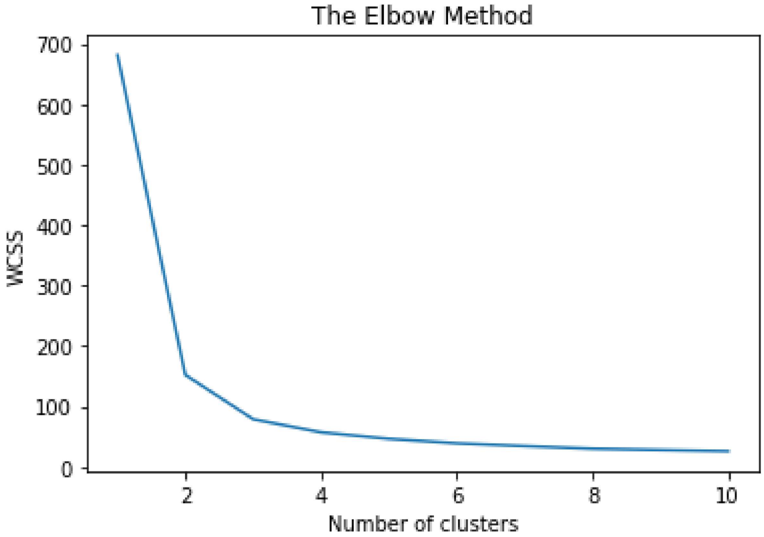
Out[73]:
```
array([0.92461872, 0.05306648])
```

1st and 2nd elements represents variance in 1st and 2nd columns in transformed dataset respectively

In [75]:
```
#dfs
```

K-Means with PCA

In [76]:
```
wcss_p = []
for i in range(1, 11):
    kmeans = KMeans(n_clusters = i, init = 'k-means++', random_state = 42)
    kmeans.fit(dfs)
    wcss_p.append(kmeans.inertia_)
plt.plot(range(1, 11), wcss)
plt.title('The Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')
plt.show()
```



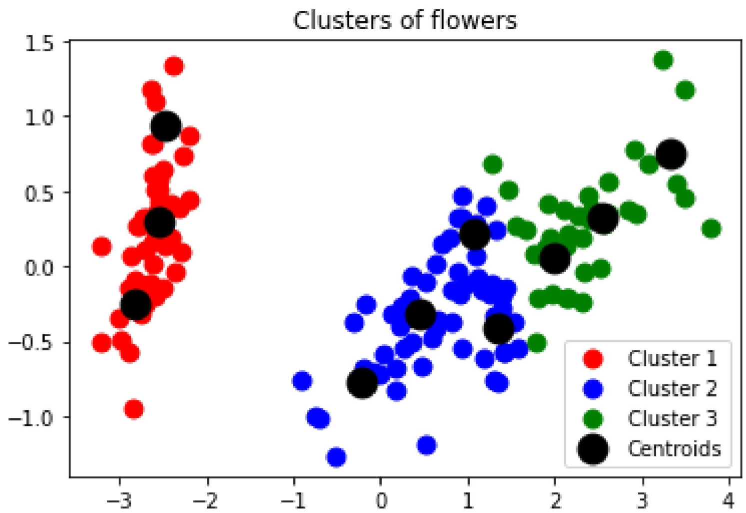
In [77]:
```
kmeans_p = KMeans(n_clusters = 3, init = 'k-means++', random_state = 42)
y_kmeans_p= kmeans_p.fit_predict(dfs)

y_kmeans_p
```

Out[77]:
```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 2, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 1, 2, 2, 2, 2, 1, 2, 2, 2,
       2, 2, 2, 1, 1, 2, 2, 2, 2, 1, 2, 1, 2, 1, 2, 2, 1, 1, 2, 2, 2, 2,
       2, 1, 2, 2, 2, 2, 1, 2, 2, 2, 1, 2, 2, 2, 1, 2, 2, 1], dtype=int32)
```

In [78]:
```
#from sklearn.metrics import accuracy_score

print('The accuracy of K-Mean model with PCA is: {}'.format(accuracy_score(Y,y_kmeans_p)))
```

```
The accuracy of K-Mean model with PCA is: 0.8866666666666667
```

In [79]:
```
plt.scatter(dfs[y_kmeans_p == 0, 0], dfs[y_kmeans_p == 0, 1], s = 80, c = 'red', label = 'Clust
plt.scatter(dfs[y_kmeans_p == 1, 0], dfs[y_kmeans_p == 1, 1], s = 80, c = 'blue', label = 'Clus
plt.scatter(dfs[y_kmeans_p == 2, 0], dfs[y_kmeans_p == 2, 1], s = 80, c = 'green', label = 'Clu

plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], s = 220, c = 'black',
plt.title('Clusters of flowers')

plt.legend()
plt.show()
```



In [79]:

An insight we can get from the scatterplot is the model's accuracy in determining Cluster 1 is comparatively more to Cluster 2 and Cluster 3.

EM algorithm

In [81]:
```
from sklearn.datasets import load_iris
iris = load_iris()
from sklearn.utils import shuffle
X = pd.DataFrame(iris.data)

Y = pd.DataFrame(iris.target)
X,Y = shuffle(X,Y)
from sklearn.mixture import GaussianMixture

model21=GaussianMixture(n_components=3,random_state=3425)
model21.fit(X)

uu= model21.predict(X)

#Accuracy of EM Model

#from sklearn.metrics import confusion_matrix

#cm=confusion_matrix(Y,uu)

#print(cm)

#from sklearn.metrics import accuracy_score

print('The accuracy of EM model is: {}'.format(accuracy_score(Y,uu)))
```

```
The accuracy of EM model is: 0.3333333333333333
```

EM algorithm with PCA

In [82]:
```
from sklearn.datasets import load_iris
iris = load_iris()
from sklearn.utils import shuffle
X = pd.DataFrame(iris.data)

Y = pd.DataFrame(iris.target)
X,Y = shuffle(X,Y)

from sklearn.decomposition import PCA

pca = PCA(n_components=2)
X_p = pca.fit_transform(X)

from sklearn.mixture import GaussianMixture

model2=GaussianMixture(n_components=3,random_state=3425)
model2.fit(X_p)

res= model2.predict(X_p)

#Accuracy of EM Model with PCA

#from sklearn.metrics import confusion_matrix

#cm=confusion_matrix(Y,res)

#print(cm)

#from sklearn.metrics import accuracy_score

print('The accuracy of EM model is: {}'.format(accuracy_score(Y,res)))
```

```
The accuracy of EM model is: 0.98
```

RESULTS

Accuracy of K-means and EM models

1. **The accuracy of K-Mean model is: 0.24**
2. **The accuracy of EM model is: 0.3333333333333333**

Accuracy of K-means and EM models on applying PCA

1. **The accuracy of K-Mean model with PCA is: 0.8866666666666667**
2. **The accuracy of EM model is: 0.98**

Conclusion

It can be observed that in both, raw data and PCA data (dimensionally reduced data), EM algorithm seems to behave and perform better as compared to K-means model. EM Algorithm is a solid alternative to traditional k-means clustering on semi-supervised learning. It produces stable solutions by finding multivariate Gaussian distributions for each cluster.