2. Questions

2.1. As explained in class, the provided third-party face recognition library can extract a 512-dimensional float feature vector from a given face image, as well as calculate the angular distance between two feature vectors, using ArcFace (https://arxiv.org/abs/1801.07698). The expected behavior of the software is to generate small distances for two face images depicting the same individual (a genuine pair) and large distances for two images depicting different individuals (an impostor pair).

Leveraging the content of **only** the "dataset" folder within the provided data, the third-party face recognition library, and metrics learned in class, please determine **what a good angular distance threshold is to separate genuine from impostor pairs**. While providing your answer for the distance threshold, please explain in detail how you computed it. (1 point)

Based on my computation, the optimal distance threshold to separate genuine pairs from imposter pairs is T = 0.9970.

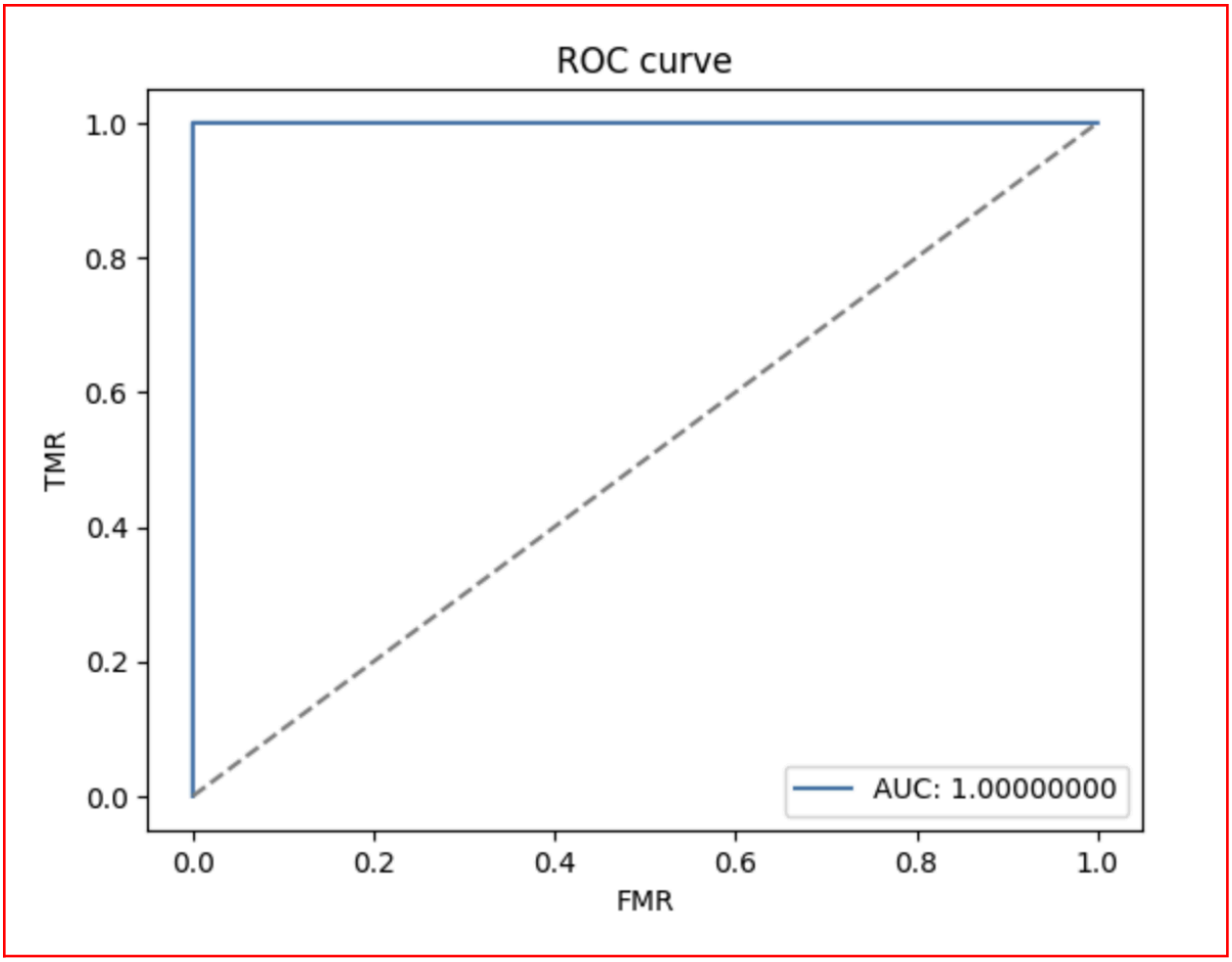
I determined the threshold by identifying the Equal Error Rate (EER) point on the system's ROC curve. Since the EER is the point where the False Match Rate (FMR) and the False Non-Match Rate (FNMR) are equal, choosing this point ensures that the system's risk of incorrectly accepting an imposter is balanced with the risk of incorrectly rejecting a genuine user.

First, I used the ArcFace library to extract a 512-dimensional feature vector for each of the 90 images in the dataset folder. The angular distance, using the match function, was calculated for all 4,005 unique pairwise combinations of the 90 feature vectors. The genuine and the impostor pairs were then classified. A range of potential distance thresholds (T) was iteratively tested against the genuine and imposter distance distributions. So, for each threshold (T), the FMR(T) was calculated as the proportion of impostor distances that fell ≤ T, which resulted in a false match. The FNMR(T) was also calculated as the proportion of genuine distances that fell > T, which resulted in a false non-match. The final threshold, T = 0.9970, was selected because it minimized the absolute difference $|FMR(T) - FNMR(T)|$. This point yielded a low EER of 0.0001, showing the ArcFace features are highly discriminative on the dataset we are using.

A new comparison distance (D) can be classified as:
- Match (Genuine) if $D \leq 0.9970$
- No Match (Imposter) if $D > 0.9970$

2.2. **What is the AUC** of the face recognition system you are using? In addition, please provide a graph with the system's **ROC curve**. (1 point)

The AUC is 1.00, which is ideal.



2.3. By leveraging the face recognition system and the distance threshold previously computed, and by either capturing your face with your webcam or providing an image with your face, find within the "dataset" folder which individual is the most similar to you. **Please provide the subject ID and the angular distance between your face and theirs**. In your *opinion*, do you have anything in common with this subject (e.g., gender, ethnicity, age, pose, etc.)? If yes, what do you think it is? (2 points)

I used the webcam to capture an image of my face, and the individual in the dataset who was most similar to it was subject05. Even though this was identified as the individual most similar to me in the dataset, the minimum angular distance was still 1.4066, which is significantly above the optimal threshold (0.9970).

The verification decision was rejected, so the system classified the pair (my face, subject05) as an impostor pair. This is correct because the system recognized that the difference between my face and the nearest subject in the database is too large to be considered a genuine match.

Subject 05 and I do not have much in common. Subject 05 is an older, white man, while I am a younger, white female. We are both of the same race, and we both have deep smile lines. I also took a photo with more light shining on the right side of my face, similar to the subject05.rightlight.png photo in the dataset. I think that is where the similarities between my face and subject05's face end.

2.4. By leveraging the face recognition system and the distance threshold previously computed, **please provide the subject ID** (or "**UNKNOWN**", if the individual does not have a face within the "datasets" folder), as well as **the respective angular distances** that supported your decision, for each one of the 15 images provided within the "queries" folder. (6 points)

The table below provides the subject ID and the minimum angular distance for each of the 15 query images. The decision is based on comparing the minimum angular distance against the optimal threshold (T = 0.9970).

Query File	Subject ID	Angular Distance	Decision
4168.png	subject01	0.1335	Match
4387.png	subject02	0.1141	Match
4507.png	subject07	0.1041	Match
4535.png	subject03	0.2219	Match
5314.png	subject08	0.2157	Match
6012.png	UNKNOWN	1.4626	Unknown
6510.png	UNKNOWN	1.511	Unknown
6653.png	subject05	0.1023	Match
6706.png	UNKNOWN	1.5998	Unknown
7076.png	subject06	0.1153	Match
7549.png	subject09	0.1755	Match
7633.png	subject04	0.0749	Match
7745.png	UNKNOWN	1.4957	Unknown
9395.png	subject10	0.0776	Match
9708.png	UNKNOWN	1.2653	Unknown

Ten of the query images were successfully identified. For these images, the minimum angular distance to a subject in the dataset was low, all well below 0.3, confirming a very high probability of a genuine match and supporting the identification decision. Five of the query images were classified as UNKNOWN. For these images, even the closest subject in the dataset had a minimum angular distance greater than the 0.9970 threshold, with distances ranging from 1.2653 to 1.5998. This suggests that the individuals depicted in these five queries do not have a corresponding image within the dataset gallery, confirming the system's ability to reject impostors.