CS663 - Assignment 4 - Question 5

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In this part, we will use the value $k = 75$ since, in the previous question, we achieved a very good recognition rate with this value. To report the case where no matching identity is found, a thresholding technique will be employed. Specifically, for all the face images, if the minimum squared difference between the eigencoefficients of the image and any of the training images exceeds the threshold, the image will be classified as having no matching identity. The remaining task is to determine the appropriate threshold value.

We initially calculated the mean error to be 368.1617 and the standard deviation as 109.8. Based on these values, we decided to test threshold values ranging from 75 to 400, ultimately selecting the one that yields the best results. To determine the optimal threshold, we performed cross-validation, using accuracy, F1-score, specificity, and recall as the key evaluation metrics.

Accuracy:

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \tag{1}$$

Maximizing the accuracy gave us the following threshold value:

```
Accuracy: 0.812500
F1 Score: 0.895105
Best Threshold: 172.222222
Confusion matrix:
TP: 128  FP: 30
FN: 0    TN: 2
Recognition rate: 0.756250
```

We determined a threshold value of 172.22. At this threshold, the **accuracy is 0.8125**, and the F1-score is 0.8951. Additionally, the recognition rate is 0.7562, which represents the rate at which a given face is correctly identified as having a matching identity.

F1-score:

$$\text{F1-score} = \frac{2TP}{2TP + FP + FN} \tag{2}$$

So maximizing the F1-score gave us the following threshold value.

```
Accuracy: 0.812500
F1 Score: 0.895105
Best Threshold: 172.222222
Confusion matrix:
TP: 128 FP: 30
FN: 0    TN: 2
Recognition rate: 0.756250
```

The threshold value obtained is 172.22. At this threshold, the accuracy is 0.8125, and the **F1-score is 0.8951**. Furthermore, the recognition rate is 0.7562, which reflects the rate at which a given face is correctly identified as having a matching identity.

Specificity:

$$\text{Specificity} = \frac{TN}{TN + FP} \tag{3}$$

So maximizing the specificity gave us the following threshold value:

```
Accuracy: 0.700000
F1 Score: 0.769231
Specificity: 1.000000
Best Threshold: 70.000000
Confusion matrix:
TP: 80   FP: 0
FN: 48   TN: 32
Recognition rate: 0.500000
```

The threshold value obtained is 70. At this threshold, the specificity is 1, while the accuracy is 0.70. Additionally, the F1-score is 0.769, and the recognition rate is 0.5, indicating the rate at which a given face is correctly identified as having a matching identity in this scenario.

Recall:

$$\text{Recall} = \frac{TP}{TP + FN} \tag{4}$$

So maximizing the recall gave us the following threshold value:

```
Accuracy: 0.812500
F1 Score: 0.895105
Recall: 1.000000
Best Threshold: 172.222222
Confusion matrix:
TP: 128 FP: 30
FN: 0    TN: 2
Recognition rate: 0.756250
```

At the threshold value of 172.22, the recall is 1.0, and the accuracy is 0.8125. Additionally, the F1-score is 0.8951, and the recognition rate is 0.7562. These results are identical to those obtained when we aimed to maximize accuracy.

Therefore, depending on the application, any of the thresholds mentioned above can be selected. However, for general purposes, where minimizing both False Positives and False Negatives is important, a threshold value of 100 would be a suitable choice.

The results we get for a threshold of 100 are as follows.

```
Accuracy: 0.756250
F1 Score: 0.834043
Recall: 0.765625
Best Threshold: 100.000000
Confusion matrix:
TP: 98   FP: 9
FN: 30   TN: 23
Recognition rate: 0.612500
```

In this case, the total number of False Positives is **9**, and the number of False Negatives is **30**. Additionally, the accuracy is **0.756**, and the F1-score is **0.834**.