SMAI : Assignment 2

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October 30, 2019

1 Purpose

The objective of this assignment is to get familiar with problems of `classification` and `verification` with a popular problem space of `face`

Problem has asked to use 6 different features/representations. They are (a) PCA/Eigen face (b) KernelPCA (c) LDA/Fisher face (d) Kernel Fisher Face (e) VGGFace (f) ResNet features

Using these features, we need to analyze data and show empirically.

2 Implementation Approach

1. First of all, I have read the images from 3 different files and flatten them to get data in array.

2. Now, I have shown scatter plot of these dataset in 3D, which shows similar images (of same persons) are gathered together in scatter plot. Now, I have taken number of principal components which can contribute of 90% variance in data and plotted Eigen Spectrum for all 3 datasets.

3. I have written MLP Classifier (using Keras) for these datasets and drawn table showing model performances (like accuracy, F1 Score etc.) for different features.

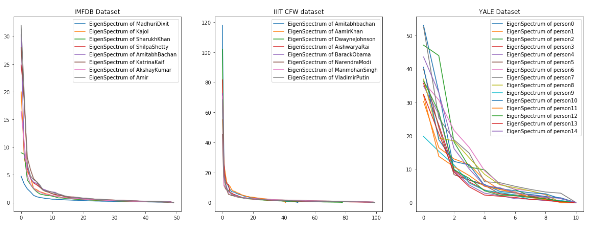
4. For verification, I have used KNN Classifier and generated similar table for these 3 datasets.

5. I have created a new dataset which contains all the images from CFW and IMFDB datasets and generated image label as 0 (cartoon) and 1 (Real Image) for all the images. Now, I have used KNN Classifier and generated similar table of performance

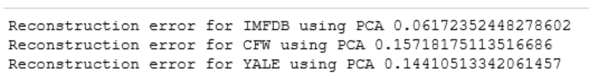
3 Answers

1(a). Eigen faces are first few eigen vectors which are good enough to represent the original image and reconstructed image from those few eigen vectors will be sufficient enough to identify the actual face. This is being done to reduce the image dimension to make calculation and model learning less complex.

1(b). Seeing the Eigen Spectrum, it is visible that IMFDB, CFW and YALE dataset needs approx. 30, 40 and 7 Principal components to contribute 90% of the variance in their data. However, exact number of eigen faces for each set of persons are calculated in program.



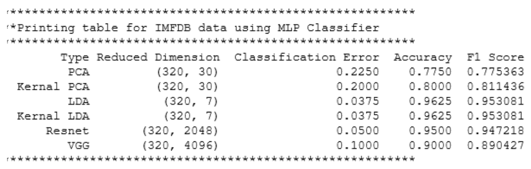
1(c). I have reconstructed the images using first few principal components and calculated reconstruction Error.



```
Reconstruction error for IMFDB using PCA 0.06172352448278602
Reconstruction error for CFW using PCA 0.15718175113516686
Reconstruction error for YALE using PCA 0.14410513342061457
```

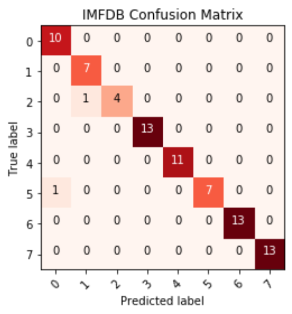
1(d). From IMFDB data,Madhuri Dixit is difficult to represent using fewer eigen vectors. Similarly, in CFW dataset, Narendra Modi is difficult to represent using fewer eigen vectors and from YALE dataset, person 7 is is difficult to represent using fewer eigen vectors. I have come to this conclusion, as in program I have calculated number of eigen vectors needed for each star/person to represent 90% variance in their individual category.

2(a). I have used Keras to implement MLP for this problem and calculated accuracy (and other performance matric) for all 3 datasets using all 6 given features (PCA, KPCA, LDA, etc..). For IMFDB dataset, below is the tabular data to show performance matric using all 6 features. You can refer program code output to get rest 2 tables (similar table was created for CFW and YALE dataset as well)

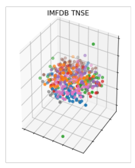


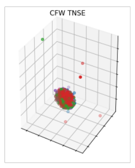
```
*********************************************************
*Printing table for IMFDB data using MLP Classifier
*********************************************************
       Type Reduced Dimension  Classification Error  Accuracy  F1 Score
        PCA          (320, 30)                0.2250    0.7750  0.775363
 Kernal PCA          (320, 30)                0.2000    0.8000  0.811436
        LDA           (320, 7)                0.0375    0.9625  0.953081
 Kernal LDA           (320, 7)                0.0375    0.9625  0.953081
     Resnet        (320, 2048)                0.0500    0.9500  0.947218
        VGG        (320, 4096)                0.1000    0.9000  0.890427
*********************************************************
```

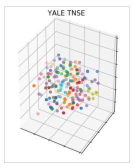
I have analyzed all 3 tables for IMFDB,CFW and Yale dataset and found the best feature that gave me best accuracy for MLP and generated confusion Matrix for the datasets for that particular Feature. Here is one of the Confusion Matrix. Rest 2 confusion Matrix can be referred in program code(I have printed them in Code)

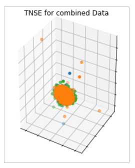


3.For all 3 datasets, I have generated t-SNE data and plotted them. IMFDB and CFW t-SNE data plot clearly shows similar faces (of same person/category) coming together in 3-D plot.





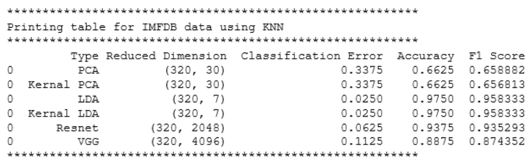




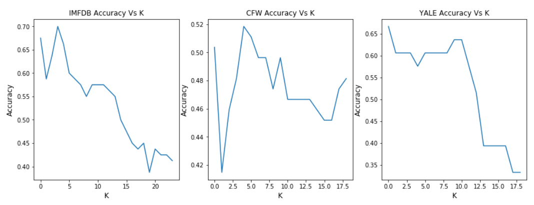
4(a) This problem can be formulated using KNN as well. If we train our data using KNN Classifier and while validation we can pass test sample and its correct label. If our model can predict same label for that test sample, response will be Yes/Correct else No/Incorrect. Based upon number of yes/correct responses, we can calculated accuracy of model.

4(b) I have used KNN Classifer and trained it on given 3 datasets (on training data by train/test split) and tested it on test data. Based on correct prediction, I have calculated similar performance matric and generated similar table. Here,I have shown table for CFW dataset using KNN Classifier. Rest 2 tables can be referred in program code.(already generated in code)

4(c) Also, by varying KNearestNeighbour count (k) I have calculated accuracy, and generated "Accuracy vs K plot" for all 3 datasets.



```
*********************************************************
Printing table for IMFDB data using KNN
*********************************************************
         Type Reduced Dimension  Classification Error  Accuracy  F1 Score
0         PCA         (320, 30)                0.3375    0.6625  0.658882
0  Kernal PCA         (320, 30)                0.3375    0.6625  0.656813
0         LDA          (320, 7)                0.0250    0.9750  0.958333
0  Kernal LDA          (320, 7)                0.0250    0.9750  0.958333
0      Resnet       (320, 2048)                0.0625    0.9375  0.935293
0         VGG       (320, 4096)                0.1125    0.8875  0.874352
*********************************************************
```

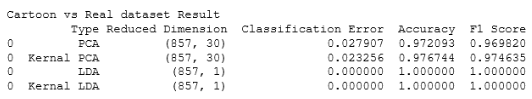


3.0.1 Extenstion / Application

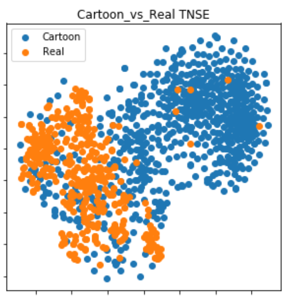
I have created a new dataset that contains cartoon and real images, which is a combination of IIIT-CFW and IMFDB datasets. I have generated data labels for these images in this combined dataset and used MLP Classifier to predict labels. Later, I have calculated performance Matric like accuracy,F1 Score etc..

Also, I have plotted TNSE 2D plot for this dataset, which shows data samples are visibly separable.

In real world, this kind of classifier may be used by Media houses or Legal team of famous personalities to classify whether images coming from social media platform are real face or some morphed/cartoon faces.



```
Cartoon vs Real dataset Result
         Type Reduced Dimension  Classification Error  Accuracy  F1 Score
0         PCA         (857, 30)              0.027907  0.972093  0.969820
0  Kernal PCA         (857, 30)              0.023256  0.976744  0.974635
0         LDA          (857, 1)              0.000000  1.000000  1.000000
0  Kernal LDA          (857, 1)              0.000000  1.000000  1.000000
```


Cartoon_vs_Real TNSE
Cartoon
Real