Biometric systems 2025/2026

Evaluation of Vision Transformers for face verification under attacks and appearance variations

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Problem Statement

Introduction

Face Verification

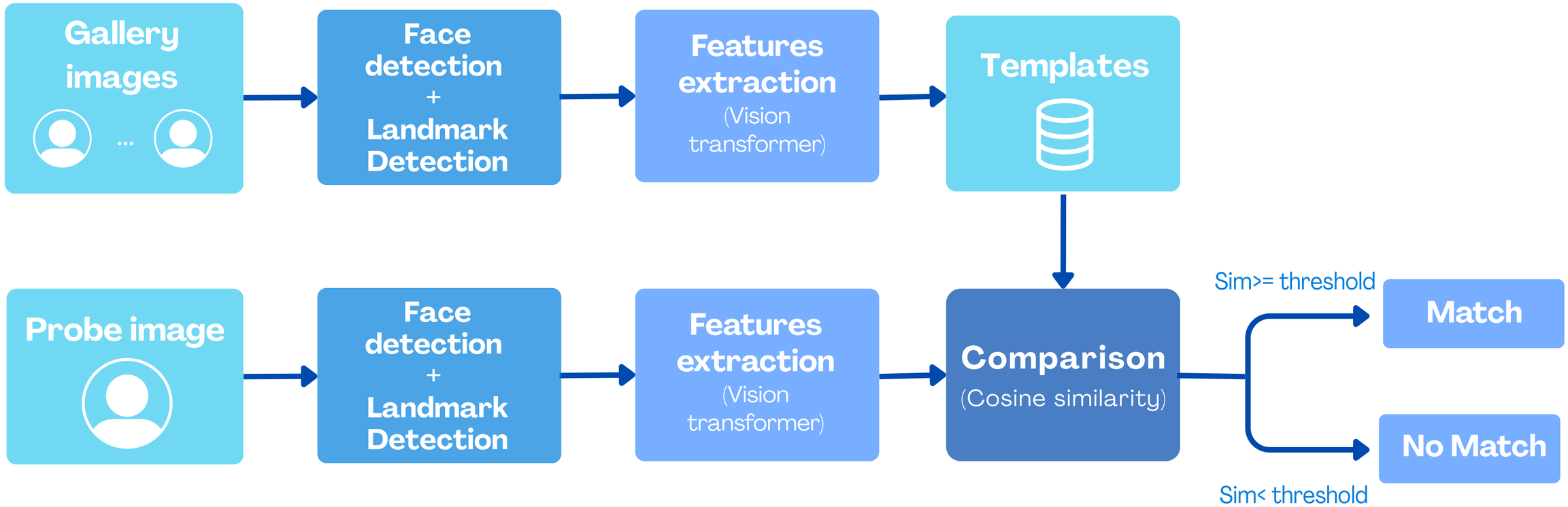
Face verification is the process of confirming a person's identity by comparing two facial images and deciding if they belong to the same individual.
Real-world conditions can significantly affect verification performance. In addition, **spoofing attacks** represent a serious threat to system reliability.

Objectives

- **Analyze** a ViT-based verification model in real-world scenarios
- **Evaluate** performance on a custom dataset
- **Assess** resistance to attacks

Project overview

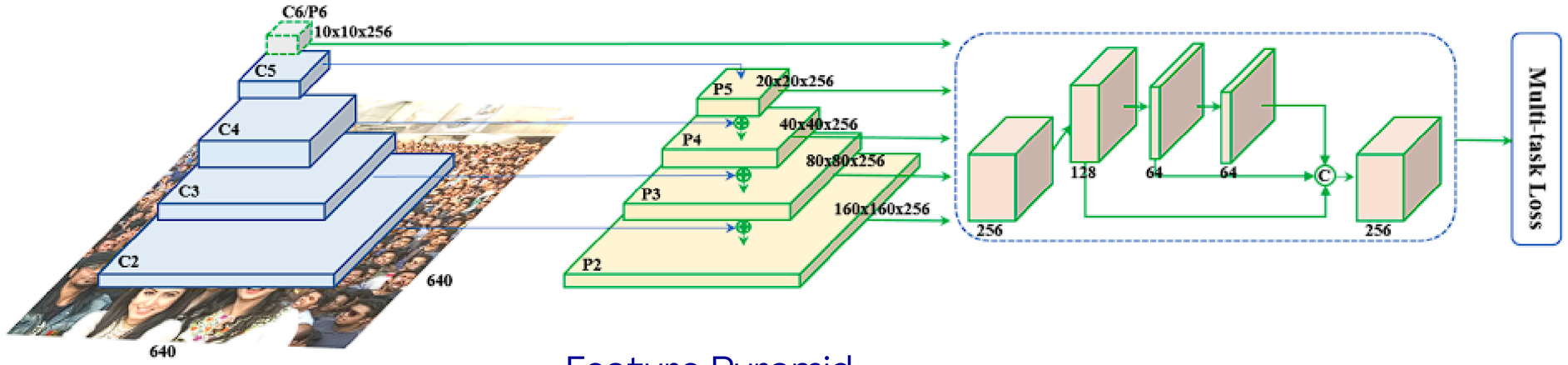
Full pipeline



Model Architectures (1)

RetinaFace

- Trained on **WIDER FACE** dataset
- **Anchor-based** training strategy



ResNet-50 backbone

Feature Pyramid Network

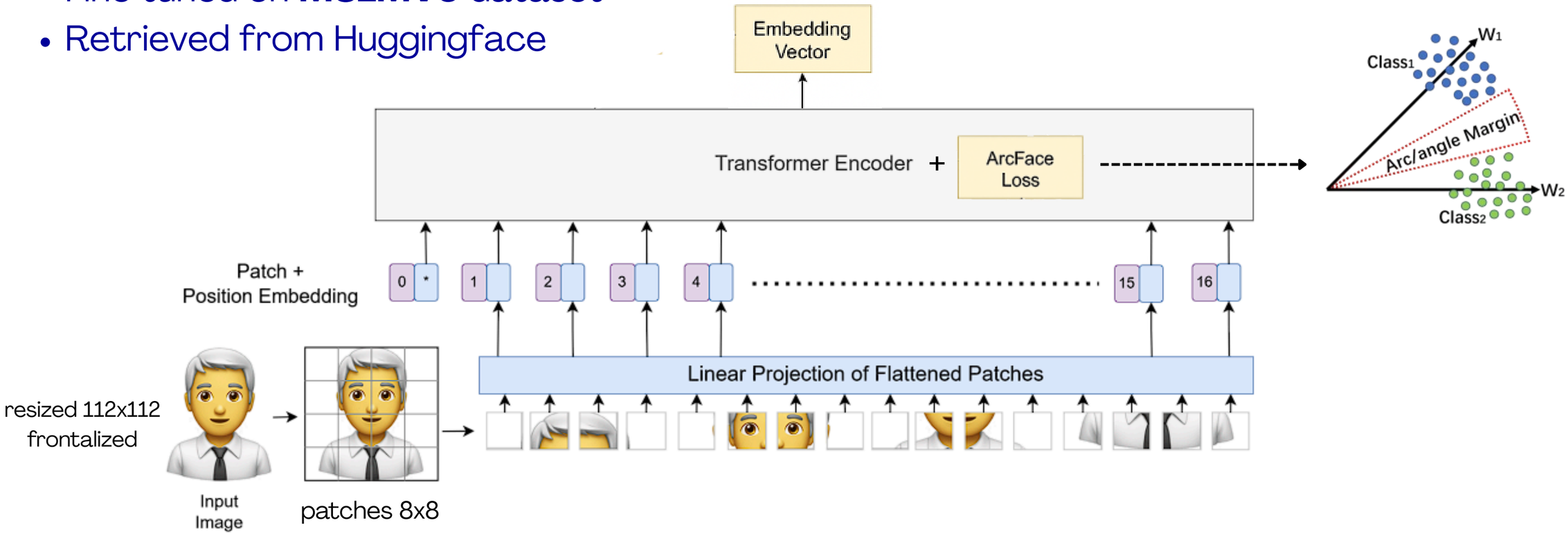
Context module

- **Face classification**
- Bounding-box regression
- **Facial landmarks**

Model Architectures (2)

ViT

- Fine tuned on **MS1MV3** dataset
- Retrieved from Huggingface



- **Arcface loss** for discriminative embeddings:

$$\mathcal{L} = \frac{-1}{N} \sum_{i=1}^{N} \log \frac{e^{s \cdot \cos \theta_{y_i} + m)}}{e^{s \cdot \cos (\theta_{y_i} + m) + \sum_{j \neq y_i} e_{s \cdot \cos \theta_j)}}$$

Datasets (1)

User variations

- Gallery: **212 images** (3 for each identity)
- Each category containes **12 images** (27 for interpersonal)
- Overlap categories

Make-up

Age

Plastic surgery

Datasets (2)

Potential attacks

Print attacks

Camouflage

Deepfake

Interpersonal

Proposed method (1)

Step 1: Landmarks detection and Face alignment

- **Frameworks**: OpenCV, insightface library

1. **Face localization** and **landmarks extraction** (buffalo_l model, RetinaFace-10GF)
2. **Matching** and **warping** with *estimateAffinePartial2D* and *warpAffine*
3. **Result**: normalised 112 × 112 face

Original image

Image with landmarks

LANDMARK	X	Y
Left eye	38.2946	51.6963
Right eye	73.5318	51.5014
Nose tip	56.0252	71.7366
Left mouth	41.5493	92.3655
Right mouth	70.7299	92.2041

Standard ArcFace 5-point template

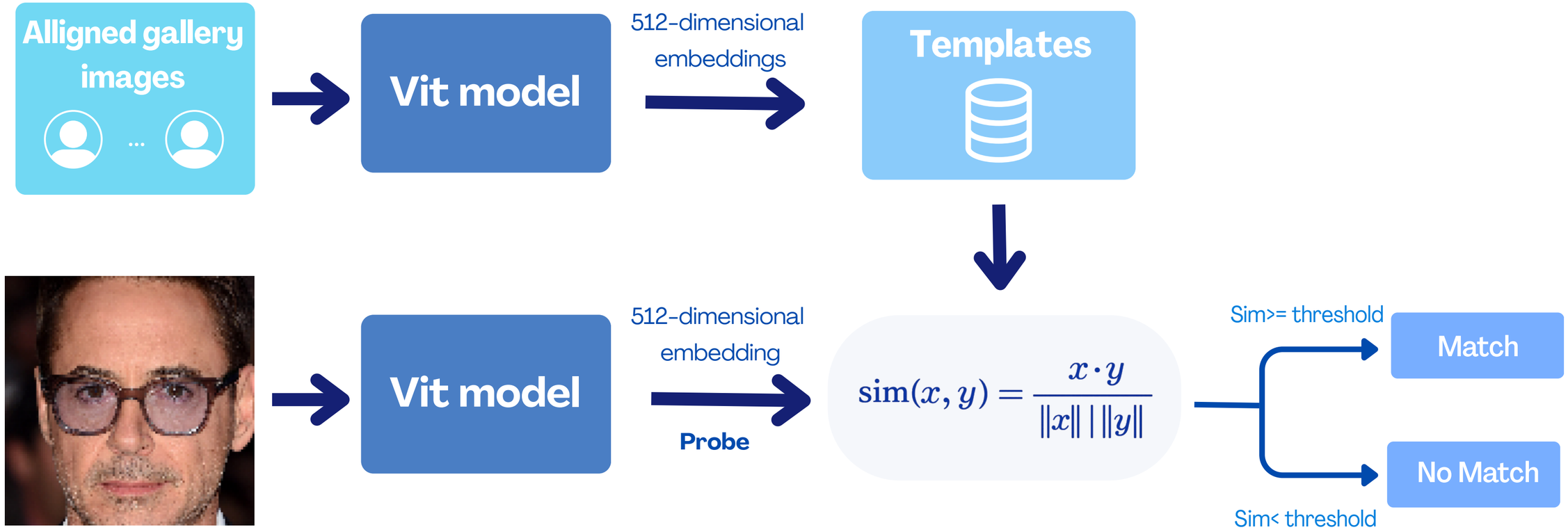
Aligned image (112x112)

*__same processing for gallery images__

Proposed method (2)

Step 2: Features Extraction and Similarity Computation

- Thresholds from 0 to 1 (step of 0.5)



*Probe vs Gallery comparisons are used to generate genuine and impostor verification trials

Proposed method (3)

Step 3: Evaluation

Scores

- Genuine Acceptance
- False Acceptance
- Genuine Rejection
- False Rejection

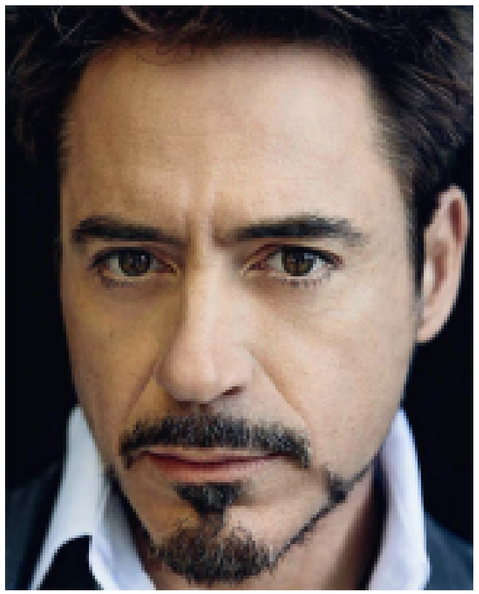
Graphics

- FAR
- FRR
- GAR
- GRR
- ERR
- ROC
- DET
- Margin

Results (1)

Detection and alignment

- Images where the face detector did not produce any bounding box:



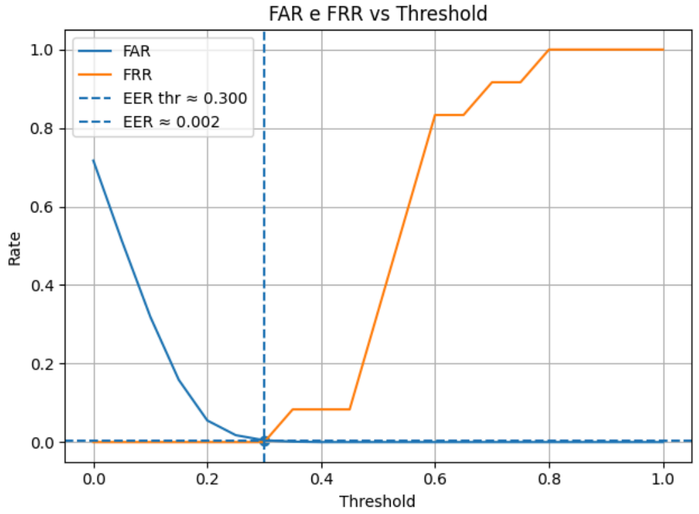
(a)

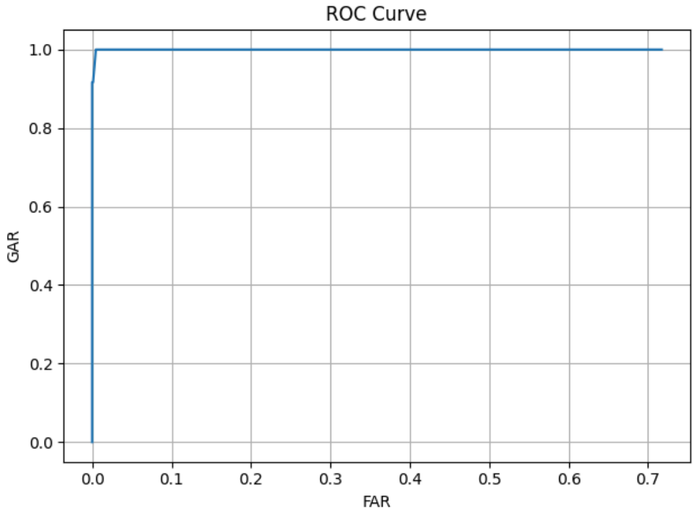
(b)

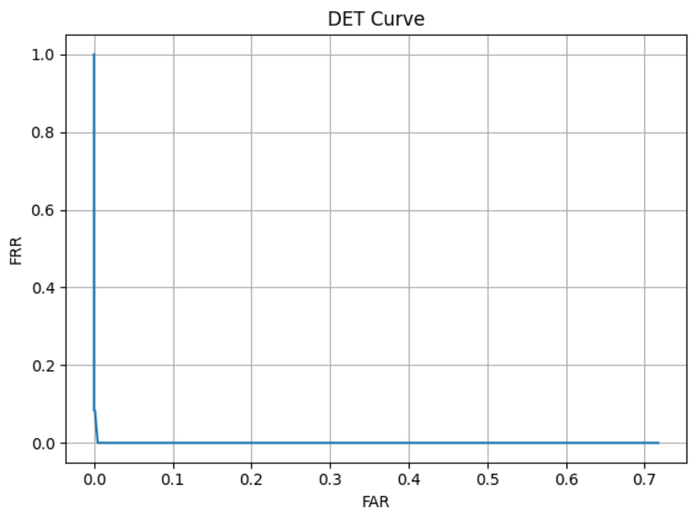
(c)

Results (2)

Age







Genuine acceptances:

Best Match: Zac Efron

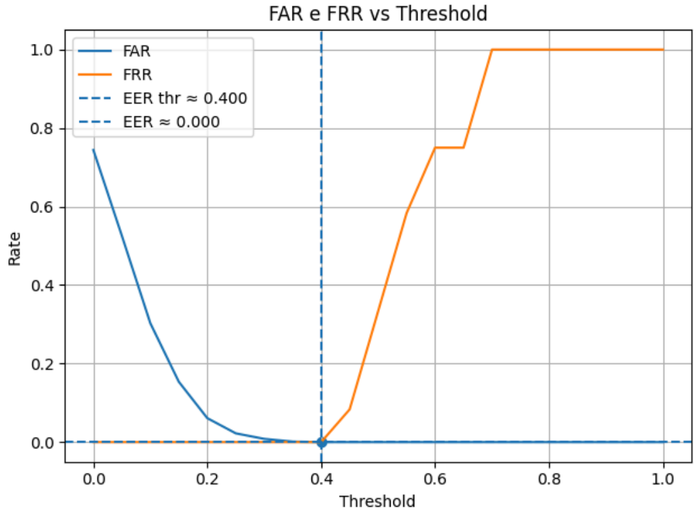
Similarity score: 0.7523

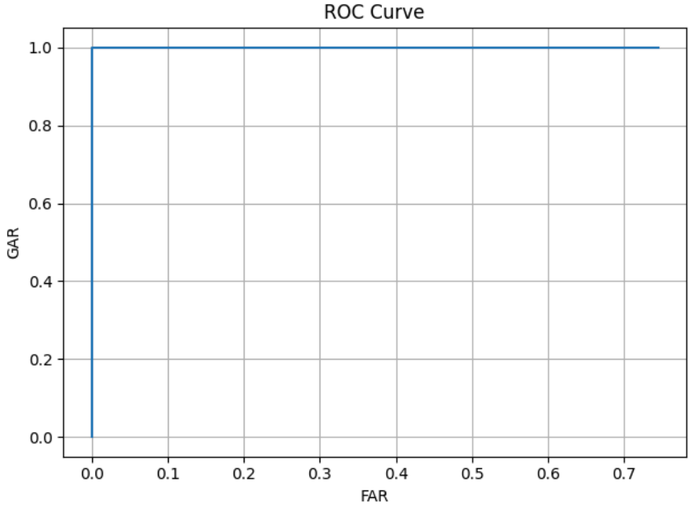
Worst Match: Queen Elizabeth

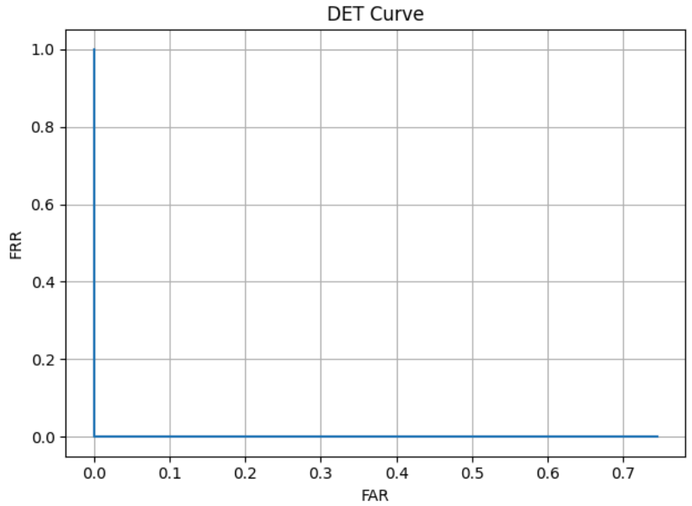
Similarity score: 0.2571

Results (3)

Camouflage







Genuine acceptances:

Best Match: Harry Styles

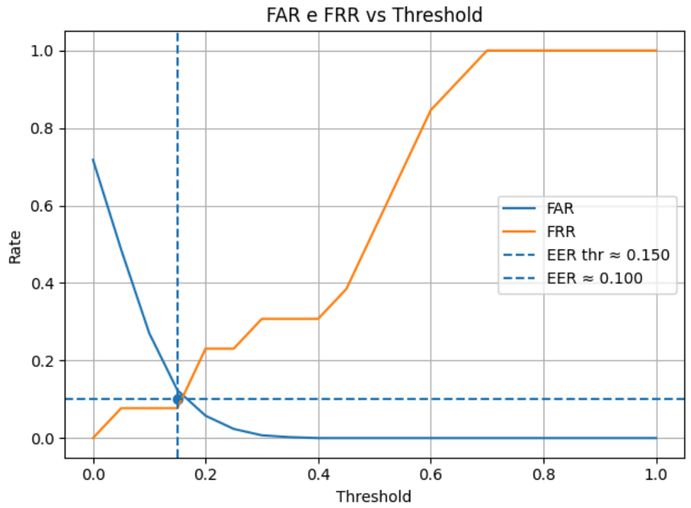
Similarity score: 0.6961

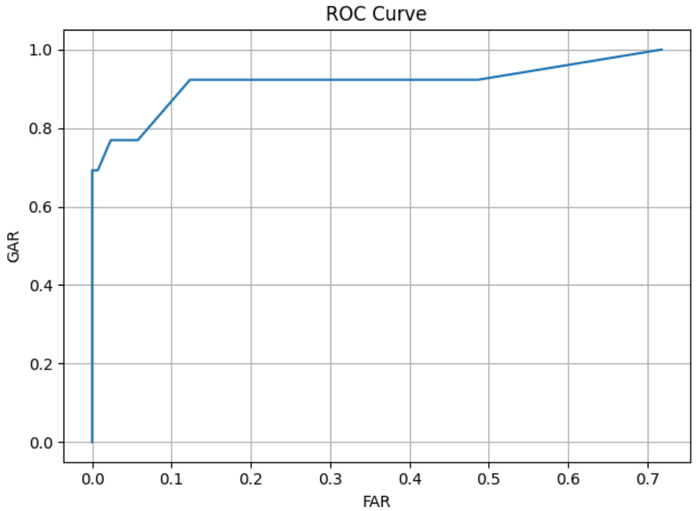
Worst Match: Chris Evans

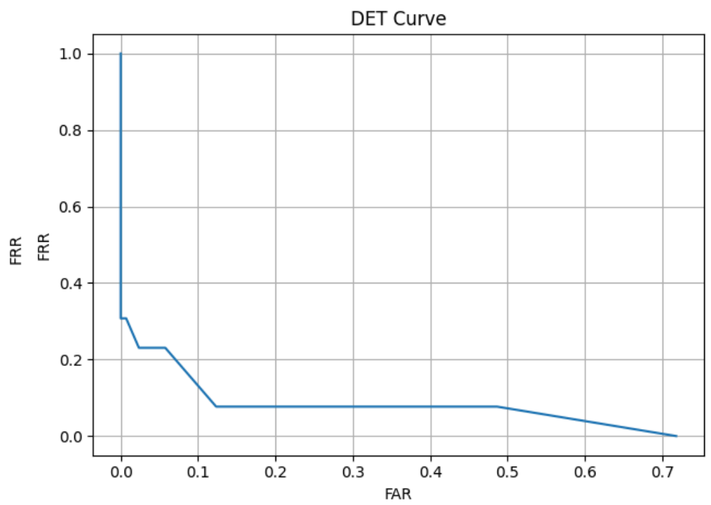
Similarity score: 0.3594

Results (4)

Make up







Genuine acceptances:

Best Match: Kylie Jenner

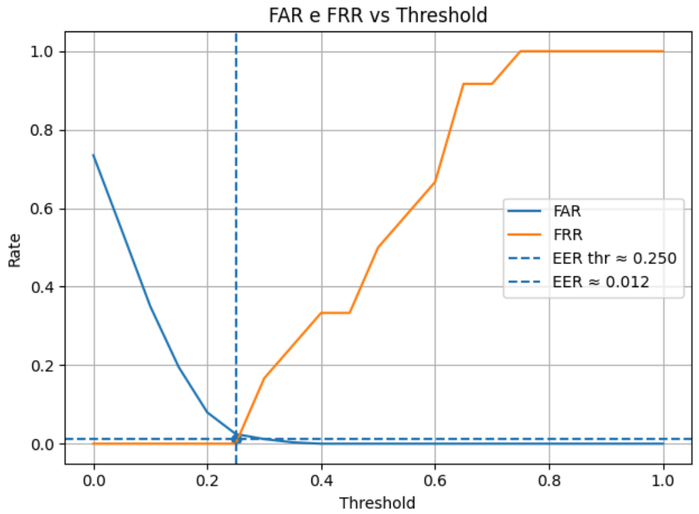
Similarity score: 0.6662

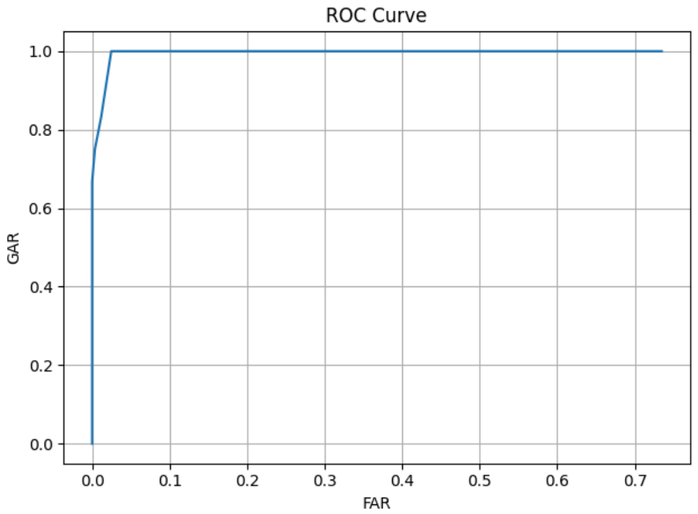
Worst Match: Robin Williams

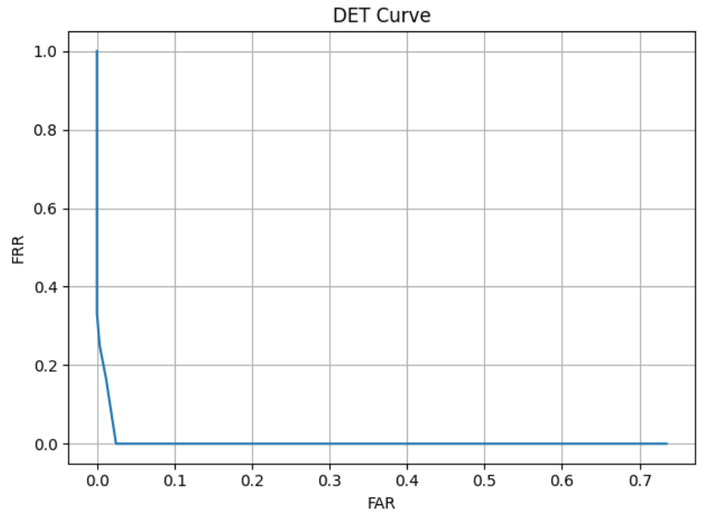
Similarity score: 0.0232

Results (5)

Plastic Surgery







Genuine acceptances:

Best Match: Zac Efron

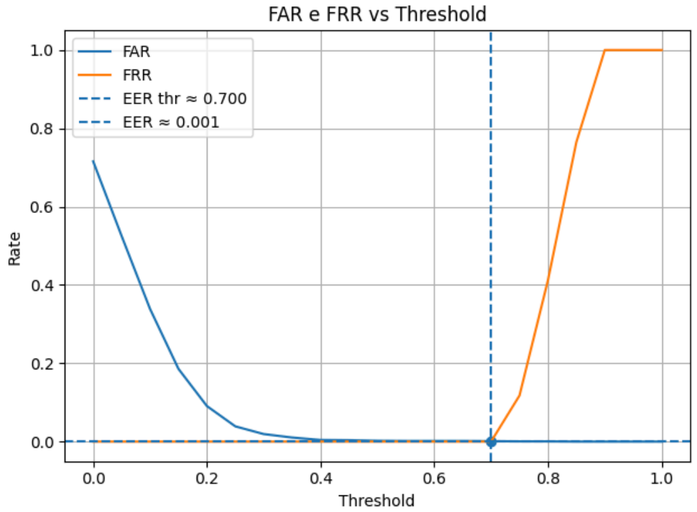
Similarity score: 0.7205

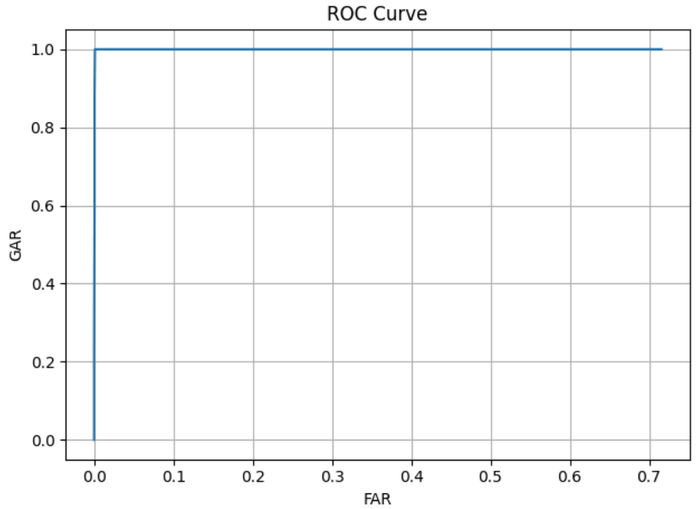
Worst Match: Lindsay Lohan

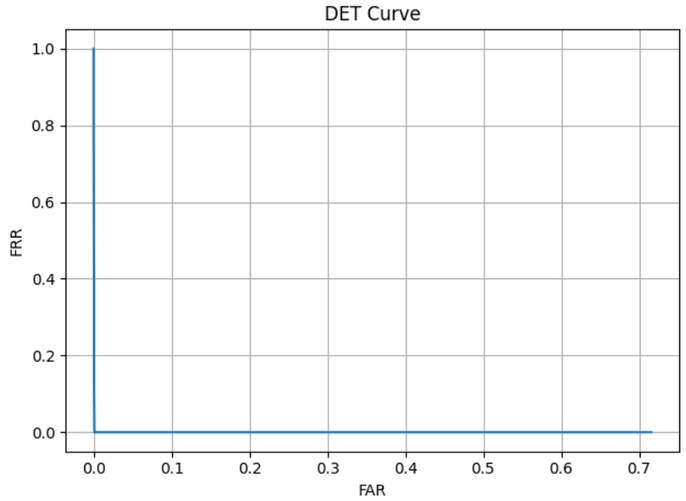
Similarity score: 0.1889

Results (6)

Inter-personal







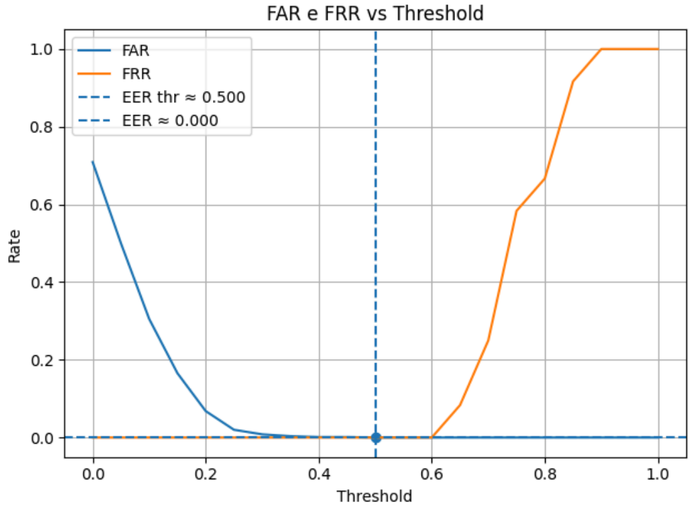
Genuine acceptances and false acceptances:

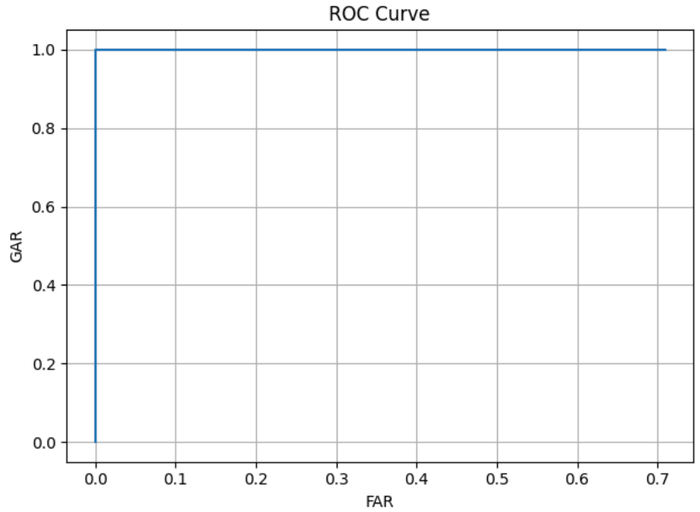
Probe (In gallery) | Genuine match Sim score: 0.8281 | Impostor match Sim score: 0.4920

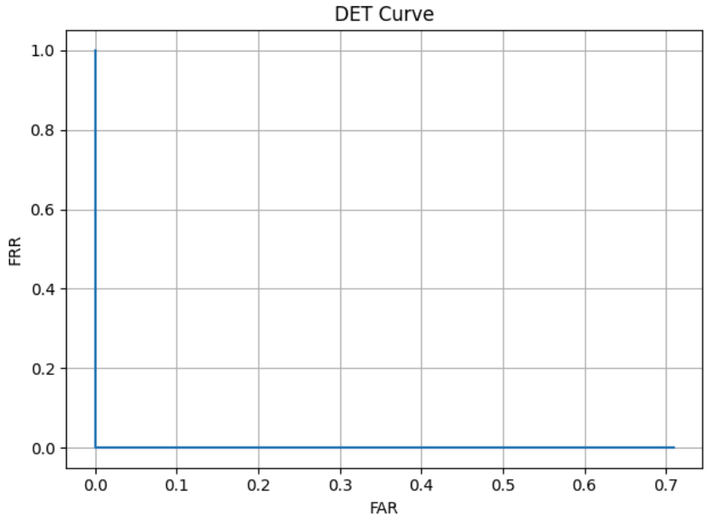
Probe (Not in gallery) | Impostor match Sim score: 0.6659

Results (7)

Print attack







Genuine acceptances:

Best Match: Leonardo Di Caprio

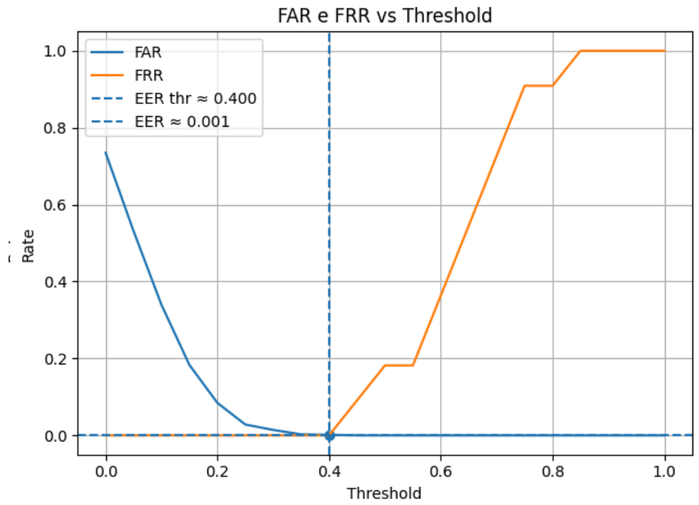
Similarity score: 0.8629

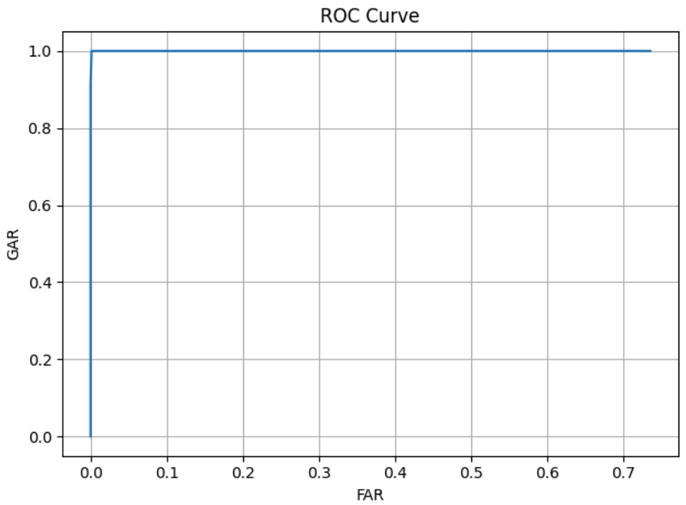
Worst Match: Johnny Depp

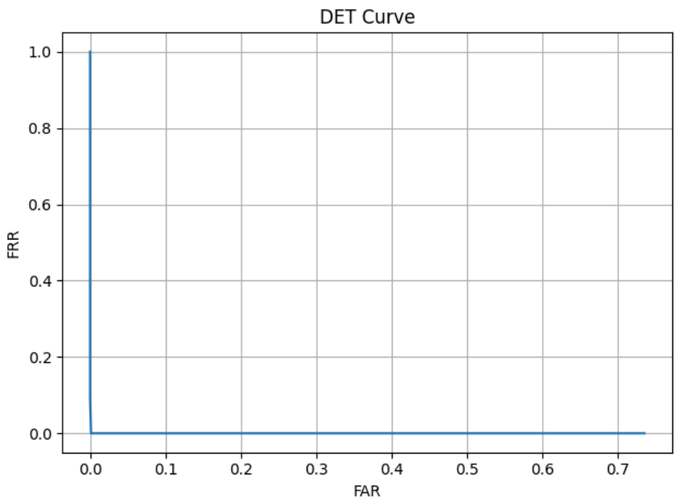
Similarity score: 0.4295

Results (8)

Deep fake







Genuine acceptances:

Best Match: Jennifer Lawrence

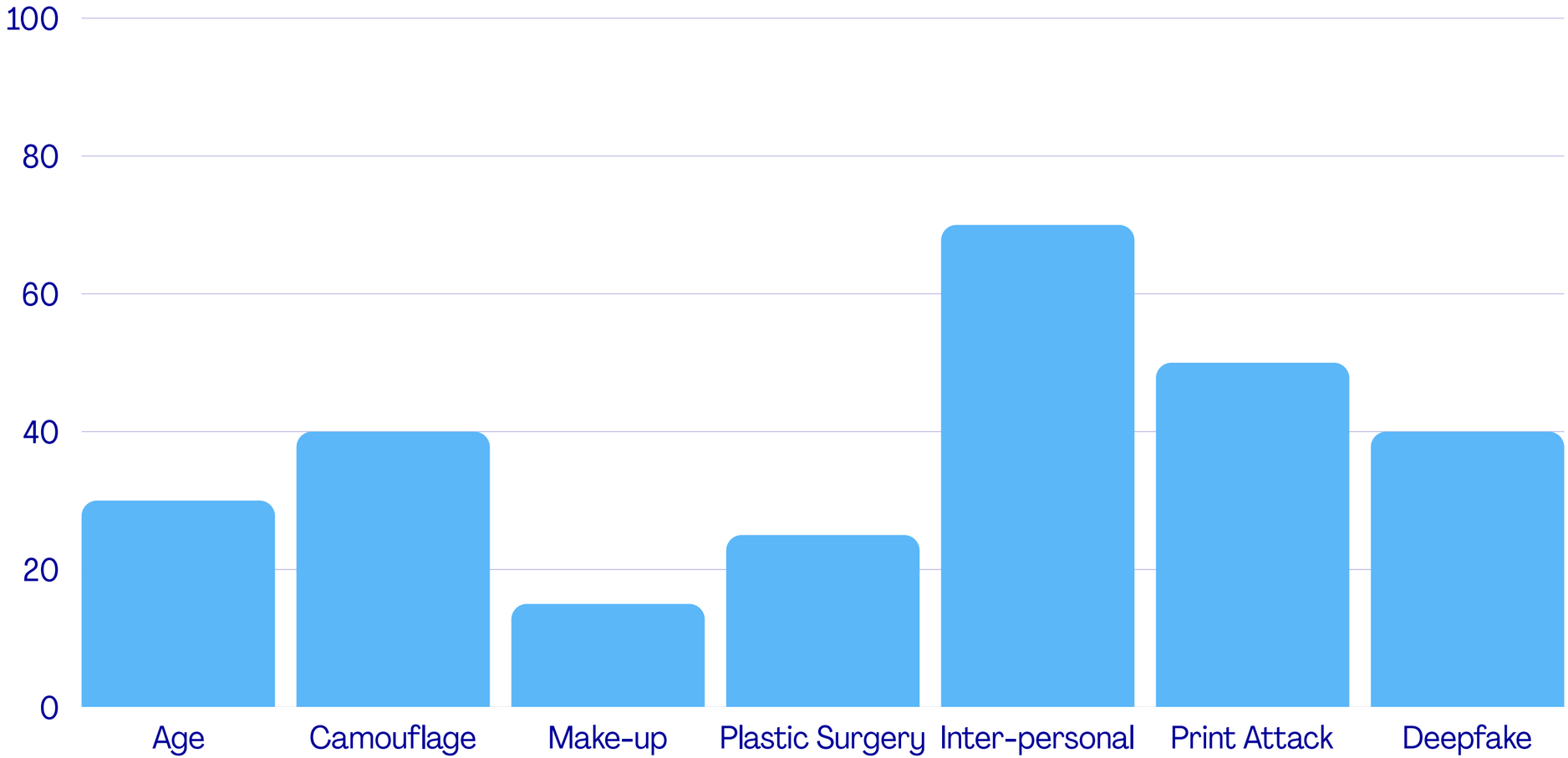
Similarity score: 0.8629

Worst Match: Johnny Depp

Similarity score: 0.4295

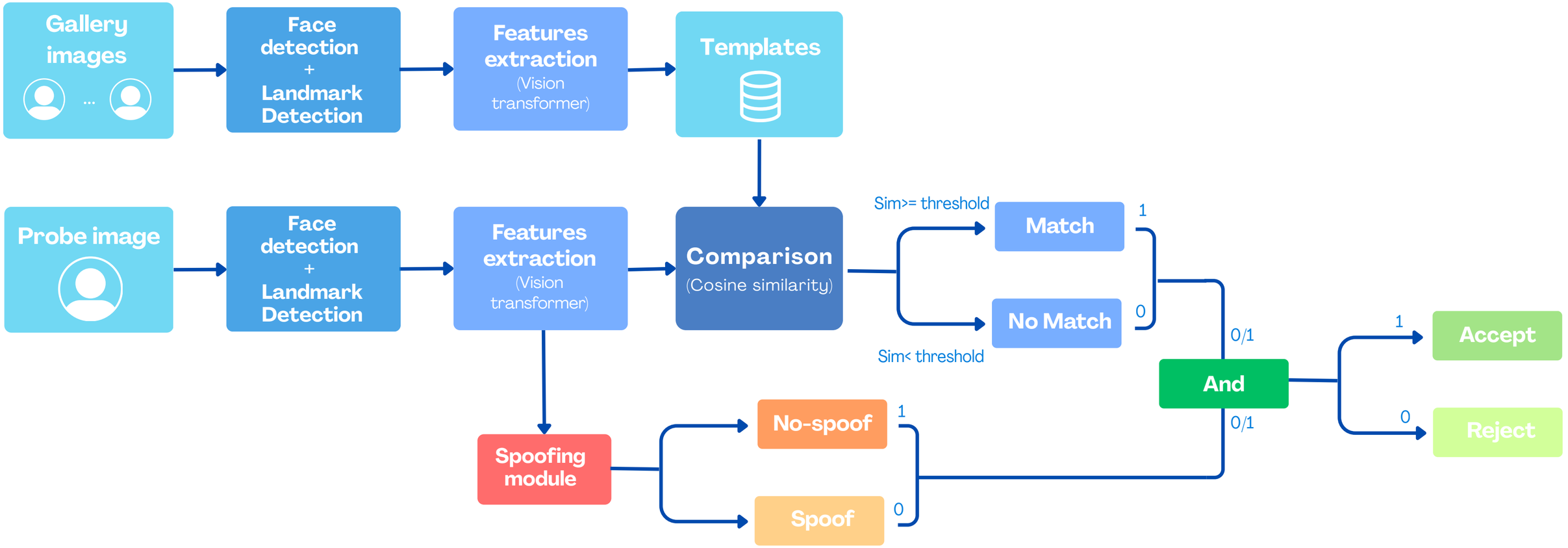
Future works

Adaptive Thresholds



Future works

What's next?



Conclusions

- ViT + ArcFace achieves **high face verification accuracy**
- Strong performance under natural variations
- **Performance decreases** under **extreme changes**
- **Spoofing attacks** are **not rejected** → require dedicated modules

References (1)

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Thank you
for your attention!