# Face Recognition:
# State of the Art + Morph Detection

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Following TRIP2023
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**NIST** NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY U.S. DEPARTMENT OF COMMERCE

**Face Recognition**

| 1:1 Verification | • Same person or not? |
| 1:N Search | • Who is that? |
| Twins Disambiguation | • Is it possible to avoid false positives in twins? |

**Face Analysis**

| Morph Detection | • Two faces in one passport! |
| Quality Summarization | • Predict future recognition failure? |
| Quality Defect Detection | • What exactly is wrong with a face image? |
| Presentation Attack Detection | • Is this image intended to subvert the system? |
| Age Estimation | • How old? Old enough? |
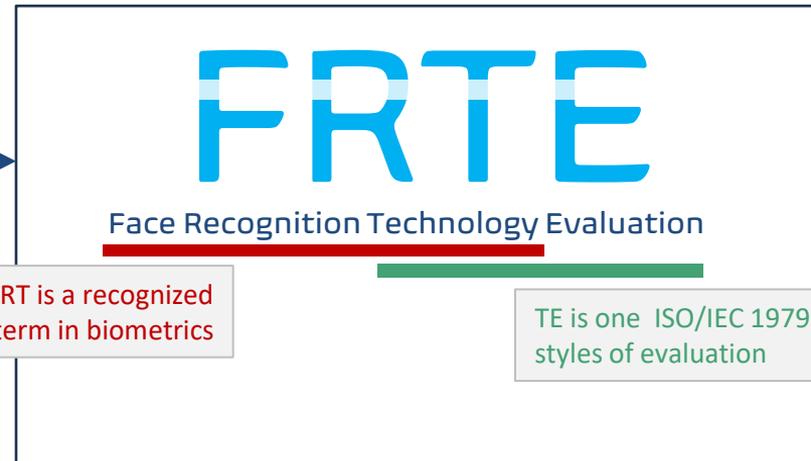
Open benchmarks | Global [+] | Independent | Free | Repeatable | Fair | Transparent | Large scale | Statistically robust | Fast | IP Protection

# The Power of AFR: 2023 Edition

Enroll 2004 portrait in to gallery with
N = 12 million other people

2004

SEARCH PHOTOS GIVING HIGH-SCORE MATE AT RANK 1

2002

2018

2007
50° YAW

2019

2008
SUNGLASSES

2014
60° YAW

2009
SHADOW

# The Power of AFR: 2023 Edition

Enroll 2004 portrait in to gallery with
N = 12 million other people

SEARCH PHOTOS GIVING HIGH-SCORE MATE AT RANK 1

2003
SHADOW

2009
POSE

2007
55º PITCH

2021
DL

2019
PITCH

2014
90º YAW

2014
40º PITCH

Enroll 2004 portrait in to gallery with
N = 12 million other people

RANK 1
WEAK HIT
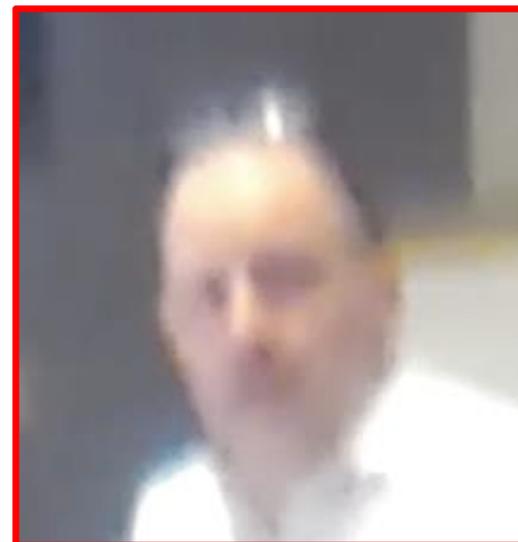
MISSED
OUTSIDE 50
RANKS

HIT BY ONE
CHINESE
ALGORITHM
RANK 15

# NEWS #3: ACCURACY GAINS CONTINUE

**Conclusions:**
- Algorithms improve regularly
- Do tech refresh!
- Contracts, agile procurement



rankone: Evolution of accuracy on five datasets 2017 – present

7
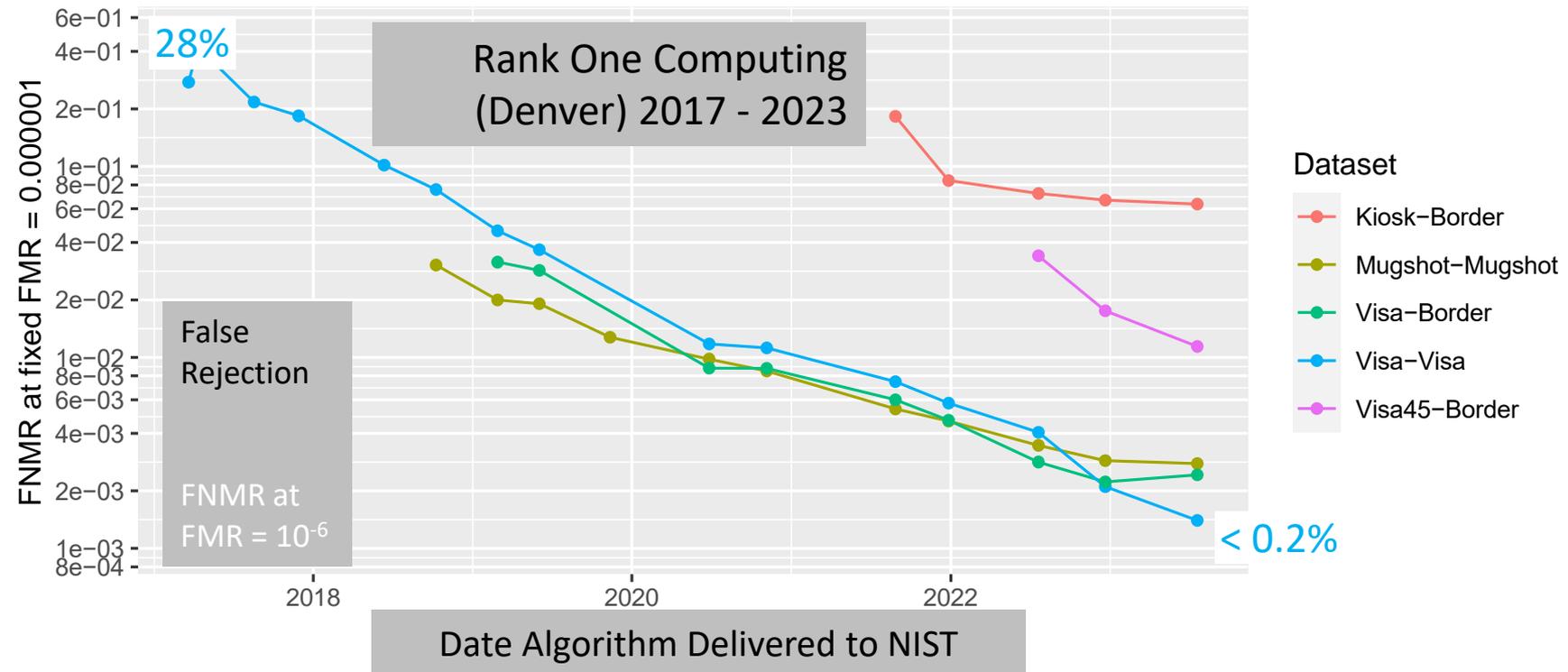
# Morphing: Can it be detected?
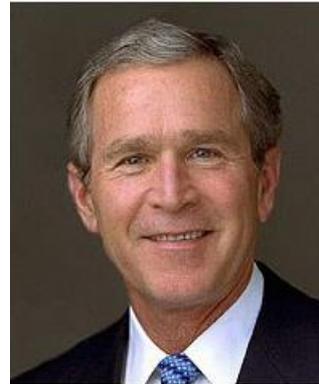


P43: George W. Bush  +  P44: Barack Obama

# Morphs or not?



A  B  C
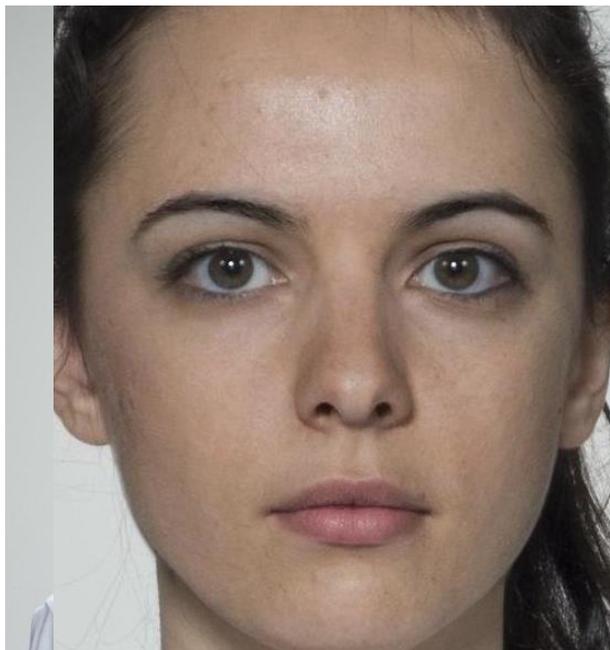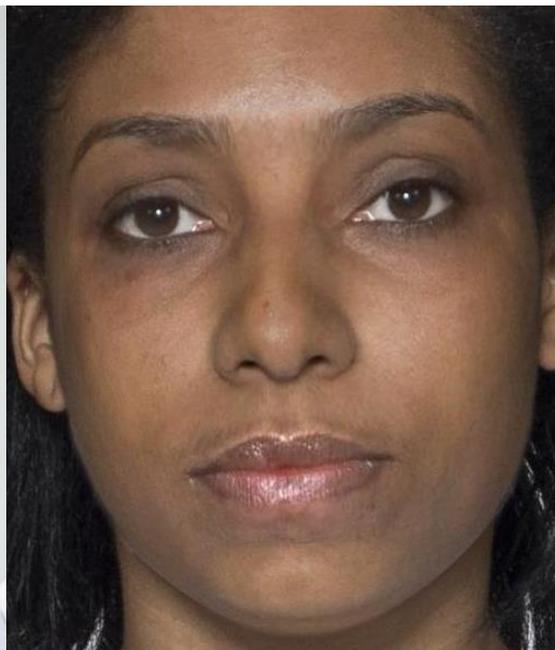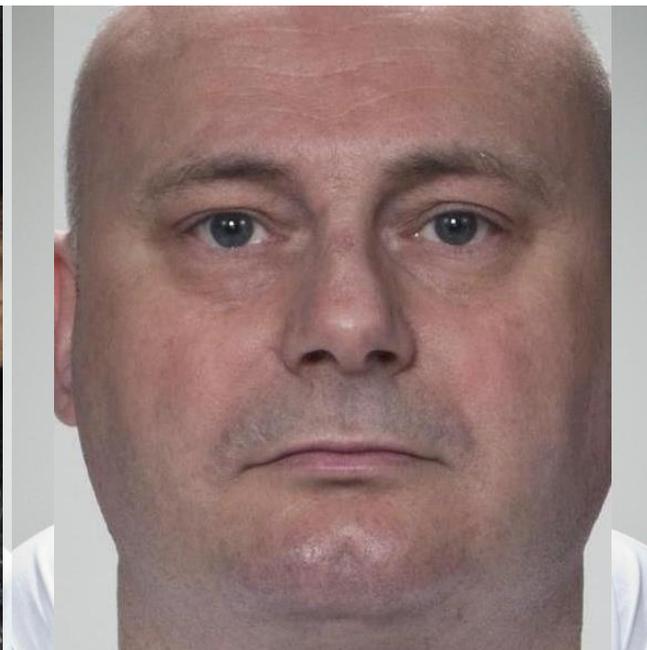
Morph of US
Presidents 43+44

**A: DOCUMENT ISSUANCE:** Suspect image in isolation:  Morph detection is difficult → impossible when attacker covers tracks
Solution: Trusted photo capture
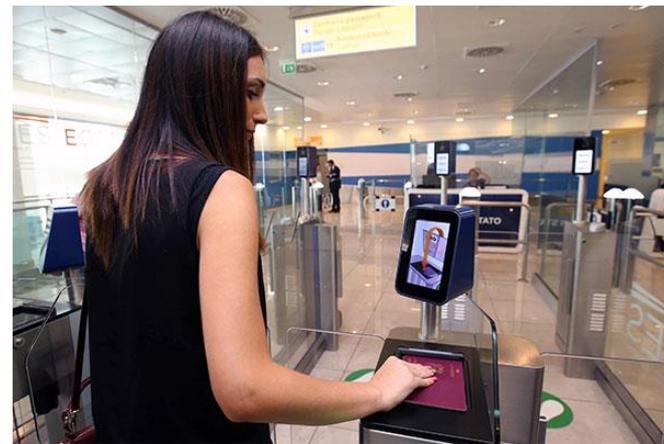


**B: BORDER CROSSING:** Suspect image + live image:  Morph detection is possible because similarity score is depressed.

# Similarity scores from AFR
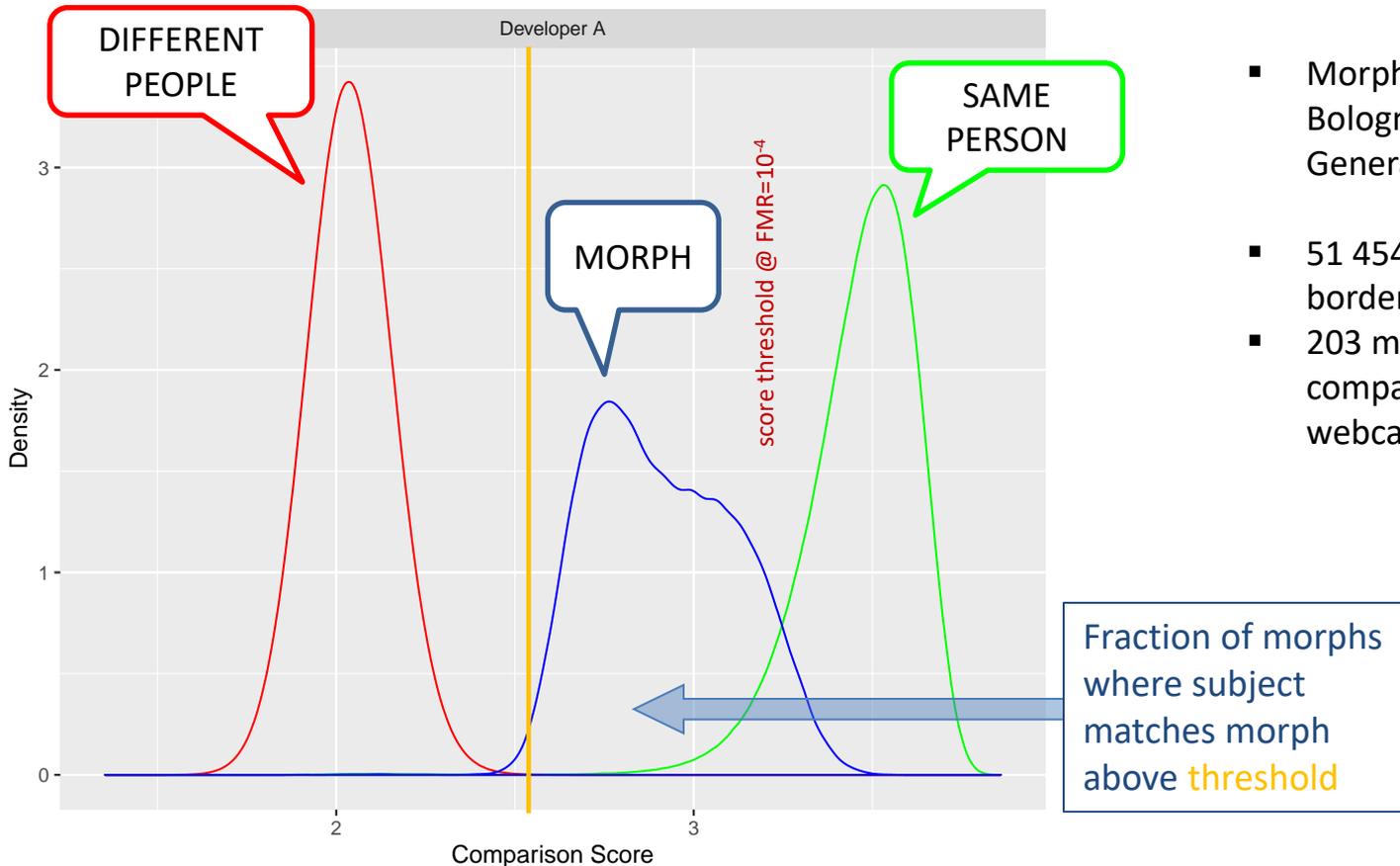
- 2-person morphs | alpha = 50%
- Similar age, same sex, nationality

- Morphed using University of Bologna Automatic Morphed Face Generation Tool v2 [1][2][3][4]

- 51 454 comparisons of morphs to border webcam photos
- 203 million non-morphed comparisons of visa-to-border webcam photos

[1] M. Ferrara, A. Franco, and D. Maltoni. The magic passport. In *IEEE International Joint Conference on Biometrics*, pages 1–7, Sep. 2014.

[2] M. Ferrara, A. Franco, and D. Maltoni. Face demorphing. *IEEE Transactions on Information Forensics and Security*, 13(4):1008–1017, April 2018.

[3] Matteo Ferrara, Annalisa Franco, and Davide Maltoni. *On the Effects of Image Alterations on Face Recognition Accuracy*, pages 195–222. Springer International Publishing, Cham, 2016.

[4] M. Ferrara, A. Franco, and D. Maltoni. Decoupling texture blending and shape warping in face morphing. In *Inter- national Conference of the Biometrics Special Interest Group (BIOSIG)*, pages 1–7, 2019.

# Morph detection: Bad news, good news



**wvusingle_002 (single–image)**  |  **secunet_002 (differential)**

FALSE DETECTION RATE (BPCER) vs MORPH MISS RATE (APCER)

BAD ... GOOD regions labeled.

False detection rate = 1%,
Morph miss rate = 9% – 36%

**Dataset**
- Global Morph
- Local Morph
- Local Morph Colorized Average
- Local Morph Colorized Match
- UNIBO Automatic Morphed Face Generation Tool v1.0
- Visa–Border
- UNIBO Automatic Morphed Face Generation Tool v2.0
- Twente
- DST
- MIPGAN–II
- Manual
- Print+Scanned

[1] U. Scherhag, C. Rathgeb, J. Merkle, and C. Busch. Deep face representations for differential morphing attack detection, 2020. https://arxiv.org/abs/2001.01202

A: Challenge: Single-image morph detectors do not generalize across different morphing methods

B: Opportunity: Two-image differential morph detection[1] can now access reduced false detection rates

Image Source: NIST

Global | Local | Local Avg | Local Match | UNIBO v1 | Visa-Border | UNIBO v2 | Twente | DST | MIPGAN-II | Manual | Print+Scanned

# THANK YOU.

ESPECIALLY

1. DHS S&T
2. DHS OBIM
3. FBI
4.