**Program 7**

**Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program (Note: Install numpy, pandas, sklearn)**

from sklearn.cluster import KMeans

from sklearn.mixture import GaussianMixture

import sklearn.metrics as metrics

import pandas as pd

import numpy as np

import matplotlib.pyplot as plt

names = ['Sepal\_Length','Sepal\_Width','Petal\_Length','Petal\_Width', 'Class']

dataset = pd.read\_csv("7-dataset.csv", names=names)

X = dataset.iloc[:, :-1]

label = {'Iris-setosa': 0,'Iris-versicolor': 1, 'Iris-virginica': 2}

y = [label[c] for c in dataset.iloc[:, -1]]

plt.figure(figsize=(14,7))

colormap=np.array(['red','lime','black'])

# REAL PLOT

plt.subplot(1,3,1)

plt.title('Real')

plt.scatter(X.Petal\_Length,X.Petal\_Width,c=colormap[y])

# K-PLOT

model=KMeans(n\_clusters=3, random\_state=0).fit(X)

plt.subplot(1,3,2)

plt.title('KMeans')

plt.scatter(X.Petal\_Length,X.Petal\_Width,c=colormap[model.labels\_])

print('The accuracy score of K-Mean: ',metrics.accuracy\_score(y, model.labels\_))

print('The Confusion matrixof K-Mean:\n',metrics.confusion\_matrix(y, model.labels\_))

# GMM PLOT

gmm=GaussianMixture(n\_components=3, random\_state=0).fit(X)

y\_cluster\_gmm=gmm.predict(X)

plt.subplot(1,3,3)

plt.title('GMM Classification')

plt.scatter(X.Petal\_Length,X.Petal\_Width,c=colormap[y\_cluster\_gmm])

print('The accuracy score of EM: ',metrics.accuracy\_score(y, y\_cluster\_gmm))

print('The Confusion matrix of EM:\n ',metrics.confusion\_matrix(y, y\_cluster\_gmm))

Data set

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5.1 | 3.5 | 1.4 | 0.2 | Iris-setosa |
| 4.9 | 3 | 1.4 | 0.2 | Iris-setosa |
| 4.7 | 3.2 | 1.3 | 0.2 | Iris-setosa |
| 4.6 | 3.1 | 1.5 | 0.2 | Iris-setosa |
| 5 | 3.6 | 1.4 | 0.2 | Iris-setosa |
| 5.4 | 3.9 | 1.7 | 0.4 | Iris-setosa |
| 4.6 | 3.4 | 1.4 | 0.3 | Iris-setosa |
| 5 | 3.4 | 1.5 | 0.2 | Iris-setosa |
| 4.4 | 2.9 | 1.4 | 0.2 | Iris-setosa |
| 4.9 | 3.1 | 1.5 | 0.1 | Iris-setosa |
| 5.4 | 3.7 | 1.5 | 0.2 | Iris-setosa |
| 4.8 | 3.4 | 1.6 | 0.2 | Iris-setosa |
| 4.8 | 3 | 1.4 | 0.1 | Iris-setosa |
| 4.3 | 3 | 1.1 | 0.1 | Iris-setosa |
| 5.8 | 4 | 1.2 | 0.2 | Iris-setosa |
| 5.7 | 4.4 | 1.5 | 0.4 | Iris-setosa |
| 5.4 | 3.9 | 1.3 | 0.4 | Iris-setosa |
| 5.1 | 3.5 | 1.4 | 0.3 | Iris-setosa |
| 5.7 | 3.8 | 1.7 | 0.3 | Iris-setosa |
| 5.1 | 3.8 | 1.5 | 0.3 | Iris-setosa |
| 5.4 | 3.4 | 1.7 | 0.2 | Iris-setosa |
| 5.1 | 3.7 | 1.5 | 0.4 | Iris-setosa |
| 4.6 | 3.6 | 1 | 0.2 | Iris-setosa |
| 5.1 | 3.3 | 1.7 | 0.5 | Iris-setosa |
| 4.8 | 3.4 | 1.9 | 0.2 | Iris-setosa |
| 5 | 3 | 1.6 | 0.2 | Iris-setosa |
| 5 | 3.4 | 1.6 | 0.4 | Iris-setosa |
| 5.2 | 3.5 | 1.5 | 0.2 | Iris-setosa |
| 5.2 | 3.4 | 1.4 | 0.2 | Iris-setosa |
| 4.7 | 3.2 | 1.6 | 0.2 | Iris-setosa |
| 4.8 | 3.1 | 1.6 | 0.2 | Iris-setosa |
| 5.4 | 3.4 | 1.5 | 0.4 | Iris-setosa |
| 5.2 | 4.1 | 1.5 | 0.1 | Iris-setosa |
| 5.5 | 4.2 | 1.4 | 0.2 | Iris-setosa |
| 4.9 | 3.1 | 1.5 | 0.1 | Iris-setosa |
| 5 | 3.2 | 1.2 | 0.2 | Iris-setosa |
| 5.5 | 3.5 | 1.3 | 0.2 | Iris-setosa |
| 4.9 | 3.1 | 1.5 | 0.1 | Iris-setosa |
| 4.4 | 3 | 1.3 | 0.2 | Iris-setosa |
| 5.1 | 3.4 | 1.5 | 0.2 | Iris-setosa |
| 5 | 3.5 | 1.3 | 0.3 | Iris-setosa |
| 4.5 | 2.3 | 1.3 | 0.3 | Iris-setosa |
| 4.4 | 3.2 | 1.3 | 0.2 | Iris-setosa |
| 5 | 3.5 | 1.6 | 0.6 | Iris-setosa |
| 5.1 | 3.8 | 1.9 | 0.4 | Iris-setosa |
| 4.8 | 3 | 1.4 | 0.3 | Iris-setosa |
| 5.1 | 3.8 | 1.6 | 0.2 | Iris-setosa |
| 4.6 | 3.2 | 1.4 | 0.2 | Iris-setosa |
| 5.3 | 3.7 | 1.5 | 0.2 | Iris-setosa |
| 5 | 3.3 | 1.4 | 0.2 | Iris-setosa |
| 7 | 3.2 | 4.7 | 1.4 | Iris-versicolor |
| 6.4 | 3.2 | 4.5 | 1.5 | Iris-versicolor |
| 6.9 | 3.1 | 4.9 | 1.5 | Iris-versicolor |
| 5.5 | 2.3 | 4 | 1.3 | Iris-versicolor |
| 6.5 | 2.8 | 4.6 | 1.5 | Iris-versicolor |
| 5.7 | 2.8 | 4.5 | 1.3 | Iris-versicolor |
| 6.3 | 3.3 | 4.7 | 1.6 | Iris-versicolor |
| 4.9 | 2.4 | 3.3 | 1 | Iris-versicolor |
| 6.6 | 2.9 | 4.6 | 1.3 | Iris-versicolor |
| 5.2 | 2.7 | 3.9 | 1.4 | Iris-versicolor |
| 5 | 2 | 3.5 | 1 | Iris-versicolor |
| 5.9 | 3 | 4.2 | 1.5 | Iris-versicolor |
| 6 | 2.2 | 4 | 1 | Iris-versicolor |
| 6.1 | 2.9 | 4.7 | 1.4 | Iris-versicolor |
| 5.6 | 2.9 | 3.6 | 1.3 | Iris-versicolor |
| 6.7 | 3.1 | 4.4 | 1.4 | Iris-versicolor |
| 5.6 | 3 | 4.5 | 1.5 | Iris-versicolor |
| 5.8 | 2.7 | 4.1 | 1 | Iris-versicolor |
| 6.2 | 2.2 | 4.5 | 1.5 | Iris-versicolor |
| 5.6 | 2.5 | 3.9 | 1.1 | Iris-versicolor |
| 5.9 | 3.2 | 4.8 | 1.8 | Iris-versicolor |
| 6.1 | 2.8 | 4 | 1.3 | Iris-versicolor |
| 6.3 | 2.5 | 4.9 | 1.5 | Iris-versicolor |
| 6.1 | 2.8 | 4.7 | 1.2 | Iris-versicolor |
| 6.4 | 2.9 | 4.3 | 1.3 | Iris-versicolor |
| 6.6 | 3 | 4.4 | 1.4 | Iris-versicolor |
| 6.8 | 2.8 | 4.8 | 1.4 | Iris-versicolor |
| 6.7 | 3 | 5 | 1.7 | Iris-versicolor |
| 6 | 2.9 | 4.5 | 1.5 | Iris-versicolor |
| 5.7 | 2.6 | 3.5 | 1 | Iris-versicolor |
| 5.5 | 2.4 | 3.8 | 1.1 | Iris-versicolor |
| 5.5 | 2.4 | 3.7 | 1 | Iris-versicolor |
| 5.8 | 2.7 | 3.9 | 1.2 | Iris-versicolor |
| 6 | 2.7 | 5.1 | 1.6 | Iris-versicolor |
| 5.4 | 3 | 4.5 | 1.5 | Iris-versicolor |
| 6 | 3.4 | 4.5 | 1.6 | Iris-versicolor |
| 6.7 | 3.1 | 4.7 | 1.5 | Iris-versicolor |
| 6.3 | 2.3 | 4.4 | 1.3 | Iris-versicolor |
| 5.6 | 3 | 4.1 | 1.3 | Iris-versicolor |
| 5.5 | 2.5 | 4 | 1.3 | Iris-versicolor |
| 5.5 | 2.6 | 4.4 | 1.2 | Iris-versicolor |
| 6.1 | 3 | 4.6 | 1.4 | Iris-versicolor |
| 5.8 | 2.6 | 4 | 1.2 | Iris-versicolor |
| 5 | 2.3 | 3.3 | 1 | Iris-versicolor |
| 5.6 | 2.7 | 4.2 | 1.3 | Iris-versicolor |
| 5.7 | 3 | 4.2 | 1.2 | Iris-versicolor |
| 5.7 | 2.9 | 4.2 | 1.3 | Iris-versicolor |
| 6.2 | 2.9 | 4.3 | 1.3 | Iris-versicolor |
| 5.1 | 2.5 | 3 | 1.1 | Iris-versicolor |
| 5.7 | 2.8 | 4.1 | 1.3 | Iris-versicolor |
| 6.3 | 3.3 | 6 | 2.5 | Iris-virginica |
| 5.8 | 2.7 | 5.1 | 1.9 | Iris-virginica |
| 7.1 | 3 | 5.9 | 2.1 | Iris-virginica |
| 6.3 | 2.9 | 5.6 | 1.8 | Iris-virginica |
| 6.5 | 3 | 5.8 | 2.2 | Iris-virginica |
| 7.6 | 3 | 6.6 | 2.1 | Iris-virginica |
| 4.9 | 2.5 | 4.5 | 1.7 | Iris-virginica |
| 7.3 | 2.9 | 6.3 | 1.8 | Iris-virginica |
| 6.7 | 2.5 | 5.8 | 1.8 | Iris-virginica |
| 7.2 | 3.6 | 6.1 | 2.5 | Iris-virginica |
| 6.5 | 3.2 | 5.1 | 2 | Iris-virginica |
| 6.4 | 2.7 | 5.3 | 1.9 | Iris-virginica |
| 6.8 | 3 | 5.5 | 2.1 | Iris-virginica |
| 5.7 | 2.5 | 5 | 2 | Iris-virginica |
| 5.8 | 2.8 | 5.1 | 2.4 | Iris-virginica |
| 6.4 | 3.2 | 5.3 | 2.3 | Iris-virginica |
| 6.5 | 3 | 5.5 | 1.8 | Iris-virginica |
| 7.7 | 3.8 | 6.7 | 2.2 | Iris-virginica |
| 7.7 | 2.6 | 6.9 | 2.3 | Iris-virginica |
| 6 | 2.2 | 5 | 1.5 | Iris-virginica |
| 6.9 | 3.2 | 5.7 | 2.3 | Iris-virginica |
| 5.6 | 2.8 | 4.9 | 2 | Iris-virginica |
| 7.7 | 2.8 | 6.7 | 2 | Iris-virginica |
| 6.3 | 2.7 | 4.9 | 1.8 | Iris-virginica |
| 6.7 | 3.3 | 5.7 | 2.1 | Iris-virginica |
| 7.2 | 3.2 | 6 | 1.8 | Iris-virginica |
| 6.2 | 2.8 | 4.8 | 1.8 | Iris-virginica |
| 6.1 | 3 | 4.9 | 1.8 | Iris-virginica |
| 6.4 | 2.8 | 5.6 | 2.1 | Iris-virginica |
| 7.2 | 3 | 5.8 | 1.6 | Iris-virginica |
| 7.4 | 2.8 | 6.1 | 1.9 | Iris-virginica |
| 7.9 | 3.8 | 6.4 | 2 | Iris-virginica |
| 6.4 | 2.8 | 5.6 | 2.2 | Iris-virginica |
| 6.3 | 2.8 | 5.1 | 1.5 | Iris-virginica |
| 6.1 | 2.6 | 5.6 | 1.4 | Iris-virginica |
| 7.7 | 3 | 6.1 | 2.3 | Iris-virginica |
| 6.3 | 3.4 | 5.6 | 2.4 | Iris-virginica |
| 6.4 | 3.1 | 5.5 | 1.8 | Iris-virginica |
| 6 | 3 | 4.8 | 1.8 | Iris-virginica |
| 6.9 | 3.1 | 5.4 | 2.1 | Iris-virginica |
| 6.7 | 3.1 | 5.6 | 2.4 | Iris-virginica |
| 6.9 | 3.1 | 5.1 | 2.3 | Iris-virginica |
| 5.8 | 2.7 | 5.1 | 1.9 | Iris-virginica |
| 6.8 | 3.2 | 5.9 | 2.3 | Iris-virginica |
| 6.7 | 3.3 | 5.7 | 2.5 | Iris-virginica |
| 6.7 | 3 | 5.2 | 2.3 | Iris-virginica |
| 6.3 | 2.5 | 5 | 1.9 | Iris-virginica |
| 6.5 | 3 | 5.2 | 2 | Iris-virginica |
| 6.2 | 3.4 | 5.4 | 2.3 | Iris-virginica |
| 5.9 | 3 | 5.1 | 1.8 | Iris-virginica |

output

The accuracy score of K-Mean: 0.09333333333333334

The Confusion matrixof K-Mean:

[[ 0 50 0]

[ 2 0 48]

[36 0 14]]

The accuracy score of EM: 0.9666666666666667

The Confusion matrix of EM:

[[50 0 0]

[ 0 45 5]

[ 0 0 50]]

