CS663 Assignment-4

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Question 5

Solution

Code is in `myMainScript.m`.
We'll use $k = 75$ as it provided sufficiently good recognition rates in Q4. We see that the test error (minimum MSE) had mean around 77.7 and standard deviation around 46.5.

```
Mean of Test Error is 77.736944...
Standard Deviation of Test Error is 46.504133...
```

So we propose that we look from $77.7 - 46.5 \approx 30$ to $77.7 + 4 \times 46.5 \approx 300$ for finding a suitable threshold. We took 4σ to the right of mean so as to cover as many big test errors as possible.
Basically we performed cross-validation to find the best threshold value. The metrics used to achieve this are:- Accuracy, F1-score, Youden's Index and one of my own. We maximise these metrics over the set of threshold values to find the best one.
Note that here "positives" are cases where a face is found to have a matching identity and "negatives" are the opposite. TP stands for "True Positive", FP stands for "False Positive", TN stands for "True Negative" and FN stands for "False Negative".

- **Accuracy:**

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

Maximising Accuracy gives:-

```
Maximising accuracy...
Accuracy: 0.812500
F1 Score: 0.895105
Youden's Index: 0.062500
My Score: 1.032258
Best Threshold: 171.818182
Confusion matrix:
TP: 128 FP: 30
FN: 0   TN: 2
Recognition rate: 0.756250
```

We see that the best threshold is around 172 and recognition rate is around 0.75 which is good. FP is also not much. Hence this seems a good metric and a good threshold.

- **F1-score:**

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

Maximising F1-score gives:-

```
Maximising f1_score...
Accuracy: 0.812500
F1 Score: 0.895105
Youden's Index: 0.062500
My Score: 1.032258
Best Threshold: 171.818182
Confusion matrix:
TP: 128 FP: 30
FN: 0   TN: 2
Recognition rate: 0.756250
```

We see that the best threshold is around 172 and recognition rate is around 0.75 which is good. FP is also not much. Hence this seems a good metric and a good threshold.

- **Youden's Index:**

$$\text{Youden's Index} = \frac{TP}{TP + FN} + \frac{TN}{TN + FP} - 1$$

Maximising Youden's Index gives:-

```
Maximising youden_index...
Accuracy: 0.725000
F1 Score: 0.792453
Youden's Index: 0.656250
My Score: 1.022222
Best Threshold: 73.636364
Confusion matrix:
TP: 84  FP: 0
FN: 44  TN: 32
Recognition rate: 0.525000
```

We see that the best threshold is around 73 and recognition rate is around 0.5 which is reasonable. Although FP is 0, FN is a little high. Though not very good, this is debatable.

- **My Metric:**

$$\text{My Metric} = \frac{1}{FP + 1} + \frac{1}{FN + 1}$$

Maximising my metric gives:-

```
Maximising my_score...
Accuracy: 0.812500
F1 Score: 0.895105
Youden's Index: 0.062500
My Score: 1.032258
Best Threshold: 171.818182
Confusion matrix:
TP: 128 FP: 30
FN: 0   TN: 2
Recognition rate: 0.756250
```

We see that the best threshold is around 172 and recognition rate is around 0.75 which is good. FP is also not much. Hence this seems a good metric and a good threshold.

Hence, depending on the application we can choose any of the thresholds mentioned above. However, for general applications, where we would like to have a low number of False Positives and False Negatives, we can use a threshold value of 140 (as this is a value in between 30 and 172 and is closer to 172, hence best of both worlds). The results we get for a threshold of 140 are as follows:-

```
Testing threshold = 140.000000...
Accuracy: 0.793750
F1 Score: 0.878229
Youden's Index: 0.179688
My Score: 0.140000
Confusion matrix:
TP: 119 FP: 24
FN: 9   TN: 8
Recognition rate: 0.737500
```

Here we have 9 false negatives and 24 false positives.