2.1. For each one of the 122 available pairs of fingerprint images (61 from genuine.txt and 61 from impostor.txt), provide the minutiae-based similarity score, as defined in slide 39 of the presentation available at https://tinyurl.com/ydwyz2jx. To present these scores, generate a single output.csv file with 122 data lines; the first 61 data lines must be respective to the 61 lines of genuine.txt, while the following 61 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
1,0.56
1,0.43678160919540023
(...)
0,0.18018018018018017
0,0.14689265536723164
(...)
```

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

1,0.582089552238806	1,0.6730769230769231	0,0.19298245614035087	0,0.1711229946524064
1,0.56	1,0.48148148148148145	0,0.1485148514851485	0,0.20869565217391303
1,0.5801526717557252	1,0.9264705882352942	0,0.15254237288135594	0,0.28346456692913385
1,0.5985401459854015	1,0.6075949367088608	0,0.1509433962264151	0,0.22727272727272727
1,0.5504587155963303	1,0.4918032786885246	0,0.24242424242424243	0,0.19672131147540983
1,0.5517241379310345	1,0.4225352112676056	0,0.19753086419753085	0,0.23853211009174313
1,0.6495726495726496	1,0.5606060606060606	0,0.25196850393700787	0,0.18333333333333332
1,0.5106382978723404	1,0.7768595041322314	0,0.2158273381294964	0,0.16666666666666666
1,0.64	1,0.3472222222222222	0,0.2	0,0.2127659574468085
1,0.7037037037037037	1,0.5142857142857142	0,0.19310344827586207	0,0.16417910447761194
1,0.9007633587786259	1,0.8031496062992126	0,0.1702127659574468	0,0.18439716312056736
1,0.676056338028169	1,0.6081081081081081	0,0.23157894736842105	0,0.13259668508287292
1,0.6573426573426573	1,0.6474820143884892	0,0.17679558011049723	0,0.15730337078651685
1,0.5365853658536586	1,0.5233644859813084	0,0.12322274881516587	0,0.2318840579710145
1,0.6461538461538462	1,0.5648854961832062	0,0.21568627450980393	0,0.19801980198019803
1,0.768	1,0.9242424242424242	0,0.22110552763819097	0,0.24324324324324326
1,0.35135135135135137	1,0.5283018867924528	0,0.16143497757847533	0,0.15384615384615385
1,0.584070796460177	1,0.6268656716417911	0,0.24427480916030533	0,0.20952380952380953
1,0.5773195876288659	1,0.6940298507462687	0,0.2318840579710145	0,0.2830188679245283
1,0.7128712871287128	1,0.43283582089552236	0,0.21176470588235294	0,0.19310344827586207
1,0.4742268041237113	1,0.4505928853754941	0,0.18018018018018017	0,0.2054794520547945
1,0.6666666666666666	1,0.6265060240963856	0,0.17391304347826086	0,0.1941747572815534
1,0.6811594202898551	1,0.48484848484848486	0,0.17142857142857143	0,0.14754098360655737

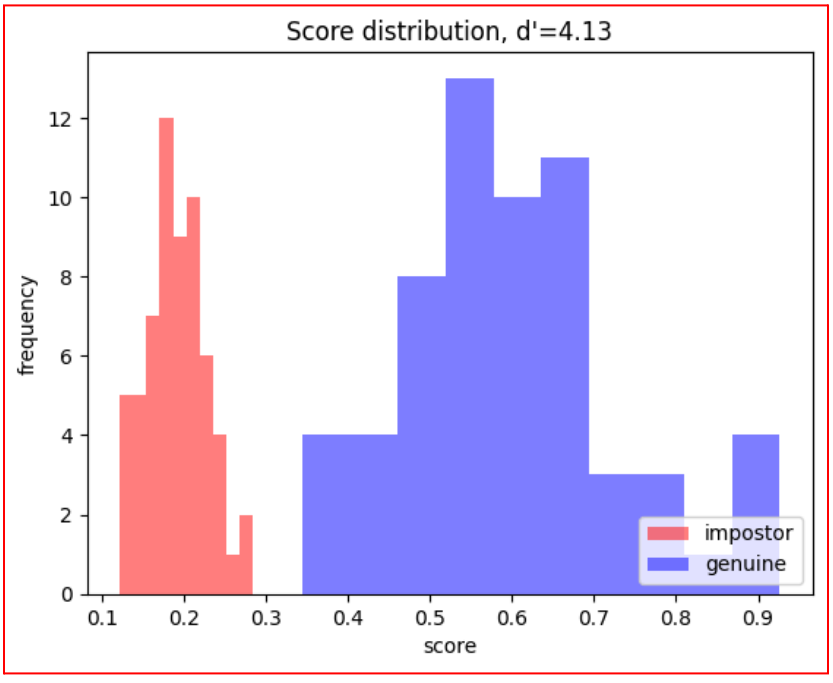
1,0.6582278481012658	1,0.44155844155844154	0,0.22058823529411764	0,0.21621621621621623
1,0.6324786324786325	1,0.375	0,0.17647058823529413	0,0.20512820512820512
1,0.5428571428571428	1,0.54421768707483	0,0.17721518987341772	0,0.12435233160621761
1,0.5490196078431373	1,0.5121951219512195	0,0.19469026548672566	0,0.17543859649122806
1,0.5504587155963303	1,0.6551724137931034	0,0.13008130081300814	0,0.18181818181818182
1,0.46511627906976744	1,0.8979591836734694	0,0.17391304347826086	0,0.12280701754385964
1,0.8347826086956521	1,0.3448275862068966	0,0.1651376146788991	0,0.21428571428571427
1,0.5945945945945946		0,0.16071428571428573	

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)

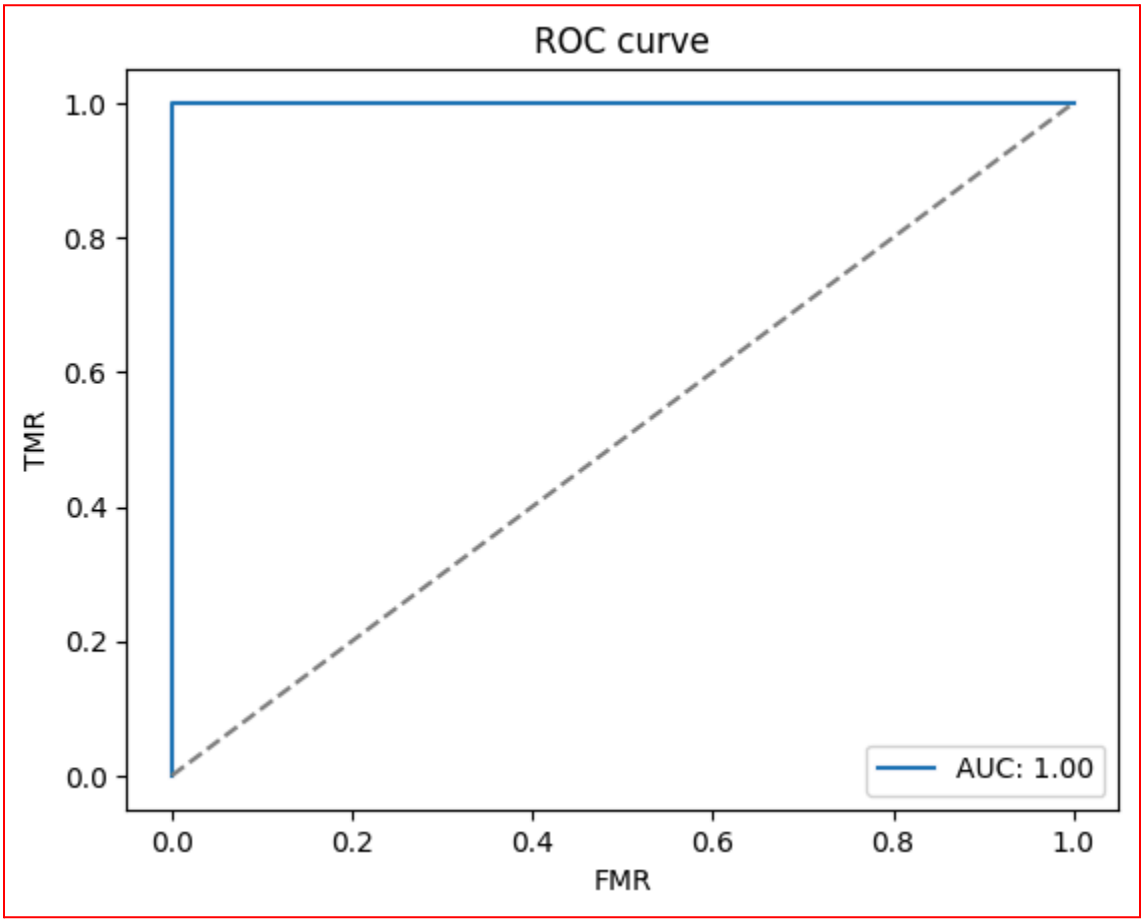
The threshold should be 0.3448275862068966. I found this score by using the `compute_sim_fmr_fnrm_eer` function to calculate the equal error rate, which is when the false match rate and false non-match rate are closest to (or ideally, equal to) each other. By using this to calculate the threshold, we avoid showing a preference for either false matches or false non-matches; instead, we find the threshold at which both are low.

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)

The system's d-prime value is approximately 4.13.



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)



This system is working significantly better than chance. The chance diagonal is the dotted gray line, representing a system with a 50/50 chance of making an error in either direction. A curve with less area than that line, in turn, would behave worse than chance.

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

This model is likely not robust enough to detect fake fingerprints such as silicone fingers. The reason is that our system analyzes only the level-2 features of the fingerprint — namely, ridge endings and bifurcations. Silicone fingers can reasonably replicate these features, but notably would not contain some of the deeper details, such as level-3 features. To combat silicone fingers, the model would require a sensor with sufficient resolution to capture level 3 features, as well as code to identify them.