NUS

Biometrics Course

Assignment#5

HEWEI

Assignment #5 Date No. HEWEI

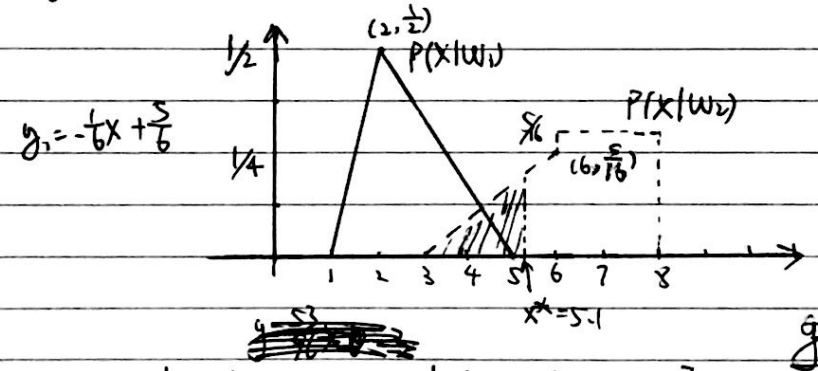
Part I

(a). Following the rule: If $x \geq x^*$ then decide w_2, else decide w_1

$\because 4 < 5.1 = x^* \quad \therefore x=4$ would be assigned to w_1

(b). Bob's classifier will always correctly classify w_1.

(c) As Bob's classifier is able to distinguish class w_1 correctly with zero error, w_2 is the class with error. and the probability of error will be the area of the specific religion under P(x) curve, as follow:



$\therefore P(\text{error}|w_2)$ = the area of the shadow $= \frac{7}{40} \times (5.1-3) \times \frac{1}{2}$

$= 0.18375$

(d). As Bayes' rule will chose the intersect point as the decision boundary, following $w^* = \underset{w_j}{\text{argmax}}\, P(w_j|X) = \underset{w_j}{\text{argmax}} \frac{P(x|w_j)P(w_j)}{P(x)} = \underset{w_j}{\text{argmax}}\, P(x|w_j)P(w_j)$

$j = 1, 2.$

We have, $x^* = \frac{13}{3} \approx 4.33$

it $x < x^*$ the decide w_1, else decide w_2.

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Part II

Q1. Print the confusion matrix and overall accuracy for three identifiers.
A:

```
Run:  FisherFace  FisherFace  FisherFace
E:\Anaconda3\python.exe "F:/Desktop/Python Project/Day10/FisherFace.py"
Confusion Matrix of PCA identifier:
[[ 7  2  0  0  0  3  0  0  0  0]
 [ 0 12  0  0  0  0  0  0  0  0]
 [ 0  2  8  0  2  0  0  0  0  0]
 [ 0  2  0  8  2  0  0  0  0  0]
 [ 0  2  0  0 10  0  0  0  0  0]
 [ 0  2  0  0  0  7  0  0  3  0]
 [ 0  2  0  0  0  2  8  0  0  0]
 [ 0  2  0  0  0  1  0  9  0  0]
 [ 0  2  0  0  0  0  0  0 10  0]
 [ 0  2  0  0  0  0  0  0  0 10]]
Accuracy:
0.741666666667
```

Fig.1 Identification Result of PCA

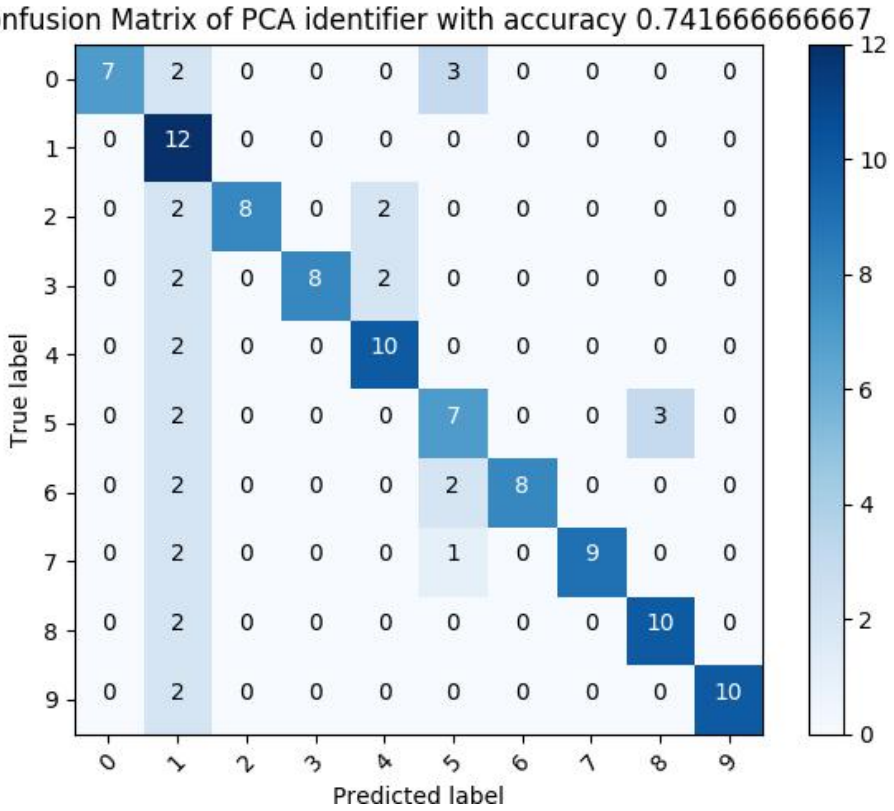

Fig.2 Confusion matrix visualization of PCA

```
Run: FisherFace  FisherFace  FisherFace
Confusion Matrix of LDA identifier:
[[12  0  0  0  0  0  0  0  0  0]
 [ 0 12  0  0  0  0  0  0  0  0]
 [ 0  0 12  0  0  0  0  0  0  0]
 [ 0  0  0 12  0  0  0  0  0  0]
 [ 0  0  0  0 12  0  0  0  0  0]
 [ 0  0  0  0  0 12  0  0  0  0]
 [ 0  0  0  0  0  0 12  0  0  0]
 [ 0  0  0  0  0  0  0 12  0  0]
 [ 0  0  0  0  0  0  0  0 12  0]
 [ 0  0  0  0  0  0  0  0  0 12]]
Accuracy:
1.0
```

Fig.3 Identification Result of LDA

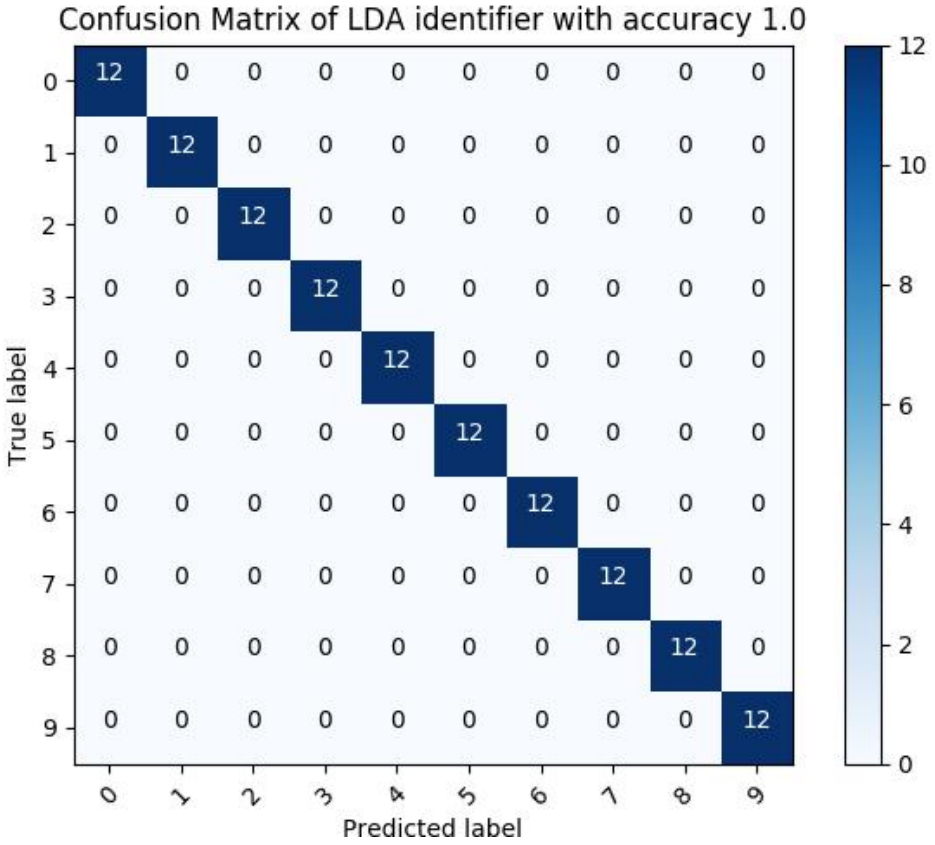

Fig.4 Confusion matrix visualization of LDA

```
Run: FisherFace  FisherFace  FisherFace
Accuracy for aplpha=
0.5
0.766666666667
Confusion Matrix of Fusion-based identifier:
[[ 9  0  0  0  0  0  0  0  0  0]
 [ 2 12  2  2  2  2  2  2  2  2]
 [ 0  0  8  0  0  0  0  0  0  0]
 [ 0  0  0  8  0  0  0  0  0  0]
 [ 0  0  2  2 10  0  0  1  0  0]
 [ 1  0  0  0  0  7  1  0  0  0]
 [ 0  0  0  0  0  0  9  0  0  0]
 [ 0  0  0  0  0  0  0  9  0  0]
 [ 0  0  0  0  0  3  0  0 10  0]
 [ 0  0  0  0  0  0  0  0  0 10]]
```

Fig.5 Identification Result of Fusion Scheme (Alpha=0.5)

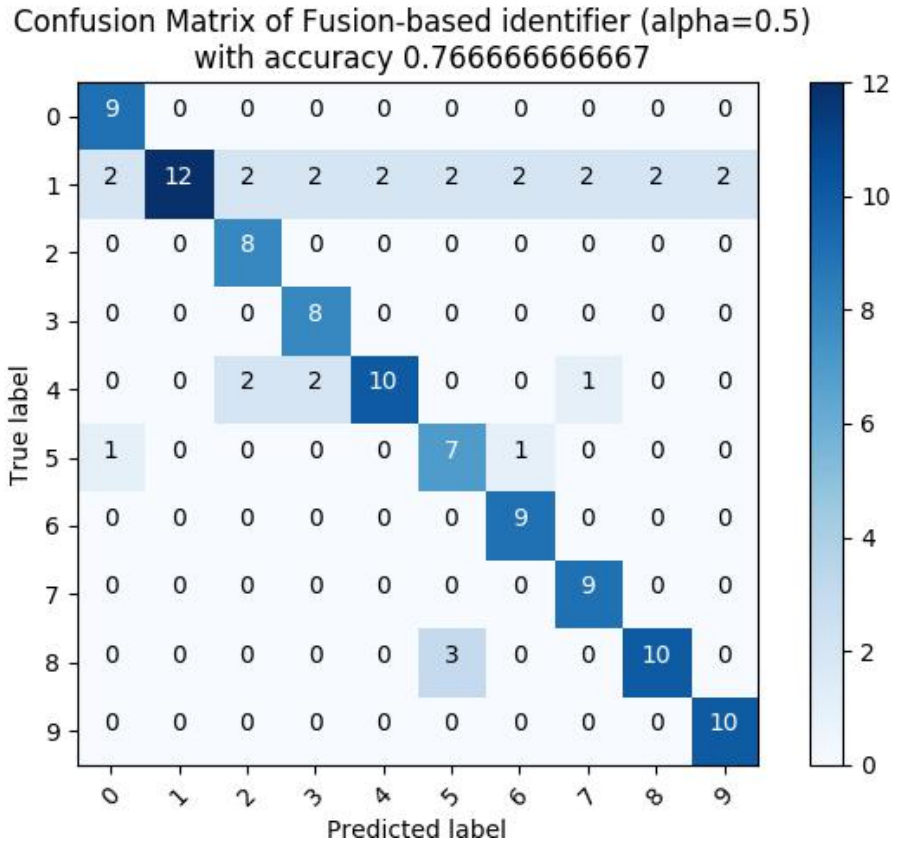

Fig.6 Confusion matrix visualization of Fusion Scheme (Alpha=0.5)

Q2. Compare the results for PCA feature and LDA feature, which feature is better? Why?

A: From Figure 1-6, we can see that both the accuracy and the confusion matrix of LDA identifier (100%) reveal better performance, comparing to the PCA identifier (74.17%). As a result, LDA feature is much better than PCA feature, with whom the identifier is able to distinguish each face correctly for 100%, which means the LDA feature of each individual face are different. For face identification task for the given data set, the former is better.

Q3. Let α = 0.1, 0.2, ... , 0.9. Retrain your identifier for fused feature and re-calculate its accuracy for each α. Plot accuracy versus α for different α . Submit this plot. What do you observe?

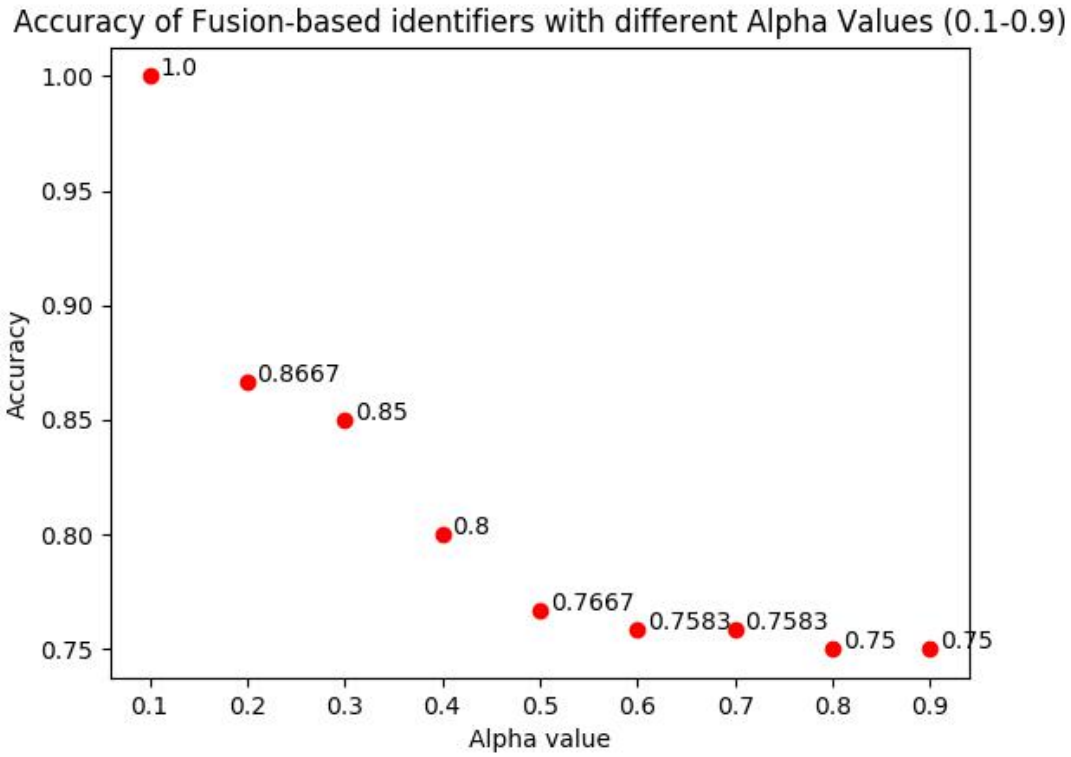

Fig.7 Accuracy of Fusion-based identifiers with different α (α = 0.1, ... , 0.9)

A: From figure 7, it is obvious that the accuracy of the identifier declines when alpha decreases. What's more, when alpha ranges from 0.5 to 0.9, the accuracy maintains around 0.75. When alpha is 1.0, which means $y = \begin{bmatrix} 0.1y_e \\ 0.9y_f \end{bmatrix}$, the accuracy will be the maximum. From where I stand, it is because the LDA feature is more sufficient than the PCA feature.

Q4. Does the fused feature outperform both PCA feature and LDA feature? Why?

A: As we can see in Figure 7, the maximum accuracy of fused feature will be 1.0 where alpha is 0.1, while the maximum accuracy of LDA and PCA are 1.0 and 0.7417 (K=30) separately. So the fused feature didn't outperform PCA feature and LDA feature, as the LDA feature has identified all faces correctly. But it indeed outperform the PCA feature. It is because the PCA feature is good at Pattern representation and dimension reduction instead of discrimination. Treating the whole data set, PCA calculates the best linear projection for the least mean-square error, which is a kind of unsupervised learning on some aspect. However, it ignores the relationship among classes, so that it sometimes is not a good feature but a excellent tool for variables dimension reduction. And, starting from the center of each class, LDA considers the spread trend of each class, compresses each data point close to their class center and

separates each class to each other, which exactly compensates the weakness of PCA feature. So, there are cases where the fused feature will outperform both PCA feature and LDA feature, for instance, data of each class overlap severely.

Reference

[1]M. Karg, R. Jenke, W. Seiberl, K. Kühnlenz, A. Schwirtz and M. Buss, "A comparison of PCA, KPCA and LDA for feature extraction to recognize affect in gait kinematics," *2009 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops*, Amsterdam, 2009, pp. 1-6.

[2]张艳君.基于 PCA 和 LDA 融合的人脸鉴别方法研究[D].华东交通大学,2006.DOI:10.7666/d.y1659819.

Appendix

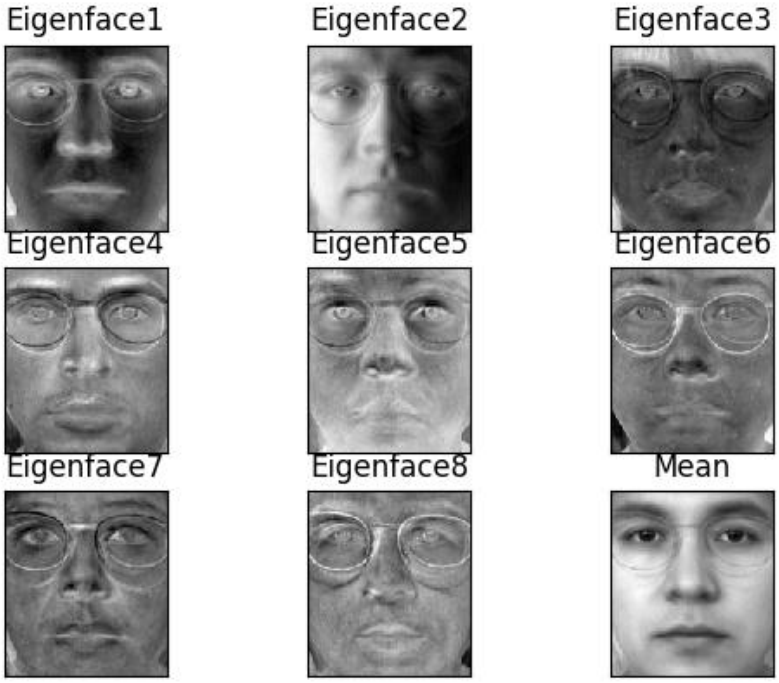

Fig.8 The mean face and top 8 Eigenfaces of PCA

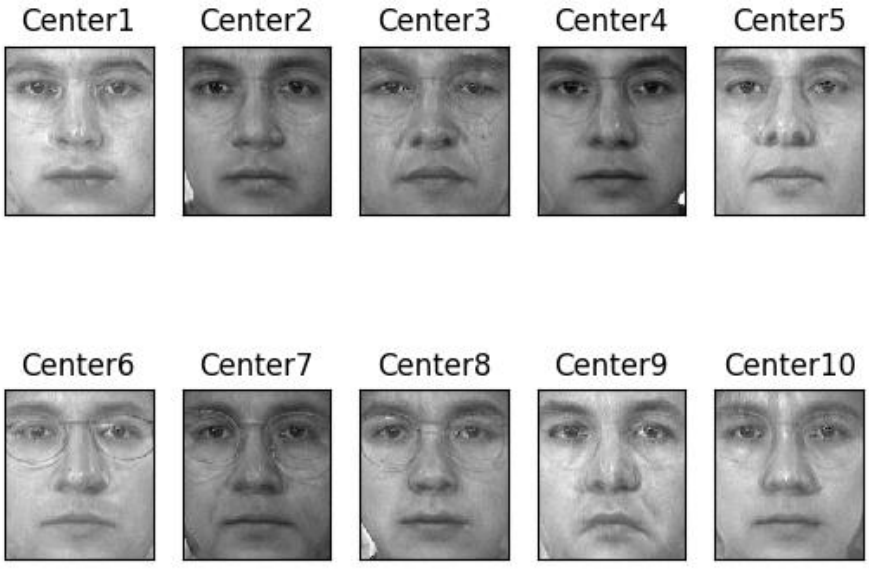

Fig.9 10 mean faces of each class using Centers of LDA