Machine Learning

Olivetti Face Data – Gaussian Naive Bayes Classifier (K-Means++ Clustering)

Download the Olivetti faces dataset.
Visit https://scikit-learn.org/0.19/datasets/olivetti_faces.html

There are 40 classes (corresponding to 40 people), each class having 10 faces of the individual; so there are a total of 400 images.
Here each face is viewed as an image of size 64 × 64 (= 4096) pixels; each pixel having values 0 to 255 which are ultimately converted into floating numbers in the range [0,1].

Split the dataset into train and test parts such that there are 320 images, 8 images per person (8 X 40) for training and 80 images, 2 images per person, (2 X 40) for testing.

Repeat the experiment using 10 different random splits having 320 training faces and 80 test faces as specified above and report the average accuracy.

Cluster the 4096 features into K = 1200; 1600; 2000; 3000 clusters using the K-means++ clustering algorithm.
So,320 X 4096 training data matrix is reduced to 320 X K matrix and 80 X 4096 test data matrix is reduced to 80 X K, for a given K. Classify the test data, of size 80 X K using the Gaussian NBC and report the test accuracy

Use the Gaussian Naive Bayes classifier (NBC) to classify the test data and report the results

CODE:

Please find the code committed for Gaussian NBC with K-Means++ clustering as *NaiveBayesClassifier_K-MeansClustering_OlivettiFaceData_Impl.py*

- **KMeans** from sklearn is used for getting **K** clusters to reduce the feature set from 4096 to different ranges of 1200, 1600, 2000 and 3000.
- **Init of Kmeans++ is used in the sklearn api.**
- For each of these features, **labels_** is obtained that contains the cluster label for each feature.
- **Cluster_centers_ contains** the centroid of each of these clusters.
- In this manner, 320 * K train samples are created and 80*K test samples are created.
- **Gaussian NBC** is then applied over this modified dataset to find the accuracy.
- 10 iterations are performed to provide the average accuracy in 10 iterations.

RESULT:

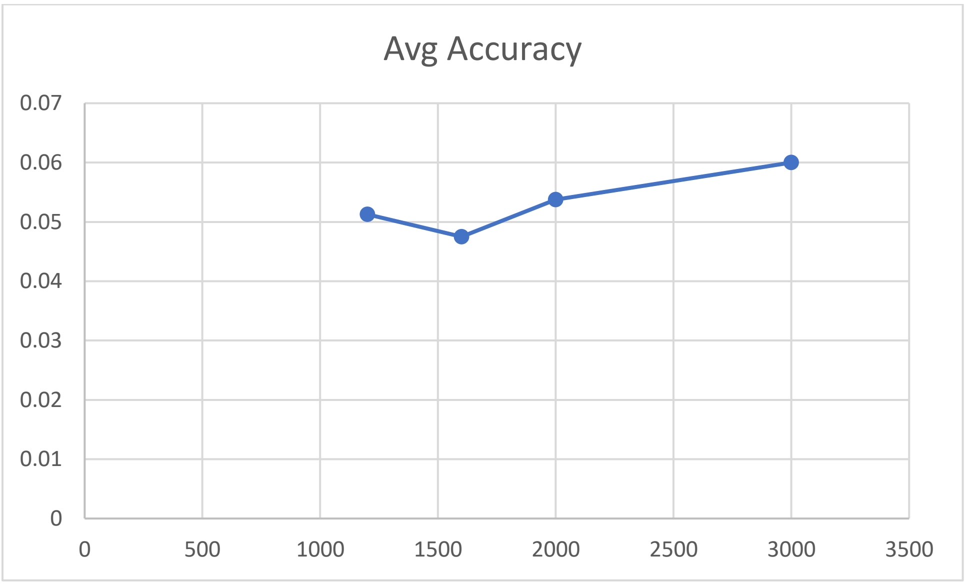
```
 (320, 1200)
(80, 1200)
accuracy_score for iteration 1 and K value 1200 =  0.05
(320, 1200)
(80, 1200)
accuracy_score for iteration 2 and K value 1200 =  0.05
(320, 1200)
(80, 1200)
accuracy_score for iteration 3 and K value 1200 =  0.0375
(320, 1200)
(80, 1200)
accuracy_score for iteration 4 and K value 1200 =  0.025
(320, 1200)
(80, 1200)
accuracy_score for iteration 5 and K value 1200 =  0.05
(320, 1200)
(80, 1200)
accuracy_score for iteration 6 and K value 1200 =  0.025
(320, 1200)
(80, 1200)
accuracy_score for iteration 7 and K value 1200 =  0.05
(320, 1200)
(80, 1200)
accuracy_score for iteration 8 and K value 1200 =  0.0625
(320, 1200)
(80, 1200)
accuracy_score for iteration 9 and K value 1200 =  0.0875
(320, 1200)
(80, 1200)
accuracy_score for iteration 10 and K value 1200 =  0.075
Average accuracy for  K value  1200 =  0.05125
(320, 1600)
(80, 1600)
accuracy_score for iteration 1 and K value 1600 =  0.05
(320, 1600)
(80, 1600)
accuracy_score for iteration 2 and K value 1600 =  0.0625
(320, 1600)
(80, 1600)
accuracy_score for iteration 3 and K value 1600 =  0.0375
(320, 1600)
(80, 1600)
accuracy_score for iteration 4 and K value 1600 =  0.0625
(320, 1600)
(80, 1600)
accuracy_score for iteration 5 and K value 1600 =  0.0625
(320, 1600)
(80, 1600)
accuracy_score for iteration 6 and K value 1600 =  0.0375
(320, 1600)
(80, 1600)
accuracy_score for iteration 7 and K value 1600 =  0.05
```

```
(320, 1600)
(80, 1600)
accuracy_score for iteration 8 and K value 1600 =  0.05
(320, 1600)
(80, 1600)
accuracy_score for iteration 9 and K value 1600 =  0.0375
(320, 1600)
(80, 1600)
accuracy_score for iteration 10 and K value 1600 =  0.025
Average accuracy for  K value  1600 =  0.0475
(320, 2000)
(80, 2000)
accuracy_score for iteration 1 and K value 2000 =  0.0375
(320, 2000)
(80, 2000)
accuracy_score for iteration 2 and K value 2000 =  0.05
(320, 2000)
(80, 2000)
accuracy_score for iteration 3 and K value 2000 =  0.05
(320, 2000)
(80, 2000)
accuracy_score for iteration 4 and K value 2000 =  0.0875
(320, 2000)
(80, 2000)
accuracy_score for iteration 5 and K value 2000 =  0.0375
(320, 2000)
(80, 2000)
accuracy_score for iteration 6 and K value 2000 =  0.05
(320, 2000)
(80, 2000)
accuracy_score for iteration 7 and K value 2000 =  0.05
(320, 2000)
(80, 2000)
accuracy_score for iteration 8 and K value 2000 =  0.025
(320, 2000)
(80, 2000)
accuracy_score for iteration 9 and K value 2000 =  0.075
(320, 2000)
(80, 2000)
accuracy_score for iteration 10 and K value 2000 =  0.075
Average accuracy for  K value  2000 =  0.05375
(320, 3000)
(80, 3000)
accuracy_score for iteration 1 and K value 3000 =  0.0625
(320, 3000)
(80, 3000)
accuracy_score for iteration 2 and K value 3000 =  0.0625
(320, 3000)
(80, 3000)
accuracy_score for iteration 3 and K value 3000 =  0.0625
(320, 3000)
(80, 3000)
accuracy_score for iteration 4 and K value 3000 =  0.0375
(320, 3000)
(80, 3000)
```

```
accuracy_score for iteration 5 and K value 3000 =  0.05
(320, 3000)
(80, 3000)
accuracy_score for iteration 6 and K value 3000 =  0.075
(320, 3000)
(80, 3000)
accuracy_score for iteration 7 and K value 3000 =  0.0875
(320, 3000)
(80, 3000)
accuracy_score for iteration 8 and K value 3000 =  0.0625
(320, 3000)
(80, 3000)
accuracy_score for iteration 9 and K value 3000 =  0.05
(320, 3000)
(80, 3000)
accuracy_score for iteration 10 and K value 3000 =  0.05
Average accuracy for  K value  3000 =  0.06000000000000001
```

PLOT:

Here is a plot of K (number of clusters) vs Avg Accuracy.



INFERENCE/ANALYSIS:

- **K-means++ based clustering is a smart centroid initialization technique before K means clustering is applied.**
- The dataset has 4096 features and using single link clustering, in this problem, we are reducing the feature set to different K values of 1200, 1600, 2000 and 3000. In each of these clusters, the value used to represent the features is not the feature itself, but its K means value.
- **The features are themselves independent and clustering does not help in this scenario as it simply identifies the centroid of each cluster and that does not help to represent the dataset completely.**
- **Gaussian NBC does not work well in this context and hence we see accuracy of classification is really low.**
- **As K increases, we see there is slight increase in overall avg accuracy.**

As Gaussian or Bernoulli NBC is applied over olivetti dataset completely , the average accuracy of classification is very high. However when clustering is applied, whether its single link, complete link or K-means++, the featureset is reduced and the representation is modified . Complete link based clustering provides better accuracy than K means++ and Single link accuracy. This impacts the overall avg accuracy of the Gaussian NBC model.

RESOURCES USED FOR THE ASSIGNMENT:

• **Environment:** Anaconda, Jupyter notebook
• **Software :** Python **Python libraries/modules:** Pandas, Numpy, SkLearn etc