SIL 775: Biometric Security
Assignment – 2
Online Signature Verification
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1. <u>**Implementation Details**</u>

Data Reading and Preprocessing:

- Signature data is read from files using *read_all_signatures* function.
- X and Y coordinates of signatures using *read_signature_file()*.
- Features like path-tangent, path-velocity, log-curvature, acceleration also extracted in *read_signature_file()*
- Average number of data points for each user's signatures is calculated using *calculate_average_data_points()*
- All the signature data are interpolated to ensure uniform length across all signatures using *interpolate_all_signatures()*

Dynamic Time Warping (DTW):

- Mean signature for each user's genuine signatures is calculated using *calculate_average_user()*
- Mean template of each user is computed by applying DTW between each user's mean signature and all its genuine signatures using *perform_dba_on_signatures()*

Performance Metrics Calculation:

- Accuracy, precision, recall, False Acceptance Rate (FAR), and False Rejection Rate (FRR) are calculated for each user using *calculate_accuracy_precision_and_recall()*.

- All the performance metrics of each user is outputted in output.txt file

- Equal Error Rate of each user can be computed using *calculate_err_for_user_and_plot()*. Since there is need of a lot of iterations to find ERR, that is why I have computed only for User 1, however it can be used for other users as well.

2. **Dataset Used:** SVC2004 (Task2)

3. **Steps to Run the Code**

- Go the directory of main.py

- Open terminal and give command "python3 main.py"

4. **Sample Input/Output**

Input of a signature of User 1:

```
84
2933 5678 31275775 0 1550 710 439
2933 5678 31275785 1 1480 770 420
3001 5851 31275795 1 1350 830 433
3114 6139 31275805 1 1350 800 422
3217 6198 31275815 1 1350 800 415
3329 6213 31275825 1 1350 800 423
3447 6199 31275835 1 1350 800 439
3542 6176 31275845 1 1350 800 491
3617 6124 31275855 1 1350 800 561
```

Output of User 1:

```
User U1: Accuracy = 82.5, Precision = 84.21052631578947, Recall = 80.0, FAR = 15.0, FRR = 20.0
```

5. Performance Metric:

```
User U1: Accuracy = 82.5, Precision = 84.21052631578947, Recall = 80.0, FAR = 15.0, FRR = 20.0
User U2: Accuracy = 85.0, Precision = 81.81818181818183, Recall = 90.0, FAR = 20.0, FRR = 10.0
User U3: Accuracy = 55.00000000000001, Precision = 54.166666666666664, Recall = 65.0, FAR = 55.00000000000001, FRR = 35.0
User U4: Accuracy = 55.00000000000001, Precision = 54.166666666666664, Recall = 65.0, FAR = 55.00000000000001, FRR = 35.0
User U5: Accuracy = 95.0, Precision = 95.0, Recall = 95.0, FAR = 5.0, FRR = 5.0
User U6: Accuracy = 90.0, Precision = 90.0, Recall = 90.0, FAR = 10.0, FRR = 10.0
User U7: Accuracy = 65.0, Precision = 61.53846153846154, Recall = 80.0, FAR = 50.0, FRR = 20.0
User U8: Accuracy = 82.5, Precision = 84.21052631578947, Recall = 80.0, FAR = 15.0, FRR = 20.0
User U9: Accuracy = 95.0, Precision = 95.0, Recall = 95.0, FAR = 5.0, FRR = 5.0
User U10: Accuracy = 85.0, Precision = 85.0, Recall = 85.0, FAR = 15.0, FRR = 15.0
User U11: Accuracy = 45.0, Precision = 43.75, Recall = 35.0, FAR = 45.0, FRR = 65.0
User U12: Accuracy = 87.5, Precision = 94.11764705882352, Recall = 80.0, FAR = 5.0, FRR = 20.0
User U13: Accuracy = 92.5, Precision = 90.47619047619048, Recall = 95.0, FAR = 10.0, FRR = 5.0
User U14: Accuracy = 87.5, Precision = 85.71428571428571, Recall = 90.0, FAR = 15.0, FRR = 10.0
User U15: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U16: Accuracy = 82.5, Precision = 84.21052631578947, Recall = 80.0, FAR = 15.0, FRR = 20.0
User U17: Accuracy = 92.5, Precision = 90.47619047619048, Recall = 95.0, FAR = 10.0, FRR = 5.0
User U18: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U19: Accuracy = 92.5, Precision = 94.73684210526315, Recall = 90.0, FAR = 5.0, FRR = 10.0
User U20: Accuracy = 95.0, Precision = 95.0, Recall = 95.0, FAR = 5.0, FRR = 5.0
User U21: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U22: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U23: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U24: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U25: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U26: Accuracy = 85.0, Precision = 81.81818181818183, Recall = 90.0, FAR = 20.0, FRR = 10.0
User U27: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U28: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U29: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U30: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U31: Accuracy = 92.5, Precision = 94.73684210526315, Recall = 90.0, FAR = 5.0, FRR = 10.0
User U32: Accuracy = 70.0, Precision = 66.66666666666666, Recall = 80.0, FAR = 40.0, FRR = 20.0
User U33: Accuracy = 85.0, Precision = 85.0, Recall = 85.0, FAR = 15.0, FRR = 15.0
User U34: Accuracy = 80.0, Precision = 77.27272727272727, Recall = 85.0, FAR = 25.0, FRR = 15.0
User U35: Accuracy = 67.5, Precision = 62.96296296296296, Recall = 85.0, FAR = 50.0, FRR = 15.0
User U36: Accuracy = 65.0, Precision = 61.53846153846154, Recall = 80.0, FAR = 50.0, FRR = 20.0
User U37: Accuracy = 72.5, Precision = 65.51724137931035, Recall = 95.0, FAR = 50.0, FRR = 5.0
User U38: Accuracy = 82.5, Precision = 84.21052631578947, Recall = 80.0, FAR = 15.0, FRR = 20.0
User U39: Accuracy = 100.0, Precision = 100.0, Recall = 100.0, FAR = 0.0, FRR = 0.0
User U40: Accuracy = 92.5, Precision = 90.47619047619048, Recall = 95.0, FAR = 10.0, FRR = 5.0
Overall Accuracy: 86.4375%
Overall Precision: 85.8448128000913%
Overall Recall: 88.75%
```

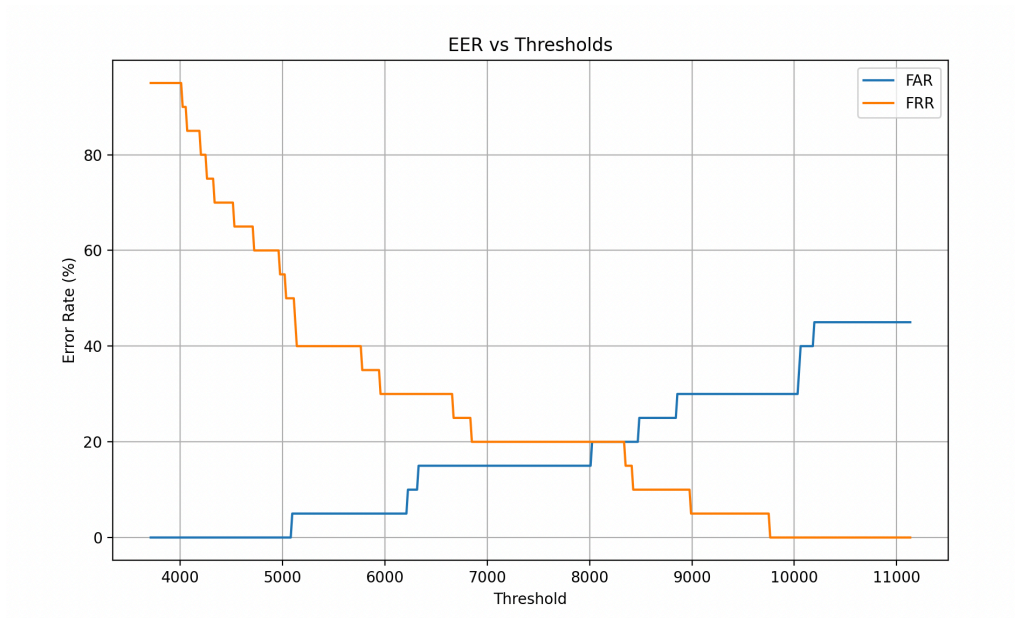| Overall Accuracy	Overall Precision	Overall Recall
86.43%	85.84%	88.75%

- FAR and FRR of each user can seen in the above output.

Fig : EER vs Threshold graph of User 1

- As can be seen from the above figure ERR for user 1 is

Equal Error Rate	Threshold
20%	8024.38