Assignment #1: Fingerprint Recognition

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***Abstract*—This paper addresses challenges in fingerprint recognition, such as reliance on heavyweight models and lack of explainability, by using the lightweight NBIS toolkit on the FVS dataset. We achieve high accuracy in both general and type-based matching with Bozorth3 scores and thresholding, offering a more interpretable and efficient alternative to complex models.**

I. Introduction

This assignment uses the NBIS toolkit to process fingerprint data, evaluating two matching approaches and assessing their classification accuracy.

II. Methodology

We used the NBIS toolkit to extract minutiae points with mindtct and compute similarity scores with Bozorth3. Thresholds were selected empirically to optimize performance. Pcasys was used for type-based fingerprint classification in one of the experiments.

III. Experiments and results

We used the FVS dataset containing fingerprint images from 21 subjects (8 samples each) which were upscaled to 512×512 pixels. Minutiae were extracted with mindtct, and Bozorth3 was used for pairwise similarity computation. Due to the small dataset, we omitted train-test splitting. We also assessed the quality of the fingerprints using nfiq algorithm. We empirically tested a range of thresholds using Bozorth3 scores, selecting the one that maximized accuracy and F1 score. Two classification tasks were performed: General Matching, using Bozorth3 scores for all pairs (excluding self/repeats), and Type-Based Matching, grouping fingerprints by type with pcasys before classifying.

As seen in Figure 1, Bozorth3 scores clearly separate impostors from genuines, supporting the effectiveness of a threshold-based approach. Figure 2 further illustrates this, with bright diagonal triangles indicating genuines. Table I shows high scores for both general and type-based matching, the latter including standard deviation from splitting data into three groups using 'pcasys'. Figure 3 confirms good overall fingerprint quality, with only few exceptions.

IV. Conclusion

The quality of the dataset enabled effective classification using thresholding, achieving strong performance in both general and type-based matching. NBIS tools streamlined the feature extraction process. Further improvements could be achieved with more advanced classification techniques and accounting for the low quality samples with another method might further improve the reliability of such system.

We achieved excellent results in fingerprint recognition using the NBIS toolkit and FVS dataset. We successfully compared general and type-based matching and outlined advantages of Bozorth3 scoring with thresholding.

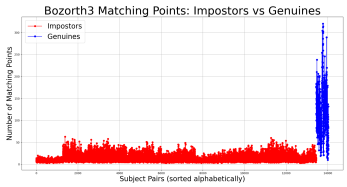

Fig. 1. Bozorth3 scores for All-vs-All matching: y-axis shows scores, x-axis shows image pairs. Impostor scores are in red, genuine scores in blue.

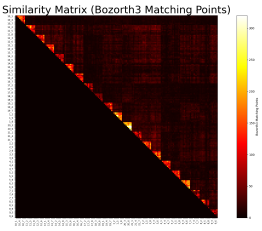

Fig. 2. Similarity matrix for fingerprint images. The black half shows non-repeated comparisons. Bright triangles on the diagonal indicate higher scores for genuines.

TABLE I
Classification results of each experiment

Experiment	Threshold	Accuracy [%]	F1 score [%]
General Matching	52	99.2	95.0
Type-Based Matching	42 ± 9.6	98 ± 0.7	96 ± 1.1

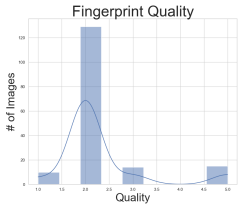

Fig. 3. NFIQ fingerprint quality distribution. The values for quality range from 1 (best) to 5 (worst).