Assignment (Healthcare and Artificial Intelligence)

Report by Asha M

Objective:

The objective of this assignment is to get familiarize with the problems of "classification" and "verification" with a popular problem space of "face".

Dataset:

There are 3 different data sets. Each data set has faces images of humans and were to perform experiments on these images.

1.Yale Face Database: This is a classical dataset.

- Faces images of 15 subjects were given.
- Each subject has 11 images with different emotions.
- An emotion.txt is also given which contains mapping the emotion of each image.

2. Indian Movie Face Database: This is an Indian dataset.

- Face images of 8 Indian movie actors were given
- 50 images are provided for each actor.

3. IIIT Cartoon Face Dataset: This is not natural face. But still can recognize.

- Cartoon faces of 8 subjects.
- 100 images are provided for each subject.

Methods and Materials:

Image Features: 6 different features/representations were used to perform the experiments on given datasets. These features are:

- PCA/Eigen face
- Kernel PCA
- LDA/Fisher face
- Kernel Fisher Face
- VGG Face
- ResNet features

Workflow:

1. To begin with Installing necessary libraries and importing modules was done. And the Data sets were loaded.
2. Working on the features provided
3. Eigen faces: Using PCA to get the Eigen faces
4. Kernel face: Using Kernel PCA to get the Eigen faces.

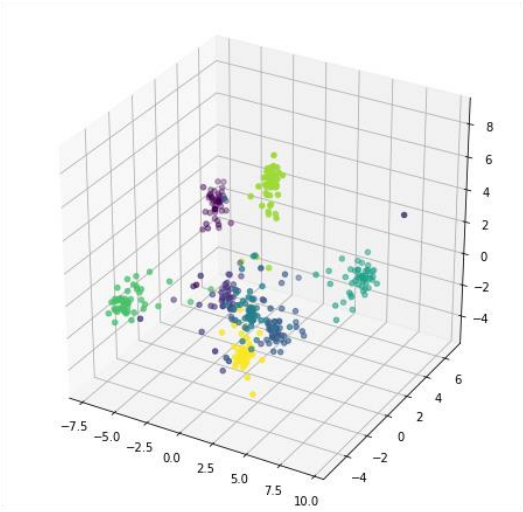
5. Fischer face: Another method similar to the eigenface technique is fisher faces which uses Linear Discriminant Analysis. This method for facial recognition is less sensitive to variation in lighting and pose of the face than using eigenfaces. Fisher face uses labelled data to retain more of the class-specific information during the dimension reduction stage.
6. Kernel Fisher Face: Uses LDA using different kernels similar to Kernel PCA. Here the input is directly transformed instead of using the kernel trick.
7. VGG features: The model was trained for face classification on each dataset and each feature the dimension of 4096.
8. Res Net features: A 50 layer Resnet model was trained for face classification on each dataset. Each feature the dimension of 2048.

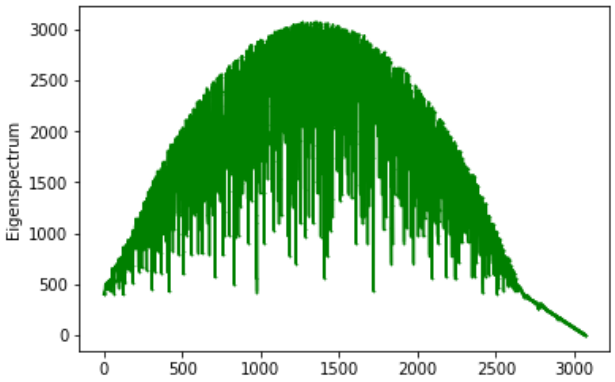
Questions

1(a). What are eigen faces?
Ans:
Patterns which can be observed in all signals (input data) could be - in the domain of facial recognition - the presence of some objects (eyes, nose, mouth) in any face as well as relative distances between these objects. These characteristic features are called eigenfaces in the facial recognition domain (or principal components generally). They can be extracted out of original image data by means of a mathematical tool called Principal Component Analysis (PCA).

1(b). How many eigen vectors/faces are required to "satisfactorily" reconstruct a person in these three datasets? (Don't forget to make your argument based on eigen value spectrum) Show appropriate graphs, qualitative examples and make a convincing argument.
Ans:

Compute the features. Below is the Scatter plot for the eigen vectors/faces





Using 130 dimensions based on the eigen spectrum and also the variance computed for that many dimensions.

Reconstruct the image back for each case: Images were successfully reconstructed, with Reconstruction error: 0.16722643335539755

1(d). Which person/identity is difficult to represent compactly with fewer eigen vectors? Why is that? Exp lain with your empirical observations and intuitive answers?
Ans:

Katrina Kaif's images are hardest to identify because the images are mostly blurred and the angles availab le in the given datasets are also not from similar/congruent angles. Ratio of face in the image also makes a difference. Complex features are harder to represent in lower dimensions. So, hair, dimples etc. might n ot be well represented as well.

Maximum error for class: 5

```
Class 0 Error:  0.14266112221220997
Class 1 Error:  0.15027930985971202
Class 2 Error:  0.13236659798034664
Class 3 Error:  0.17254464389519486
Class 4 Error:  0.1765556083821468
Class 5 Error:  0.20656515303940012
Class 6 Error:  0.15610944916029293
Class 7 Error:  0.187823314641868
Mean Square Error, Total:  0.16722643335539755
```

2(a). Use any classifier (MLP, Logistic regression, SVM, Decision Trees) and find the classification accuracy.

2(b)Which method works well? Do a comparative study.
Ans:

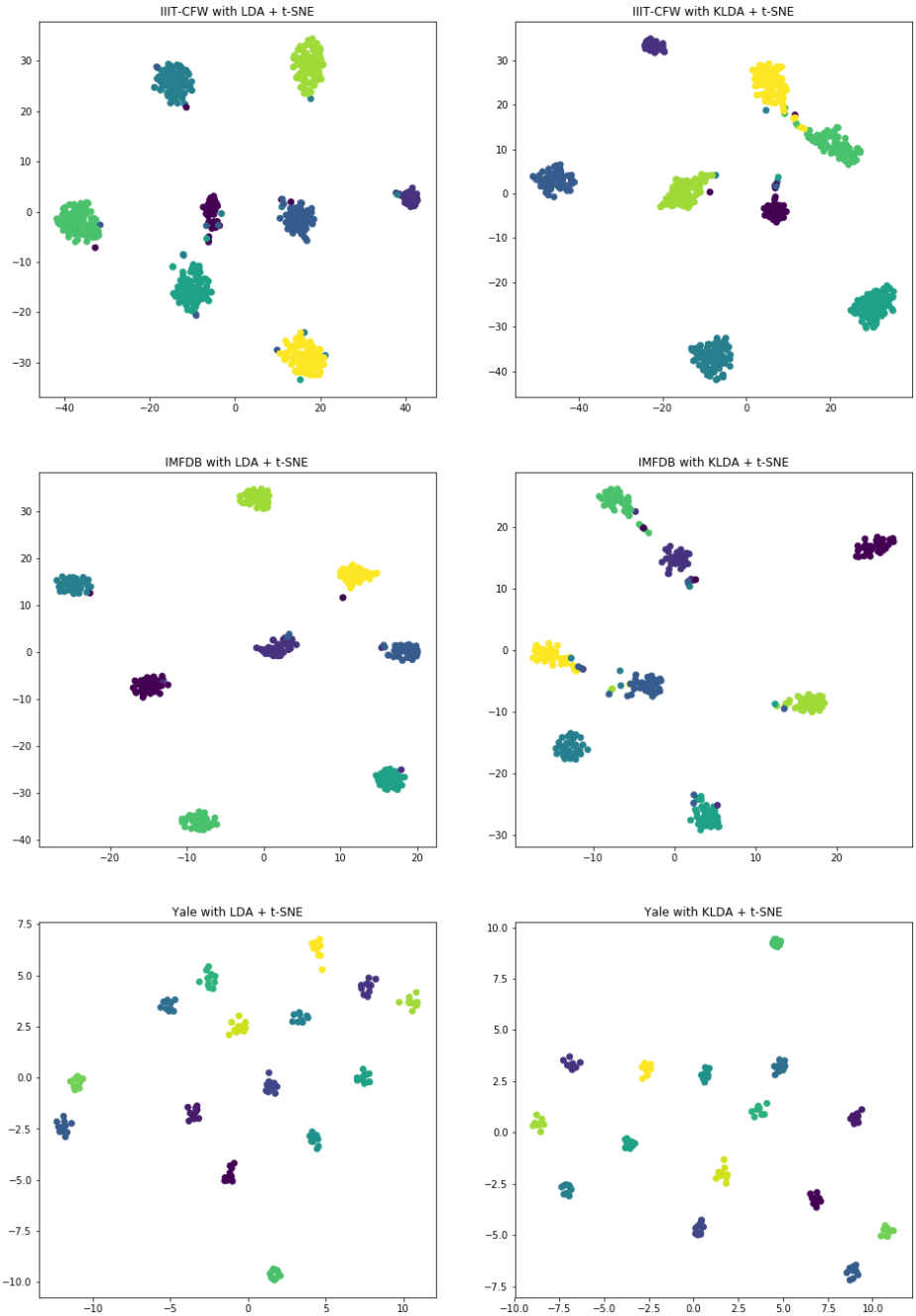
After testing all, MLP is seen to perform best
Accuracy of MLP on original space: 0.97619

3. Similar to 1(b) use t-SNE based visualization of faces? Does it make sense? Do you see similar people c oming together? or something else? Can you do visualization dataset wise and combined? Here you will use a popular implementation.

Ans:

Yes, similar faces do come close. t-SNE basically just keeps adjusting the values till the matrix comes close enough to the actual training one. So, it reduces to a lower dimension and still predicts very well.

Computed TSNE for different features and created a scatter plot



4.`face`is used for verification.
4(a) How do we formulate the problem using KNN
4(b) How do we analyse the performance? suggest the metrics (like accuracy) that is appropriate for this task.
4(c)Show empirical results with all the representations

Ans:

- Face verification done using KNN with 'k' neighbours by choosing appropriate parameters.

- F1 score and Accuracy are the appropriate metrics for this experiment.

```
LDA: accuracy, f1 score - (0.9464285714285714, 0.931611699703805)
True
Kernel LDA: accuracy, f1 score - (0.9583333333333334, 0.9454608606496477)
True
Kernel PCA: accuracy, f1 score - (0.4583333333333333, 0.45204280051248014)
True
Out[104]:
0.4583333333333333
```