2. Questions

Considering the content of both genuine.txt (with 50 pairs of fingerprint image file paths) and impostor.txt (also with 50 pairs of fingerprints), please answer the following questions.

2.1. For each one of the 100 available pairs of fingerprint images (50 from genuine.txt and 50 from impostor.txt), provide the minutiae-based similarity score, as defined in slide 41 of the presentation available at https://bit.ly/3PD35EZ. To present these scores, generate a single output.csv file with 100 data lines; the first 50 data lines must be respective to the 50 lines of genuine.txt, while the following 50 data lines must be respective to impostor.txt. Lines with comments must start with “#”. The format of this file is explained in Figure 3 through an example, and it follows the same format as the input files used in the first assignment. (4 points)

```
# System output. Line format: label [0: impostor, 1: genuine], score
1,0.6285714285714286
1,0.6046511627906976
(...)
0,0.1326530612244898
0,0.2732919254658385
(...)
```

Ans:

# System output. Line format: label [0: impostor, 1: genuine], score	
1,0.574468085	0,0.155339805825242
1,0.6	0,0.146341463414634
1,0.609375	0,0.147540983606557
1,0.607142857142857	0,0.146341463414634
1,0.6	0,0.214285714285714
1,0.342342342342342	0,0.165289256198347
1,0.86021505376344	0,0.156521739130434
1,0.5625	0,0.183673469387755
1,0.588235294117647	0,0.180327868852459
1,0.73170731707317	0,0.157894736842105
1,0.907407407407407	0,0.171428571428571
1,0.530973451327433	0,0.170212765957446
1,0.540145985401459	0,0.166666666666666
1,0.605504587155963	0,0.141935483870967
1,0.590163934426229	0,0.191489361702127
1,0.786324786324786	0,0.201342281879194
1,0.333333333333333	0,0.158536585365853
1,0.876404494382022	0,0.232142857142857
1,0.553191489361702	0,0.188976377952755
1,0.666666666666666	0,0.206451612903225
1,0.5	0,0.144329896907216
1,0.84	0,0.114285714285714
1,0.56	0,0.166666666666666
1,0.641025641025641	0,0.176991150442477
1,0.709677419354838	0,0.258823529411764

1,0.609756097560975	0,0.130434782608695
1,0.5	0,0.183673469387755
1,0.594594594594594	0,0.132075471698113
1,0.423076923076923	0,0.179310344827586
1,0.847058823529411	0,0.117647058823529
1,0.610526315789473	0,0.183673469387755
1,0.641025641025641	0,0.142857142857142
1,0.43010752688172	0,0.242990654205607
1,0.88	0,0.184873949579831
1,0.546666666666666	0,0.15126050420168
1,0.490909090909909	0,0.21505376344086
1,0.666666666666666	0,0.220183486238532
1,0.59322033898305	0,0.180327868852459
1,0.733333333333333	0,0.196428571428571
1,0.208695652173913	0,0.183206107
1,0.630434782608695	0,0.209302325581395
1,0.672897196261682	0,0.196721311475409
1,0.520547945205479	0,0.168831168831168
1,0.504504504504504	0,0.189189189189189
1,0.6	0,0.269230769230769
1,0.491525423728813	0,0.235294117647058
1,0.86440678	0,0.167938931297709
1,0.504347826086956	0,0.232142857142857
1,0.626262626262626	0,0.241758241758241
1,0.650717703349282	0,0.252631578947368

I will also include the CSV file with the assignment.

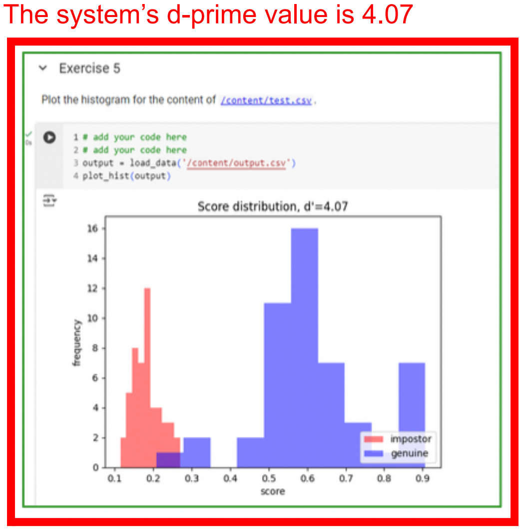
Figure 3. Expected content for output.csv. The scores and number of lines presented here are for the sake of illustration.

2.2. Based on your obtained scores, what score threshold (a.k.a. operating point) should you use for this system? Please explain your answer and describe how you have computed this threshold. (1.5 points)

Ans:
The score threshold is set at **0.2692**, which I determined by using the **compute_sim_fmr_fnmr_eer** function from Assignment 1, Exercise 3. This function calculates the Equal Error Rate (EER), which is a key performance metric in biometric systems. EER is the point at which the False Match Rate (FMR) and False Non-Match Rate (FNMR) are closest, indicating a balance between the system's tolerance for false positives and false negatives. To find this value, I input the output.csv file into the function. The score of 0.2692 reflects the threshold where the biometric system achieves its optimal trade-off between these two error rates.

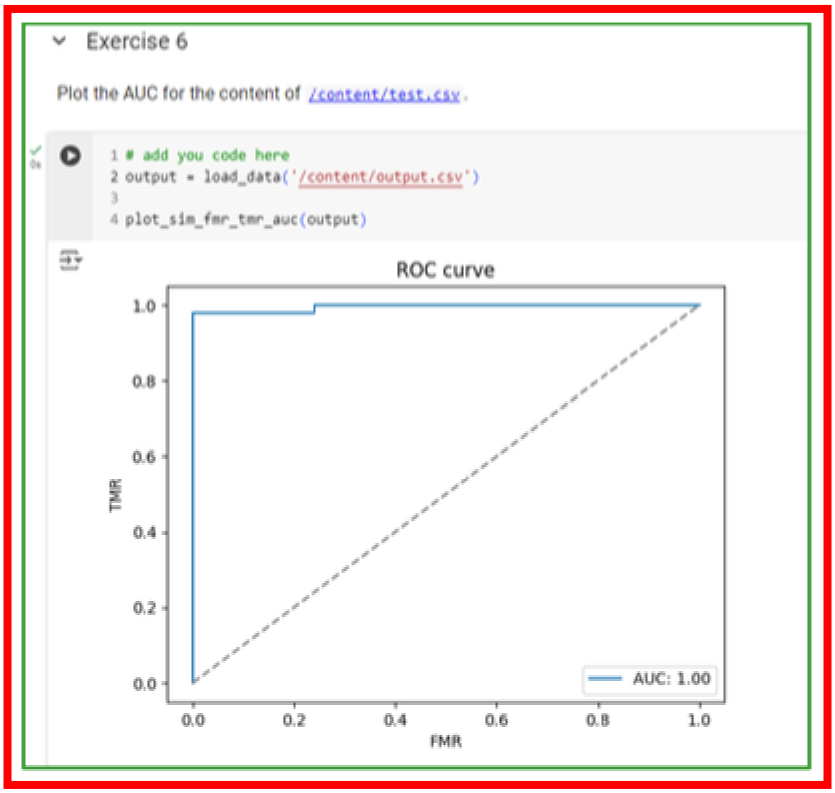
2.3. Plot and provide a graph with the distribution of the scores obtained by the system. What is the system's d-prime value? (1.5 points)

Ans:
The system's d-prime value is 4.07



2.4. Plot and provide a graph with the ROC curve and AUC of the system. Is this system working better than chance? Please explain your answer. (1.5 points)

Ans:
This system is performing exceptionally well, with an AUC of 1, indicating perfect classification ability. In an ROC curve, chance performance is represented by the dotted gray diagonal line, which signifies a system with no discriminative power, resulting in an equal likelihood of making an error in either direction. Any system that performs worse than this would have an ROC curve with an AUC less than the diagonal. However, in this case, the curve reaches the maximum AUC, demonstrating that the system can flawlessly distinguish between true positives and false positives, far surpassing random guessing.



2.5. In your opinion, would this solution be robust to fake fingerprints such as silicon fingers? Please justify your answer. (1.5 points)

Ans:
In my opinion, this model is probably not robust enough to detect fake fingerprints, like those made from silicone. This limitation arises because our system only examines level 2 features, such as ridge endings and ridge bifurcations. Silicone fingers can closely mimic these features, but they generally do not include the finer details found in level 3 features. To effectively address the issue of silicone fingers, the model would need a high-resolution sensor capable of capturing level 3 features, along with the appropriate code to identify and analyze those details.