UCS2612 Machine Learning Laboratory

Ex 6 . K-Means Clustering Algorithm

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Develop a python program to cluster the human activity using K-means clustering algorithm. Visualize the features from the dataset and interpret the results obtained by the model using Matplotlib library

Code and Output:

```
Importing The necesser Modules
```

```
import pandas as pd
import numpy as np

from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import f_classif

from sklearn.feature_selection import RFE
from sklearn.linear_model import LogisticRegression
from sklearn.decomposition import PCA

from sklearn.linear_model import Ridge
from sklearn.feature_selection import SelectFromModel

import matplotlib.pyplot as plt

from sklearn.preprocessing import LabelEncoder

from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_score, davies_bouldin_score
```

```
Reading the Training and Testing Dataset
```

```
train_df=pd.read_csv("train.csv")
test_df=pd.read_csv("test.csv")
```

```
Display the Details about Training and Testing Dataset details
```

```python
print("\n\nThe Size of The Training Dataset : ",train_df.shape)
print("\nThe Size of The Training Dataset : ",test_df.shape)
```

```
The Size of The Training Dataset :  (7352, 563)

The Size of The Training Dataset :  (2947, 563)
```

```
Printing The Training and Testing Dataset Examples
```

```python
train_df
```

	tBodyAcc-mean()-X	tBodyAcc-mean()-Y	tBodyAcc-mean()-Z	tBodyAcc-std()-X	tBodyAcc-std()-Y	tBodyAcc-std()-Z	tBodyAcc-mad()-X	tBodyAcc-mad()-Y	tBodyAcc-mad()-Z	tBodyAcc-max()-X	...	fBodyBodyGyroJerkMag-kurtosis()	angle(tBodyAccMean,gravity)	angle(tBodyAcc
0	0.288585	-0.020294	-0.132905	-0.995279	-0.983111	-0.913526	-0.995112	-0.983185	-0.923527	-0.934724	...	-0.710304	-0.112754	
1	0.278419	-0.016411	-0.123520	-0.998245	-0.975300	-0.960322	-0.998807	-0.974914	-0.957686	-0.943068	...	-0.861499	0.053477	
2	0.279653	-0.019467	-0.113462	-0.995380	-0.967187	-0.978944	-0.996520	-0.963668	-0.977469	-0.938692	...	-0.760104	-0.118559	
3	0.279174	-0.026201	-0.123283	-0.996091	-0.983403	-0.990675	-0.997099	-0.982750	-0.989302	-0.938692	...	-0.482845	-0.036788	
4	0.276629	-0.016570	-0.115362	-0.998139	-0.980817	-0.990482	-0.998321	-0.979672	-0.990441	-0.942469	...	-0.699205	0.123320	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
7347	0.299665	-0.057193	-0.181233	-0.195387	0.039905	0.077078	-0.282301	0.043616	0.060410	0.210795	...	-0.880324	-0.190437	
7348	0.273853	-0.007749	-0.147468	-0.235309	0.004816	0.059280	-0.322552	-0.029456	0.080585	0.117440	...	-0.680744	0.064907	
7349	0.273387	-0.017011	-0.045022	-0.218218	-0.103822	0.274533	-0.304515	-0.098913	0.332584	0.043999	...	-0.304029	0.052806	
7350	0.289654	-0.018843	-0.158281	-0.219139	-0.111412	0.268893	-0.310487	-0.068200	0.319473	0.101702	...	-0.344314	-0.101360	
7351	0.351503	-0.012423	-0.203867	-0.269270	-0.087212	0.177404	-0.377404	-0.038678	0.229430	0.269013	...	-0.740738	-0.280088	

7352 rows × 563 columns

```python
test_df
```

	tBodyAcc-mean()-X	tBodyAcc-mean()-Y	tBodyAcc-mean()-Z	tBodyAcc-std()-X	tBodyAcc-std()-Y	tBodyAcc-std()-Z	tBodyAcc-mad()-X	tBodyAcc-mad()-Y	tBodyAcc-mad()-Z	tBodyAcc-max()-X	...	fBodyBodyGyroJerkMag-kurtosis()	angle(tBodyAccMean,gravity)	angle(tBodyAcc
0	0.257178	-0.023285	-0.014654	-0.938404	-0.920091	-0.667683	-0.952501	-0.925249	-0.674302	-0.894088	...	-0.705974	0.006462	
1	0.286027	-0.013163	-0.119083	-0.975415	-0.967458	-0.944958	-0.986799	-0.968401	-0.945823	-0.894088	...	-0.594944	-0.083495	
2	0.275485	-0.026050	-0.118152	-0.993819	-0.969926	-0.962748	-0.994403	-0.970735	-0.963483	-0.939260	...	-0.640736	-0.034956	
3	0.270298	-0.032614	-0.117520	-0.994743	-0.973268	-0.967091	-0.995274	-0.974471	-0.968897	-0.938610	...	-0.736124	-0.017067	
4	0.274833	-0.027848	-0.129527	-0.993852	-0.967445	-0.978295	-0.994111	-0.965953	-0.977346	-0.938610	...	-0.846595	-0.002223	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2942	0.310155	-0.053391	-0.099109	-0.287866	-0.140589	-0.215088	-0.356083	-0.148775	-0.232057	0.185361	...	-0.750809	-0.337422	
2943	0.363385	-0.039214	-0.105915	-0.305388	0.028148	-0.196373	-0.373540	-0.030036	-0.270237	0.185361	...	-0.700274	-0.736701	
2944	0.349966	0.030077	-0.115788	-0.329638	-0.042143	-0.250181	-0.388017	-0.133257	-0.347029	0.007471	...	-0.467179	-0.181560	
2945	0.237594	0.018467	-0.096499	-0.323114	-0.229775	-0.207574	-0.392380	-0.279610	-0.289477	0.007471	...	-0.617737	0.444558	
2946	0.153627	-0.018437	-0.137018	-0.330046	-0.195253	-0.164339	-0.430974	-0.218295	-0.229933	-0.111527	...	-0.436940	0.598808	

2947 rows × 563 columns

```
Data Preprocessing ( Handling Missing values )
```

```python
print("The Missing Values in The Training
Dataset\n\n",train_df.isnull().sum())
```

```
The Missing Values in The Training Dataset

 tBodyAcc-mean()-X       0
tBodyAcc-mean()-Y       0
tBodyAcc-mean()-Z       0
tBodyAcc-std()-X        0
tBodyAcc-std()-Y        0
                       ..
angle(X,gravityMean)    0
angle(Y,gravityMean)    0
angle(Z,gravityMean)    0
subject                 0
Activity                0
Length: 563, dtype: int64
```

```
print("The Missing Values in The Testing Dataset\n\n",test_df.isnull().sum())
```

```
The Missing Values in The Testing Dataset

 tBodyAcc-mean()-X       0
tBodyAcc-mean()-Y       0
tBodyAcc-mean()-Z       0
tBodyAcc-std()-X        0
tBodyAcc-std()-Y        0
                       ..
angle(X,gravityMean)    0
angle(Y,gravityMean)    0
angle(Z,gravityMean)    0
subject                 0
Activity                0
Length: 563, dtype: int64
```

```
Display The Features in Dataset
```

```
print(train_df.columns)
```

```
Index(['tBodyAcc-mean()-X', 'tBodyAcc-mean()-Y', 'tBodyAcc-mean()-Z',
       'tBodyAcc-std()-X', 'tBodyAcc-std()-Y', 'tBodyAcc-std()-Z',
       'tBodyAcc-mad()-X', 'tBodyAcc-mad()-Y', 'tBodyAcc-mad()-Z',
       'tBodyAcc-max()-X',
       ...
       'fBodyBodyGyroJerkMag-kurtosis()', 'angle(tBodyAccMean,gravity)',
       'angle(tBodyAccJerkMean),gravityMean)',
       'angle(tBodyGyroMean,gravityMean)',
       'angle(tBodyGyroJerkMean,gravityMean)', 'angle(X,gravityMean)',
       'angle(Y,gravityMean)', 'angle(Z,gravityMean)', 'subject', 'Activity'],
      dtype='object', length=563)
```

```
x=train_df.drop(columns={"Activity"})
y=train_df["Activity"]
```

```
Feature Engineering Techniques

1) Select Best K        (  Filter method )

2) Ridge Regression     (  Embedded Method )

3) PCA
```

```
1) Select Best K  (  Filter method )
```

```
test = SelectKBest(score_func=f_classif, k=5)
fit = test.fit(x, y)
np.set_printoptions(precision=10)

features = fit.transform(x)

selected_indices = fit.get_support(indices=True)

selected_feature_names = x.columns[selected_indices]

print("Selected feature names : \n")
print(selected_feature_names)
```

```
Selected feature names :

Index(['tGravityAcc-mean()-X', 'tGravityAcc-max()-X', 'tGravityAcc-min()-X',
       'fBodyAccJerk-entropy()-X', 'fBodyAccJerk-entropy()-Y'],
      dtype='object')
```

```
train_df1 = train_df[selected_feature_names].copy()
test_df1 = test_df[selected_feature_names].copy()
```

```
print("\nAfter Feature Selection The Shape of The Training Dataset :
",train_df1.shape)
print("After Feature Selection The Shape of The Testing Dataset   :
",test_df1.shape)
```

```
After Feature Selection The Shape of The Training Dataset :  (7352, 5)
After Feature Selection The Shape of The Testing Dataset  :  (2947, 5)
```

```python
n_clusters = 3
kmeans = KMeans(n_clusters=n_clusters, n_init=10, random_state=42)
kmeans.fit(train_df1)
train_clusters = kmeans.predict(train_df1)
test_clusters = kmeans.predict(test_df1)
cluster_centroids = kmeans.cluster_centers_
```

```python
silhouette_avg11 = silhouette_score(train_df1, train_clusters)
silhouette_avg12 = silhouette_score(test_df1, test_clusters)
print(f"Silhouette Score ( Training dataset )    : {silhouette_avg11}")
print(f"Silhouette Score ( Testing dataset  )    : {silhouette_avg12}")
```

```
Silhouette Score ( Training dataset )   : 0.8270090285139965
Silhouette Score ( Testing dataset  )   : 0.830854104944898
```

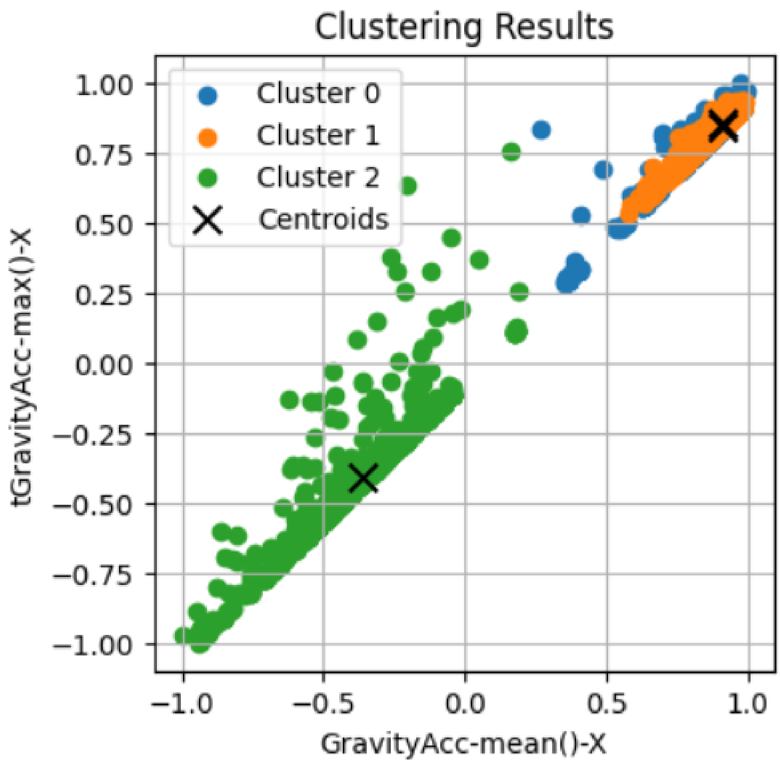
```python
plt.figure(figsize=(4, 4))

for cluster in range(n_clusters):
    cluster_data = train_df1[train_clusters == cluster]

    plt.scatter(cluster_data['tGravityAcc-mean()-X'],
cluster_data['tGravityAcc-max()-X'], label=f'Cluster {cluster}')

plt.scatter(cluster_centroids[:, 0], cluster_centroids[:, 1], marker='x',
color='black', s=100, label='Centroids')

plt.title('Clustering Results')
plt.xlabel('GravityAcc-mean()-X')
plt.ylabel('tGravityAcc-max()-X')
plt.legend()
plt.grid(True)
plt.show()
```




```
2) Ridge Regression    ( Embedded Method )
```

```
label_encoder = LabelEncoder()
y_encoded = label_encoder.fit_transform(y)

ridge = Ridge(alpha=1.0)
select_from_model = SelectFromModel(ridge, max_features=8)
select_from_model.fit(x, y_encoded)
features_selected = select_from_model.transform(x)
selected_indices = select_from_model.get_support(indices=True)
selected_feature_names = x.columns[selected_indices]
print("Selected feature names : \n")
print(selected_feature_names)
```

```
Selected feature names :

Index(['tBodyAcc-std()-X', 'tBodyAcc-sma()', 'tGravityAcc-std()-X',
       'tBodyGyroJerk-std()-Z', 'tBodyGyroJerk-energy()-Z', 'fBodyAcc-std()-X',
       'fBodyGyro-bandsEnergy()-9,16.2', 'fBodyGyro-bandsEnergy()-17,32.2'],
      dtype='object')
```

```python
train_df2 = train_df[selected_feature_names].copy()
test_df2 = test_df[selected_feature_names].copy()
```

```python
n_clusters = 3
kmeans = KMeans(n_clusters=n_clusters, n_init=10, random_state=42)
kmeans.fit(train_df2)
train_clusters = kmeans.predict(train_df2)
test_clusters = kmeans.predict(test_df2)
cluster_centroids = kmeans.cluster_centers_
```

```python
silhouette_avg21 = silhouette_score(train_df2, train_clusters)
silhouette_avg22 = silhouette_score(test_df2, test_clusters)
print(f"Silhouette Score ( Training dataset )   : {silhouette_avg21}")
print(f"Silhouette Score ( Testing dataset  )   : {silhouette_avg22}")
```

```
Silhouette Score ( Training dataset )   : 0.7140380577893611
Silhouette Score ( Testing dataset  )   : 0.7355803254687658
```

```python
plt.figure(figsize=(4, 4))

for cluster in range(n_clusters):
    cluster_data = train_df2[train_clusters == cluster]

    plt.scatter(cluster_data['tBodyAcc-std()-X'], cluster_data['tBodyAcc-
sma()'], label=f'Cluster {cluster}')

plt.scatter(cluster_centroids[:, 0], cluster_centroids[:, 1], marker='x',
color='black', s=100, label='Centroids')

plt.title('Clustering Results')

plt.xlabel('GravityAcc-mean()-X')
plt.ylabel('tGravityAcc-max()-X')

plt.legend()
plt.grid(True)

plt.show()
```


```
3) PCA
```

```
pca = PCA(n_components=11)

pca.fit(x)

selected_feature_indices = pca.components_

selected_feature_names = [x.columns[i] for i in
range(len(selected_feature_indices))]

print("Selected feature names:")
print(selected_feature_names)
```

```
Selected feature names:
['tBodyAcc-mean()-X', 'tBodyAcc-mean()-Y', 'tBodyAcc-mean()-Z', 'tBodyAcc-std()-X', 'tBodyAcc-std()-Y', 'tBodyAcc-std()-Z', 'tBodyAcc-mad()-X', 'tBodyAcc-mad()-Y', 'tBodyAcc-mad()-Z',
```

```
train_df3 = train_df[selected_feature_names].copy()
test_df3 = test_df[selected_feature_names].copy()
n_clusters = 3
kmeans = KMeans(n_clusters=n_clusters, n_init=10, random_state=42)
kmeans.fit(train_df3)
train_clusters = kmeans.predict(train_df3)
test_clusters = kmeans.predict(test_df3)
```

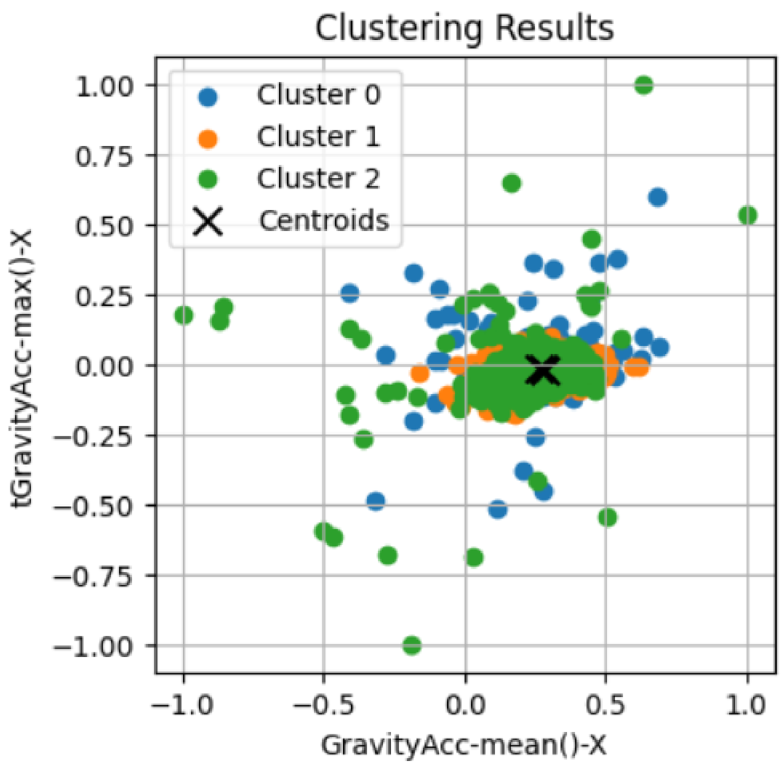
```
cluster_centroids = kmeans.cluster_centers_
```

```
silhouette_avg31 = silhouette_score(train_df3, train_clusters)
silhouette_avg32 = silhouette_score(test_df3, test_clusters)
print(f"Silhouette Score ( Training dataset )   : {silhouette_avg31}")
print(f"Silhouette Score ( Testing dataset  )   : {silhouette_avg32}")
```

```
Silhouette Score ( Training dataset )   : 0.6488163273987868
Silhouette Score ( Testing dataset  )   : 0.6478744052260157
```

```
plt.figure(figsize=(4, 4))
for cluster in range(n_clusters):
    cluster_data = train_df3[train_clusters == cluster]

    plt.scatter(cluster_data['tBodyAcc-mean()-X'], cluster_data['tBodyAcc-
mean()-Y'], label=f'Cluster {cluster}')
plt.scatter(cluster_centroids[:, 0], cluster_centroids[:, 1], marker='x',
color='black', s=100, label='Centroids')
plt.title('Clustering Results')
plt.xlabel('GravityAcc-mean()-X')
plt.ylabel('tGravityAcc-max()-X')
plt.legend()
plt.grid(True)
plt.show()
```



Conclusion

```
print("\n\n1) Select Best K  (  Filter method )")

print(f"Silhouette Score ( Training dataset )   : {silhouette_avg11}")
print(f"Silhouette Score ( Testing dataset  )   : {silhouette_avg12}")


print("\n\n2) Ridge Regression")

print(f"Silhouette Score ( Training dataset )   : {silhouette_avg21}")
print(f"Silhouette Score ( Testing dataset  )   : {silhouette_avg22}")

print("\n\n3) PCA")

print(f"Silhouette Score ( Training dataset )   : {silhouette_avg31}")
print(f"Silhouette Score ( Testing dataset  )   : {silhouette_avg32}")
```

```
1) Select Best K  (  Filter method )
Silhouette Score ( Training dataset )   : 0.8270090285139965
Silhouette Score ( Testing dataset  )   : 0.830854104944898


2) Ridge Regression
Silhouette Score ( Training dataset )   : 0.7140380577893611
Silhouette Score ( Testing dataset  )   : 0.7355803254687658


3) PCA
Silhouette Score ( Training dataset )   : 0.6488163273987868
Silhouette Score ( Testing dataset  )   : 0.6478744052260157
```

Learning Outcome

-1 <= Silhouette score <= 1

- A **Silhouette score of 1** indicates that the **object is well matched to its own cluster**

- A **Silhouette score of 0** indicates that the **object is on or very close to the decision boundary between two neighboring clusters.**

- A **Silhouette score of -1** indicates that the **object is poorly matched to its own cluster and well matched to neighboring clusters.**

1) Select Best K (Filter method)

Silhouette Score (Training dataset) : 0.8270090285139965

Silhouette Score (Testing dataset) : 0.830854104944898

2) Ridge Regression

Silhouette Score (Training dataset) : 0.7140380577893611

Silhouette Score (Testing dataset) : 0.7355803254687658

3) PCA

Silhouette Score (Training dataset) : 0.6488163273987868

Silhouette Score (Testing dataset) : 0.6478744052260157

The Model which was build using the Select best K feature Engineering techniques gives the best Silhouette Score. So This is the Best Model