FRVT MORPH - Current Vulnerability Assessment and Automated Detection Performance

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International Face Performance Conference (IFPC) 2022
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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Face Morphing

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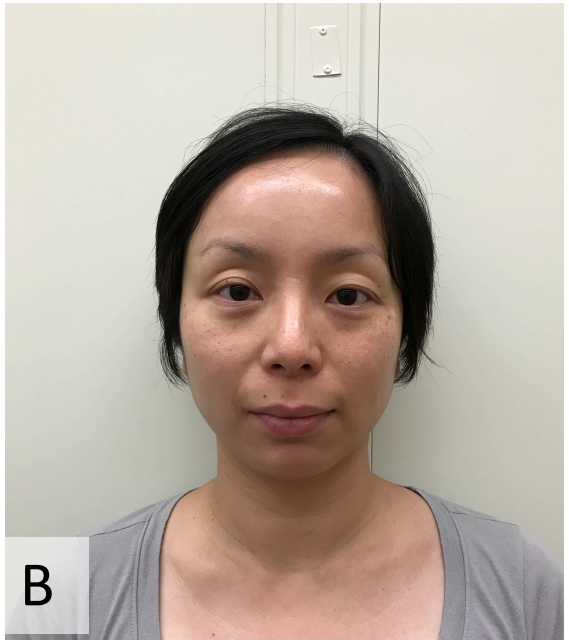

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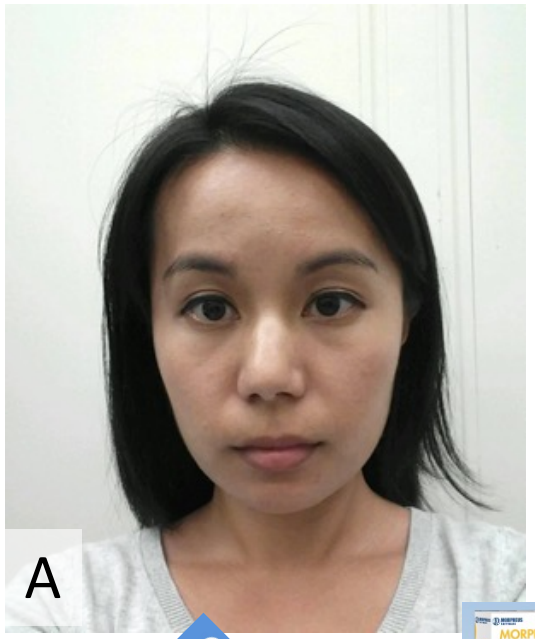
Image Source: NIST

Face Morphing



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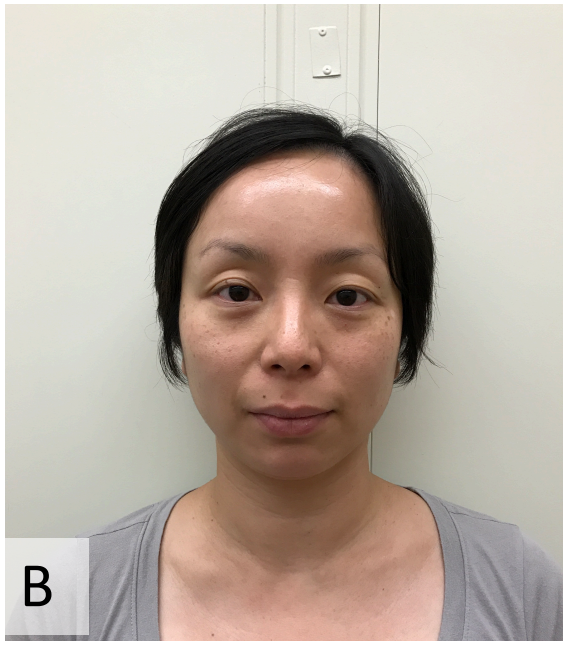

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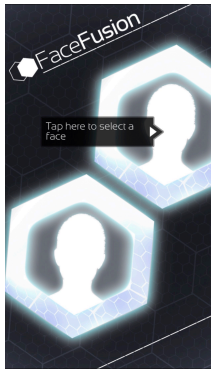
Image Source: NIST

Source: http://www.piviandco.com/apps/mixbooth



Source: https://en.softonic.com/solutions/apps/facefusion-lite

Source: http://www.morphthing.com

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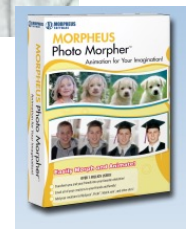
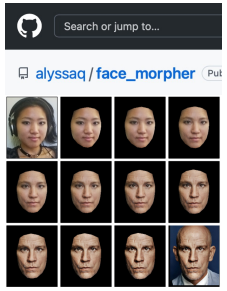
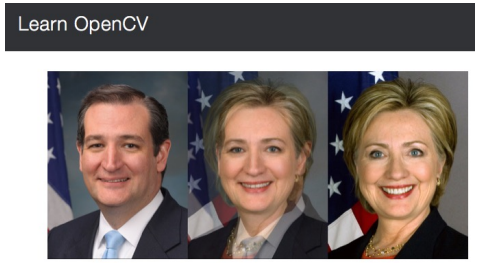


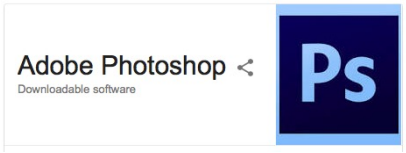
Source: http://www.morpheussoftware.net



Source: https://github.com/alyssaq/face_morpher

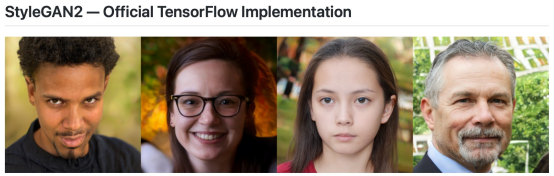


Source: https://www.learnopencv.com/face-morph-using-opencv-cpp-python



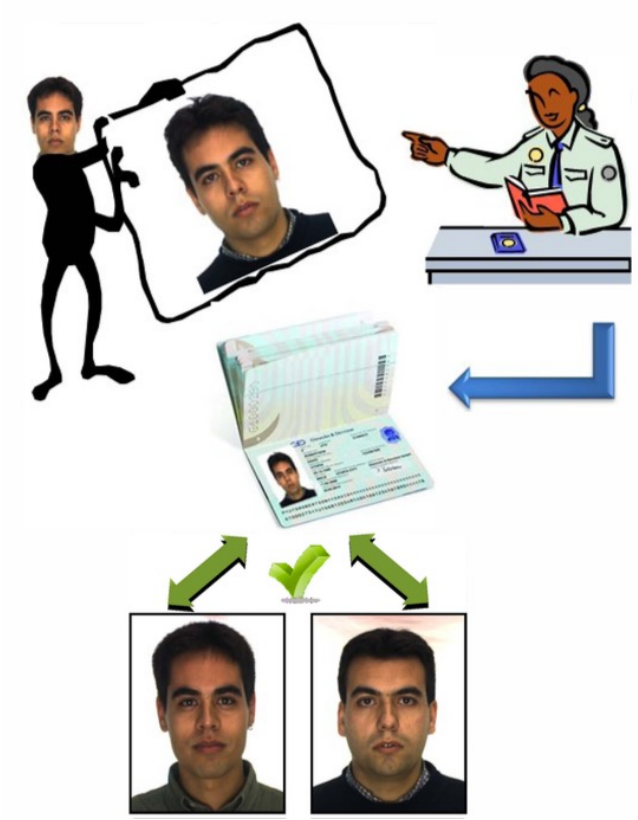
Source: https://www.adobe.com/products/photoshop.html

Source: http://www.fantamorph.com



Source: https://github.com/NVlabs/stylegan2

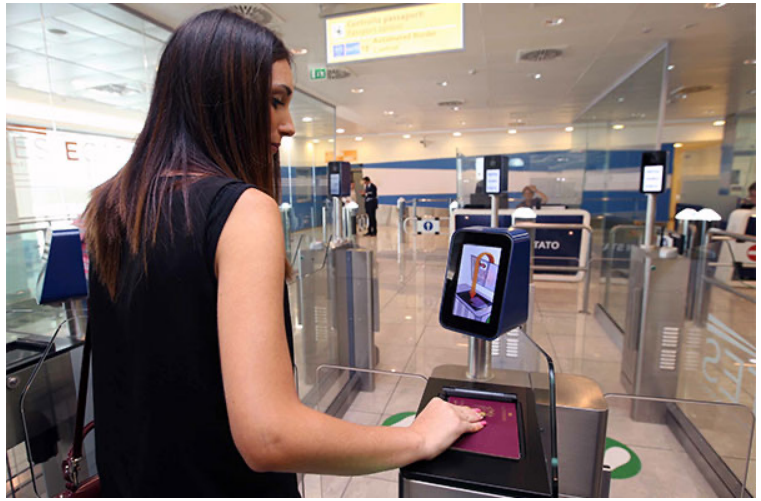
Threats & Consequences



Accomplice Attacker (other identity)

Source: Ferrara, Franco, and Maltoni, ***The Magic Passport***, IEEE International Joint Conference on Biometrics, October 2014, pp. 1-7

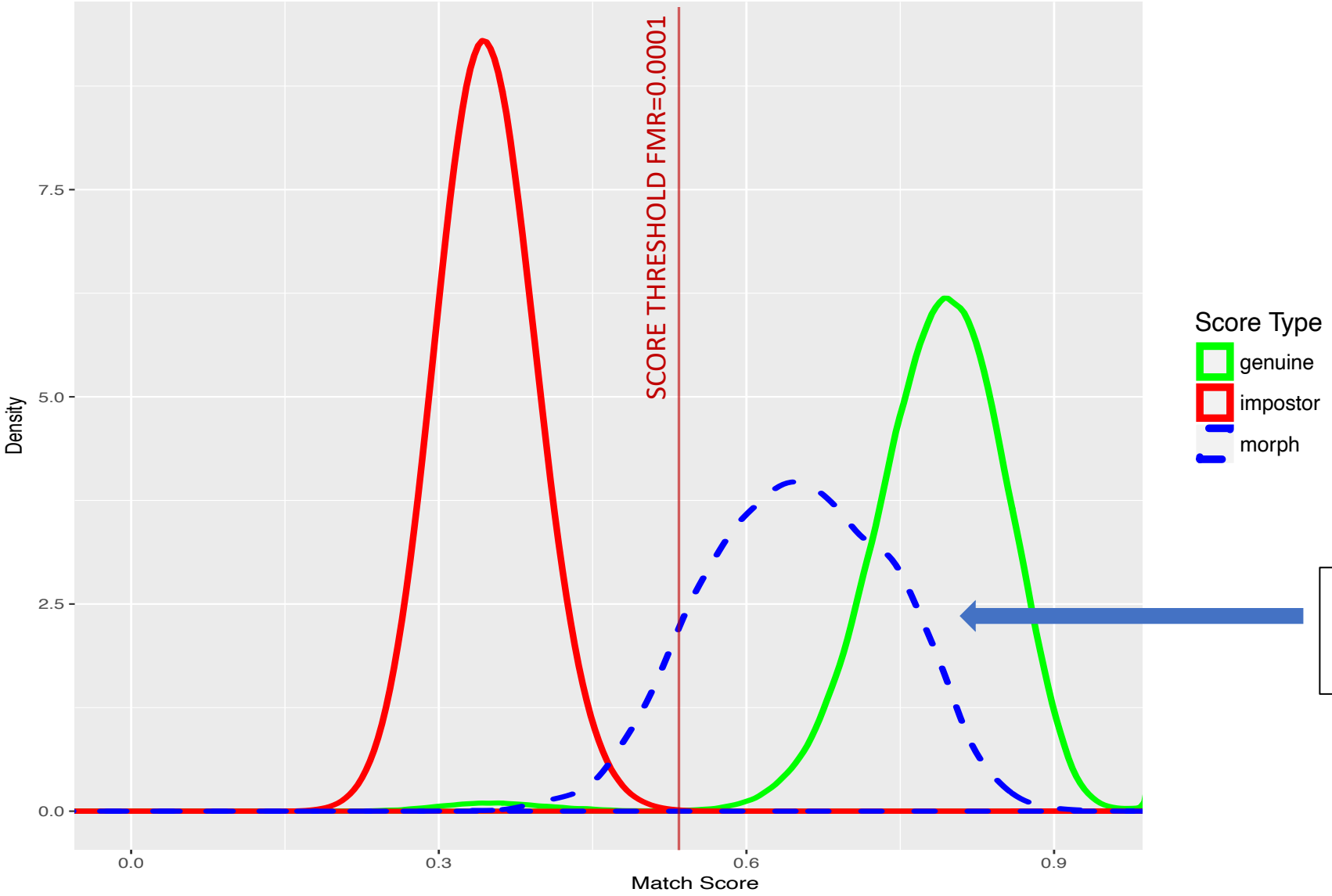
Automated Border Control Gate



Source: http://www.futuretravelexperience.com/2016/01/automated-border-control-e-gates-go-live-at-naples-airport/

Morphing poses a threat to entities that accept user-submitted photos for identity credentials

Automated Face Recognition: Genuines, Impostors, and Morphs



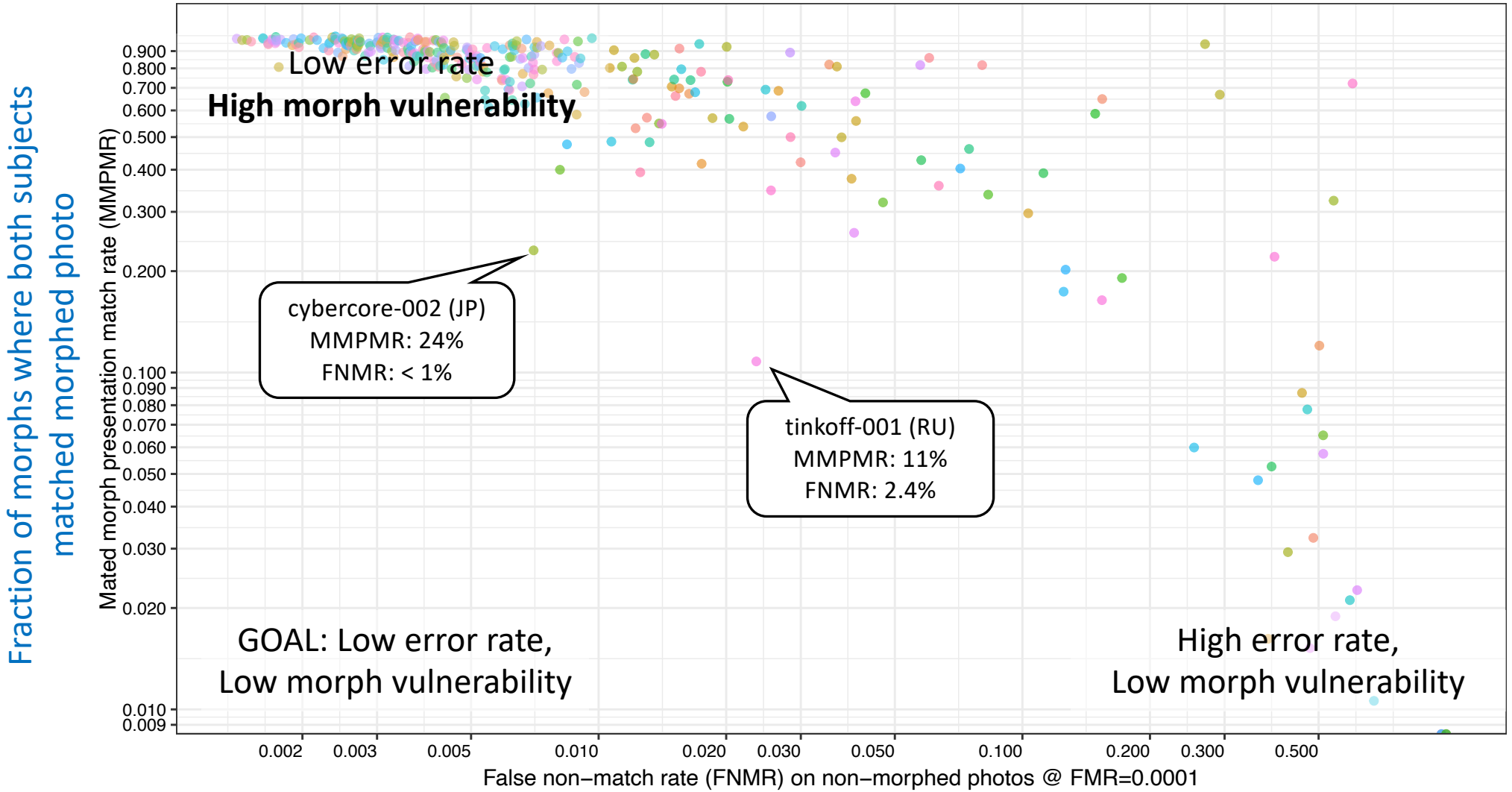
Fraction of morphs where the subject matches morphed photo above threshold

Face morphing: Current face recognition vulnerability

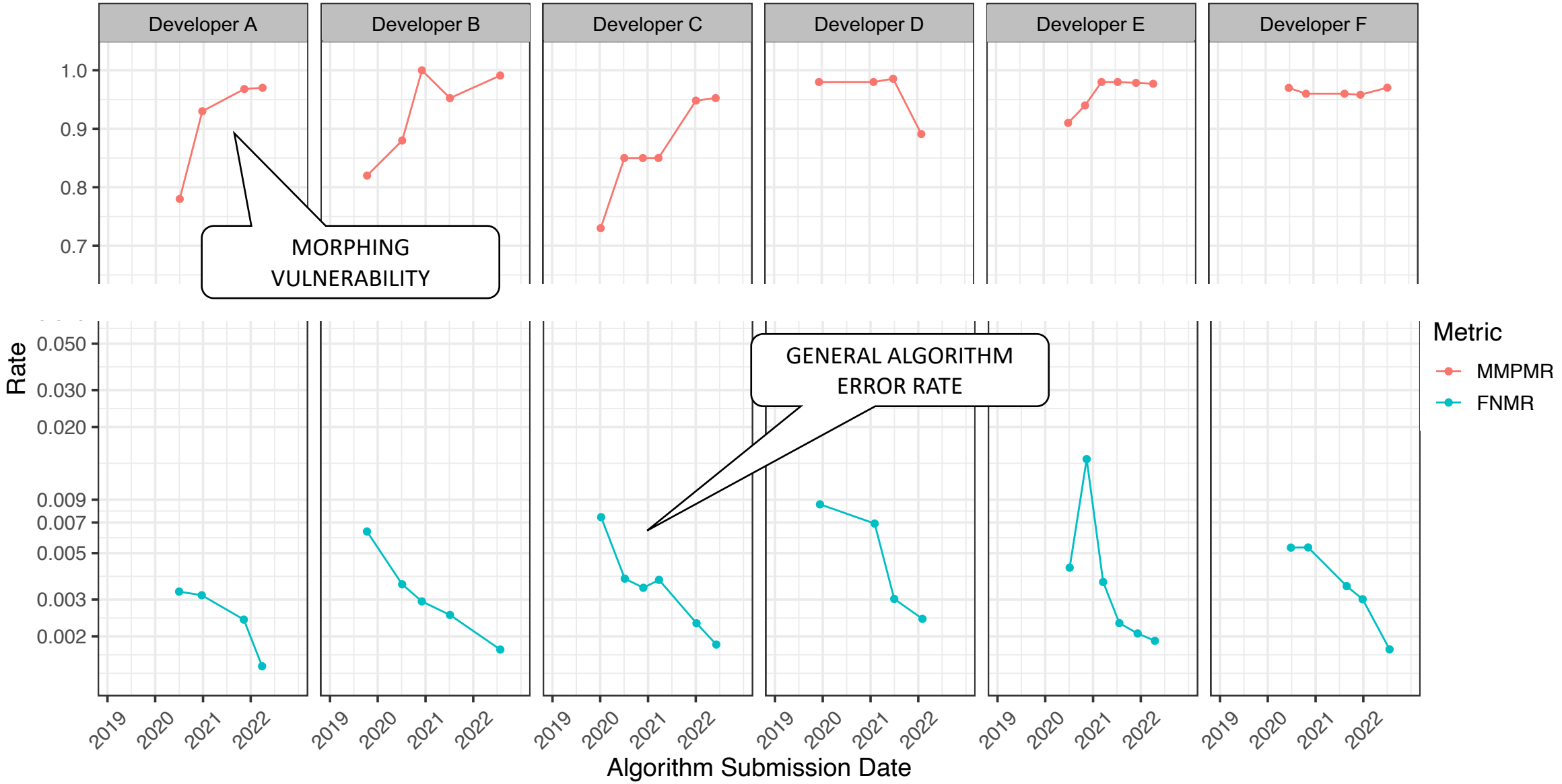
Each dot represents a recent FR algorithm submitted to the NIST Ongoing FRVT 1:1 Verification Test

Face morphing: Current face recognition vulnerability

Each dot represents a recent FR algorithm submitted to the NIST Ongoing FRVT 1:1 Verification Test



Morphing vulnerability trends

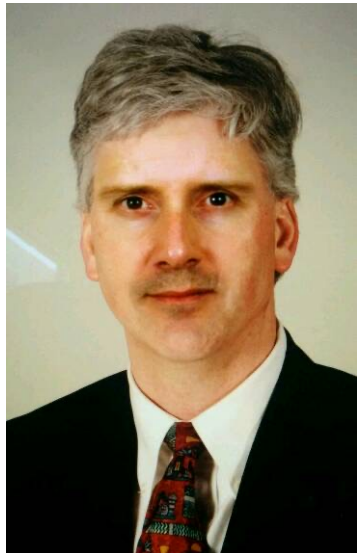


FRVT MORPH Use Case: Morph Detection

Single-image

Morph detection with single image in isolation

(e.g., initial passport application)

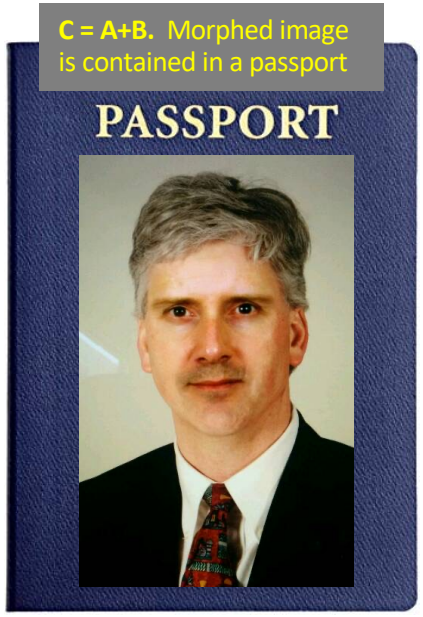


Goal: Determine whether image being submitted is a morph or not.

Differential

Morph detection with additional live capture image

(e.g., morph on passport + eGate webcam photo)



Goal: Determine whether image on passport is morphed by using the additional information available in the live capture image.

Image Source: NIST + USG employee with permission

FRVT MORPH Participation

Academia

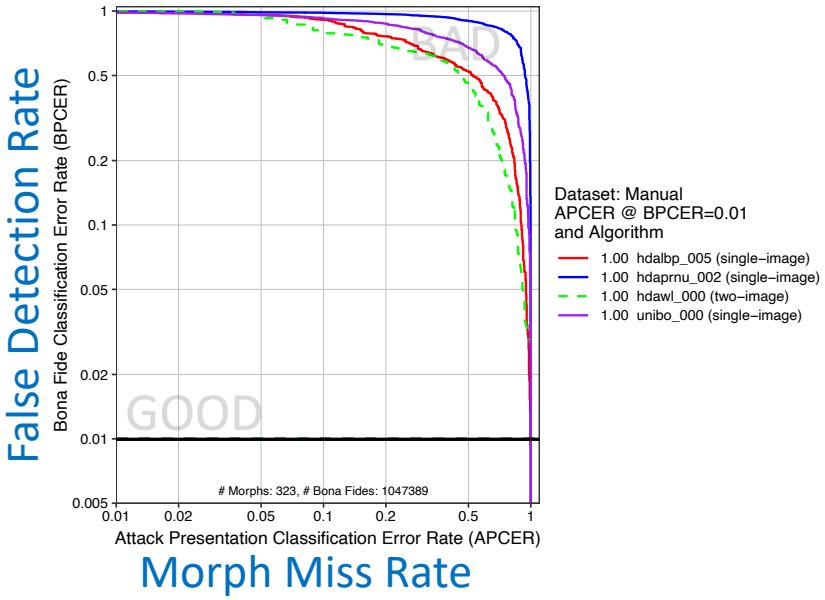
- Hochschule Darmstadt (DE)
- Norwegian University of Science and Technology (NO)
- University of Bologna (IT)
- West Virginia University (US)
- University of Coimbra (PT)

Industry

- secunet (DE)

Morph Detection: Progress

September 2019

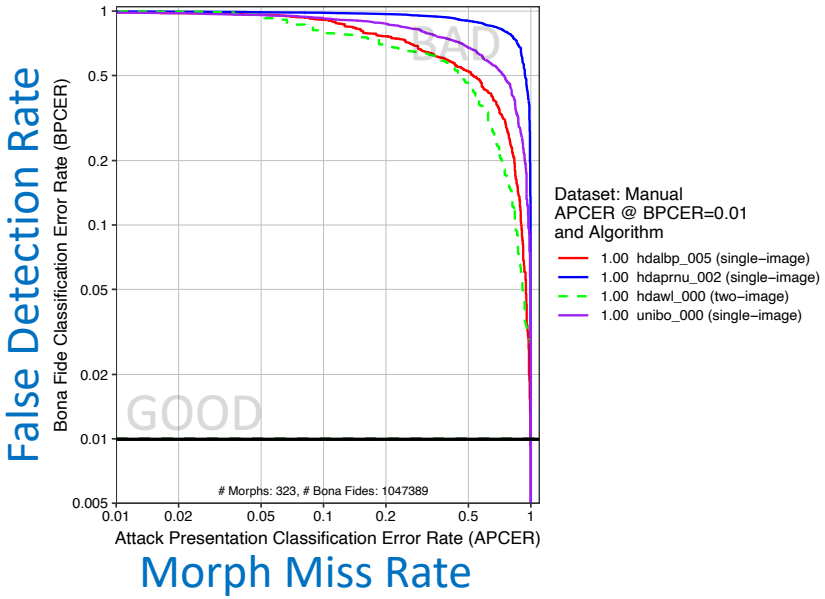


——— single-image

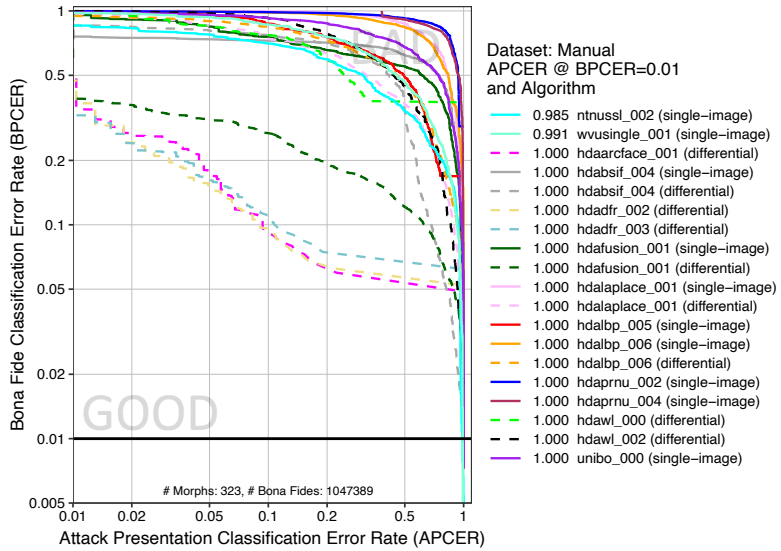
– – – differential (two-image)

Morph Detection: Progress

September 2019



September 2021

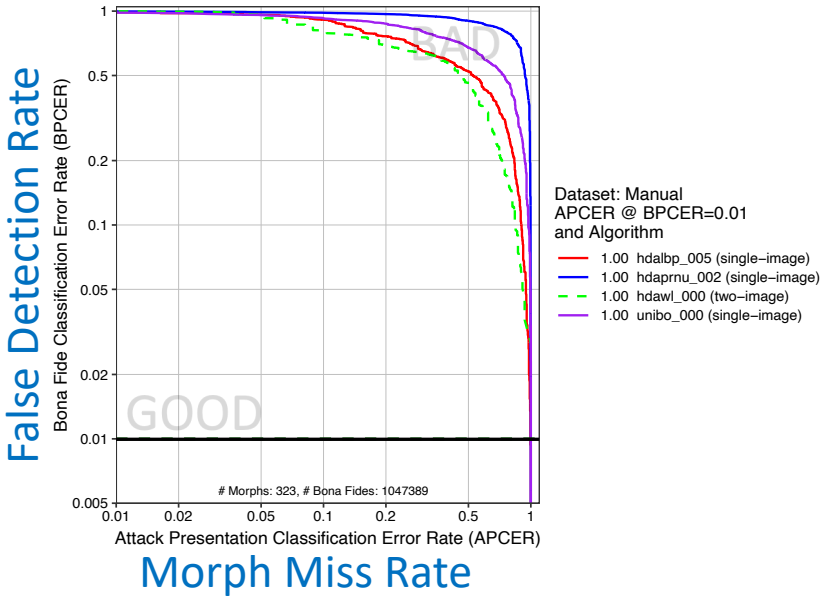


——— single-image

– – – differential (two-image)

Morph Detection: Progress

September 2019



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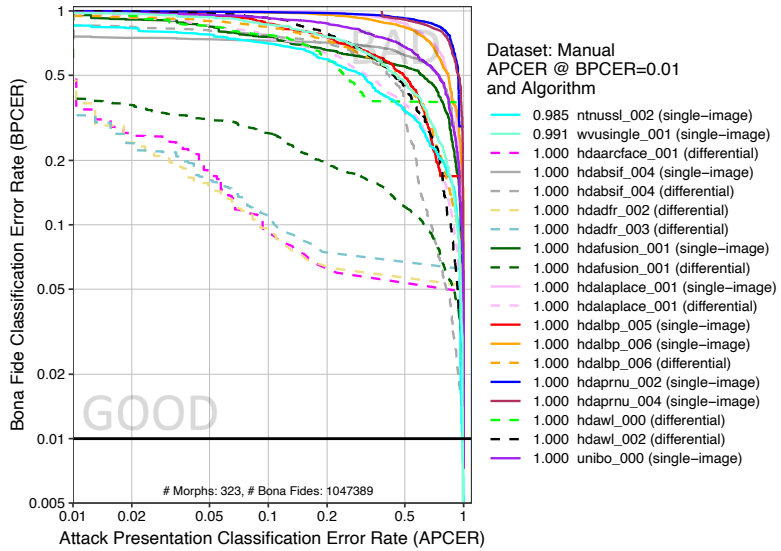
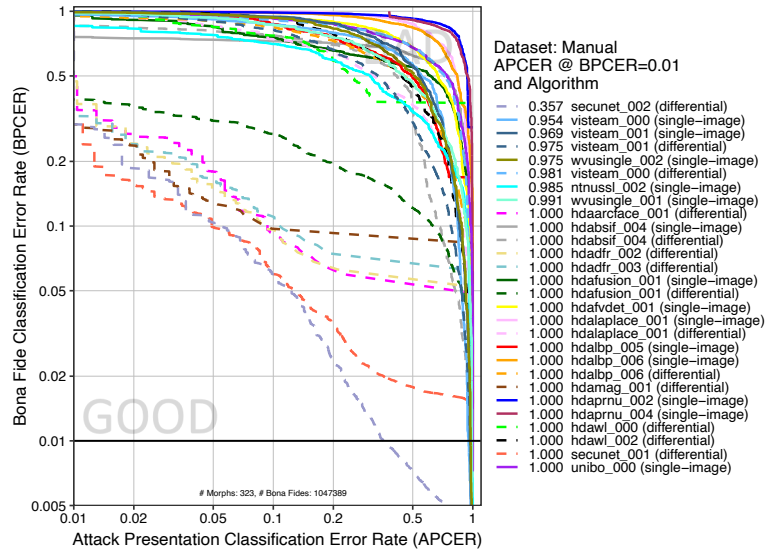


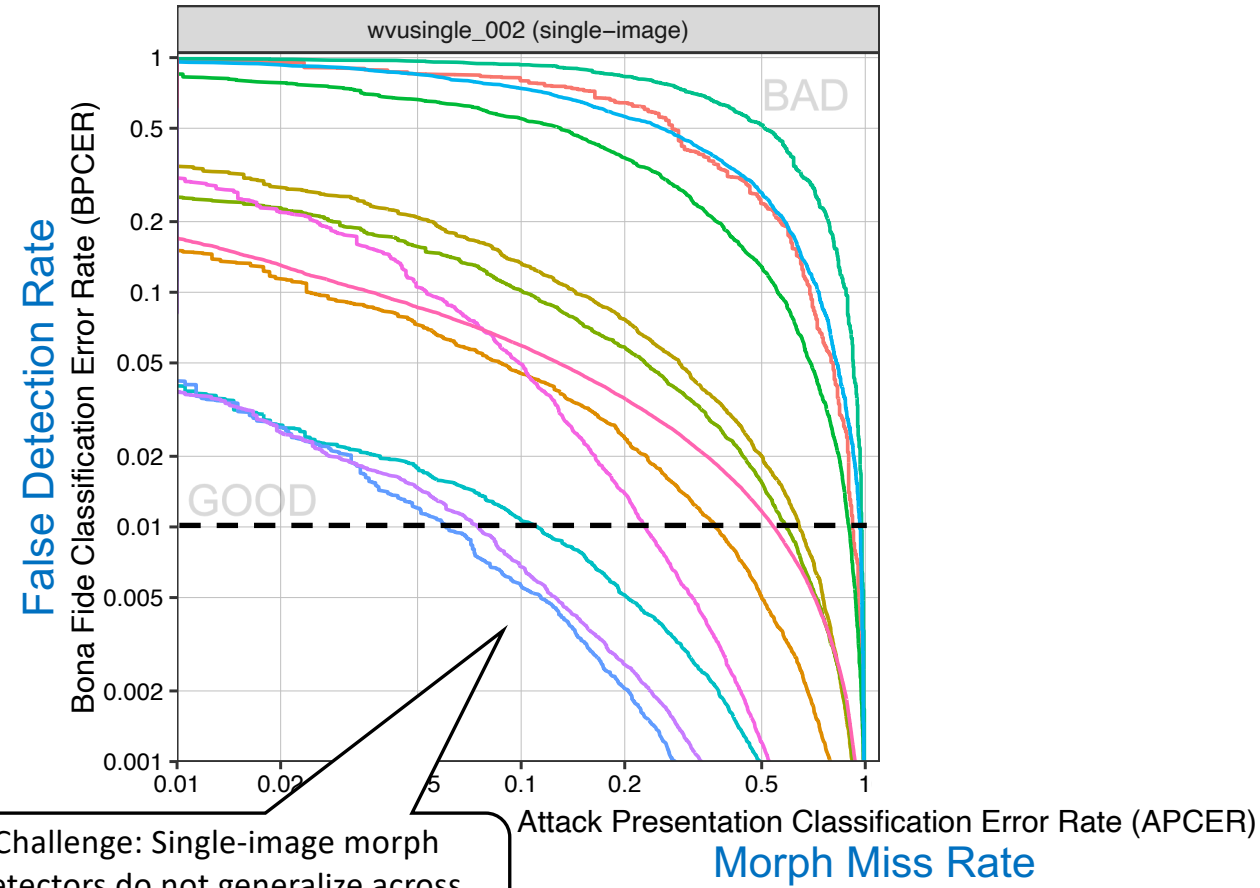
November 2022

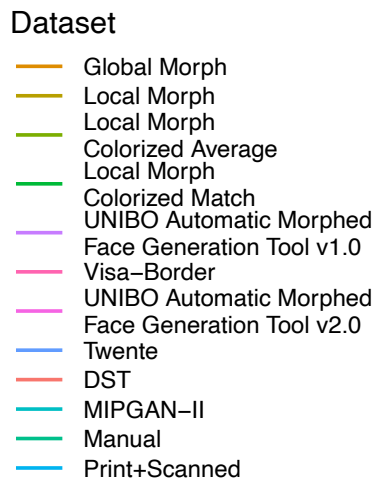


single-image

differential (two-image)

Morph Detection: Challenges and Opportunities

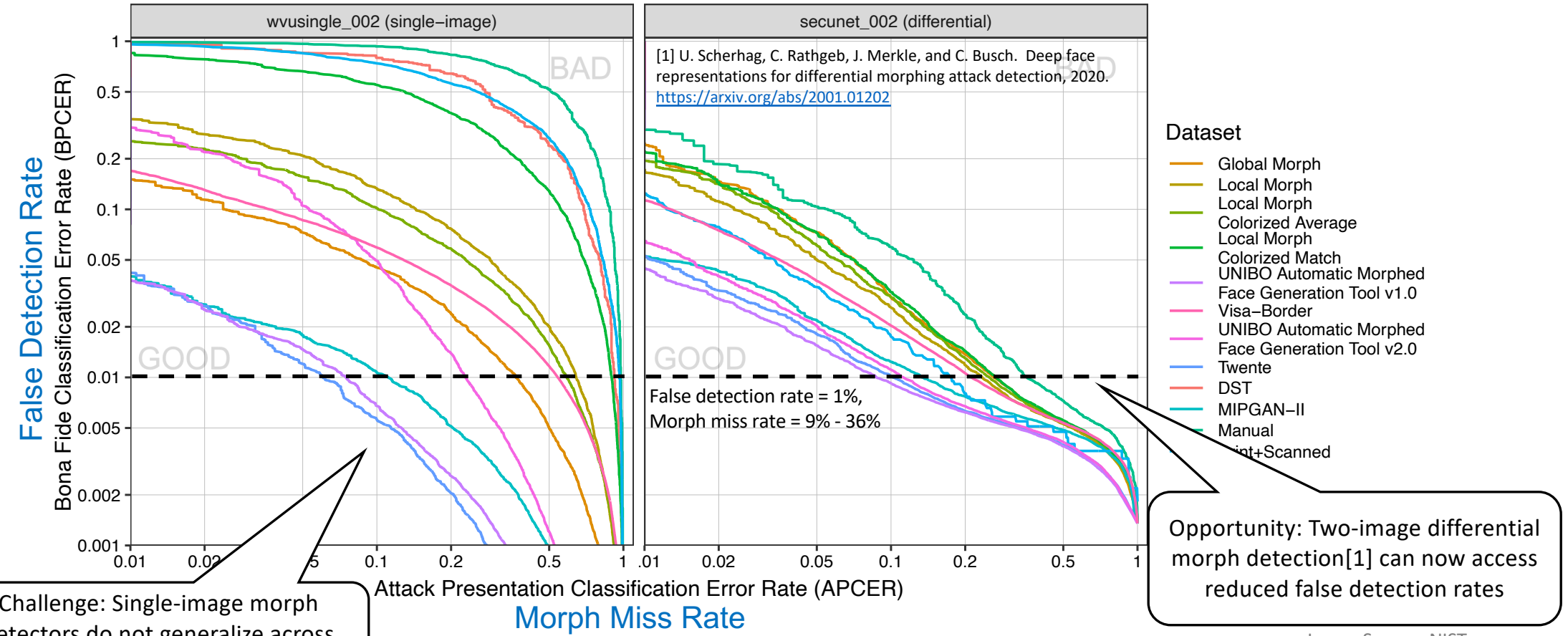




Challenge: Single-image morph detectors do not generalize across different morphing methods

Image Source: NIST

Morph Detection: Challenges and Opportunities

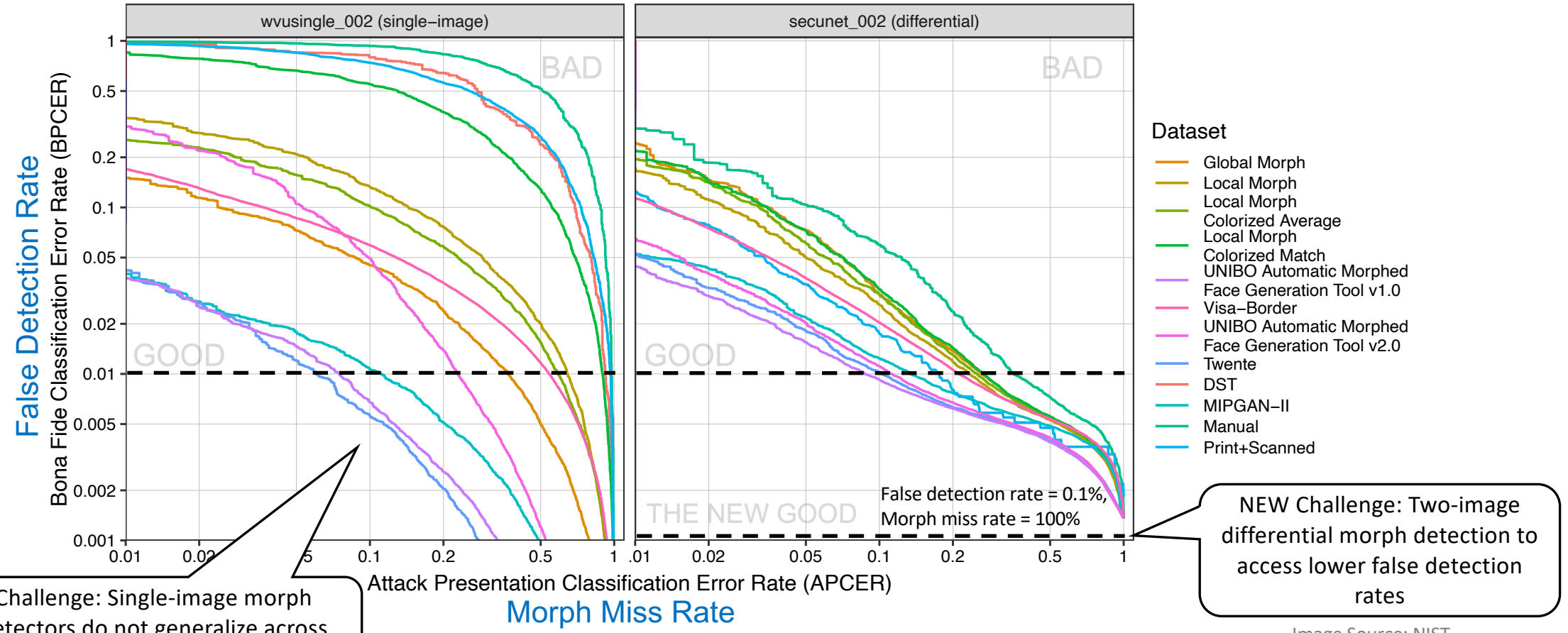


Challenge: Single-image morph detectors do not generalize across different morphing methods

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

Image Source: NIST

Morph Detection: Challenges and Opportunities



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

NEW Challenge: Two-image differential morph detection to access lower false detection rates

Image Source: NIST

FRVT MORPH Use Case:
Morph Resistant Face Recognition

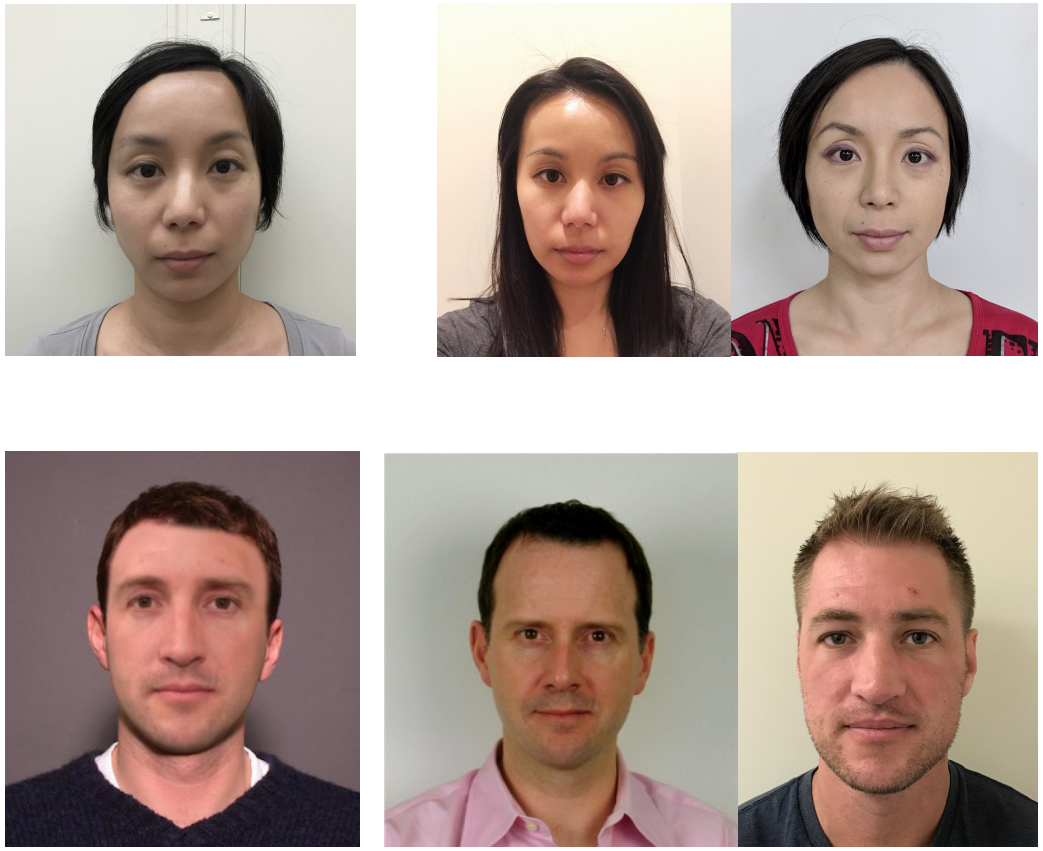


Image Source: NIST

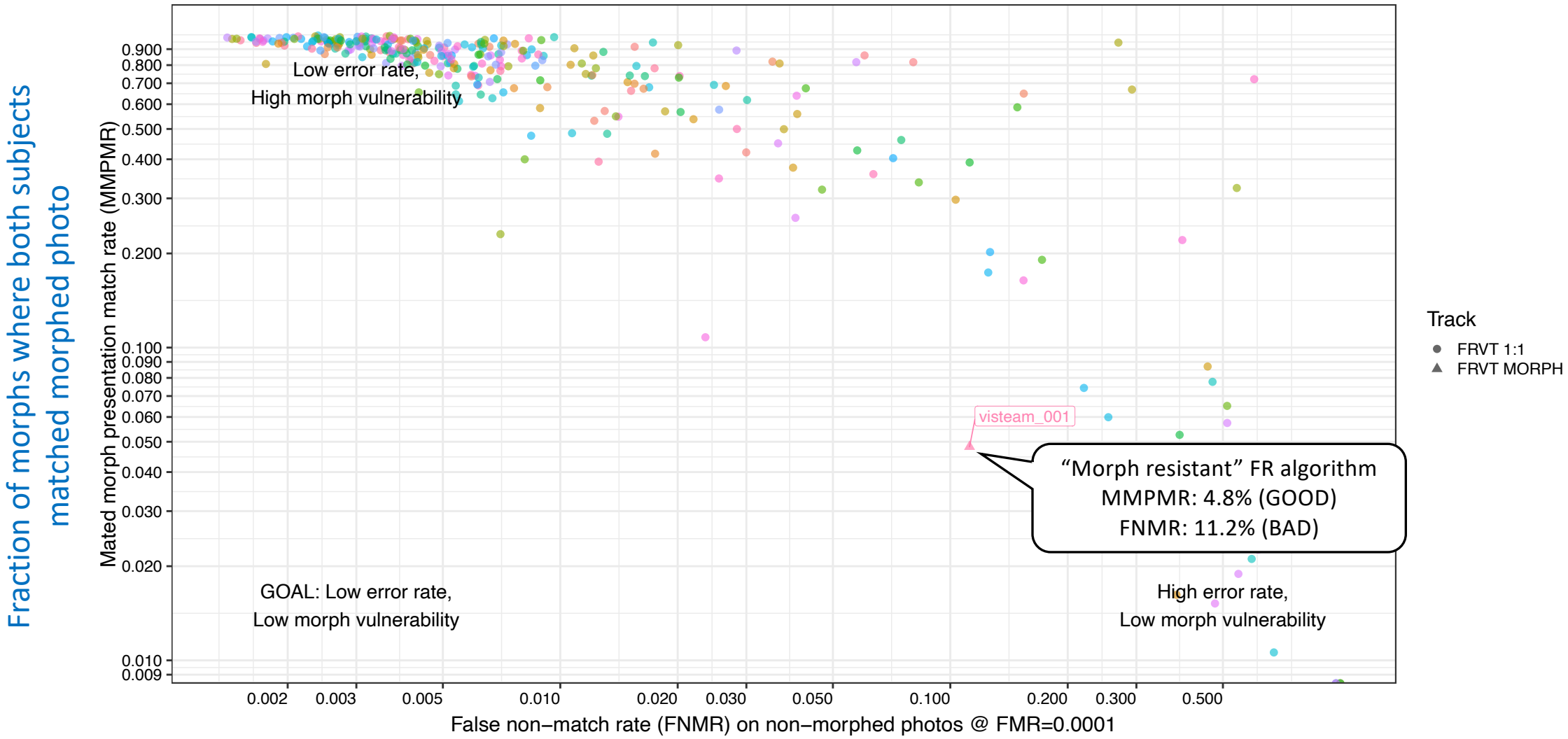
Use Case: Test FR algorithm resistance against morphing

Protocol: Given image X and image Y, produce verification similarity score

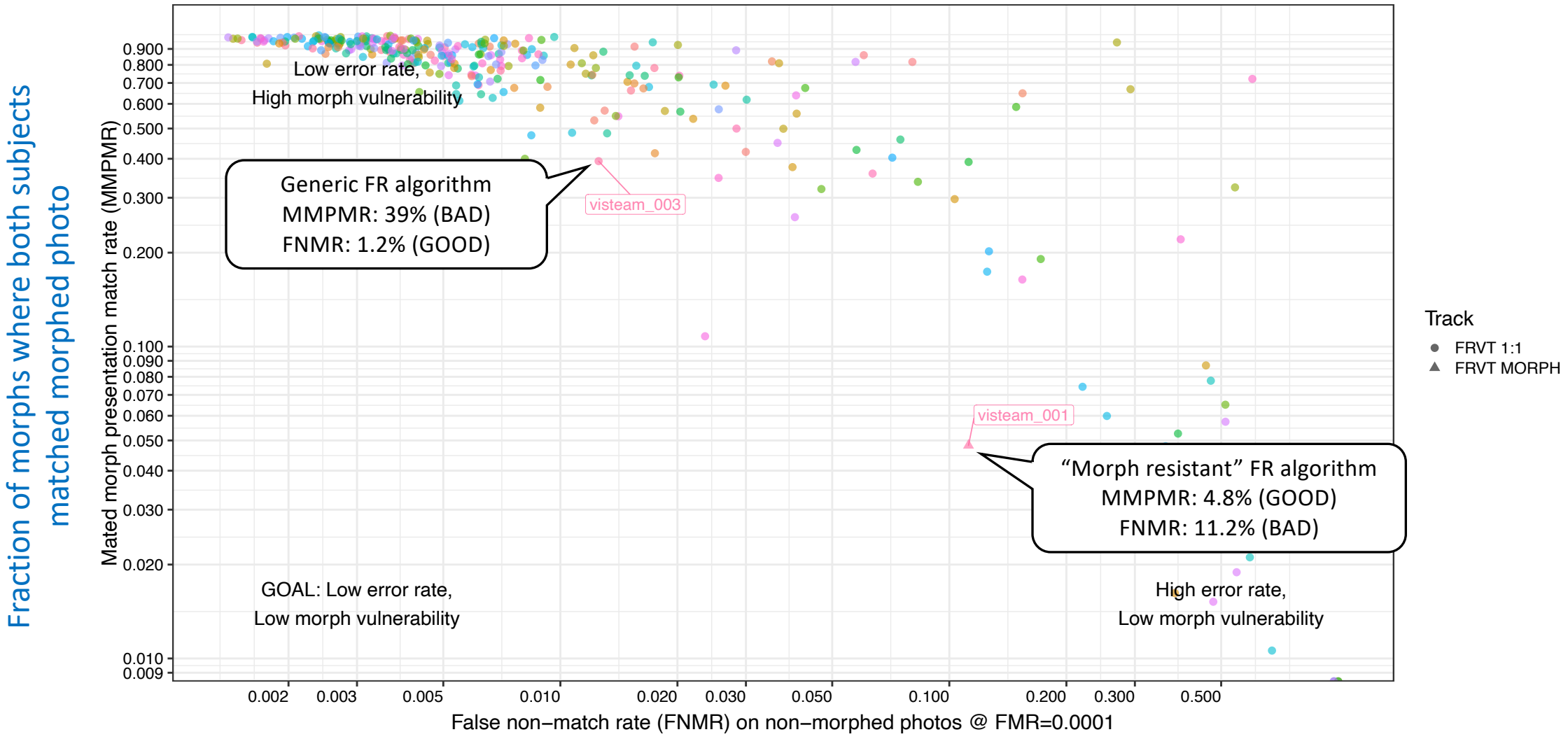
Evaluation: ISO/IEC 30107-3 metrics

- Mated Morph Presentation Match Rate (MMPMR)
- False non-match rate (FNMR)
- False match rate (FMR)
- Others TBD

Morph resistant face recognition performance



Morph resistant face recognition performance



Utility of 1:N search for morph detection

NISTIR 8430: FRVT Part 4A: MORPH – Utility of 1:N Face Recognition Algorithms for Morph Detection, July 27, 2022

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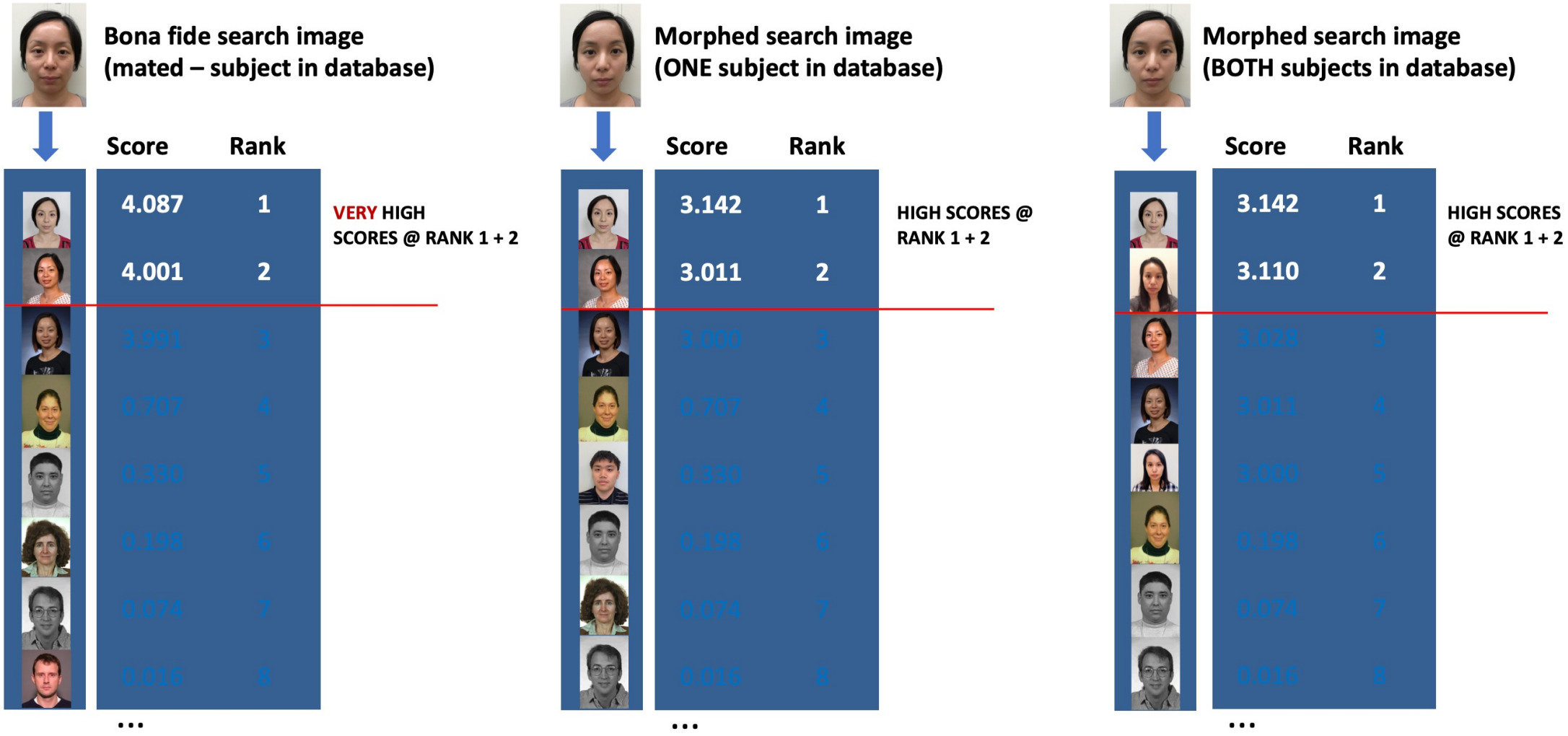
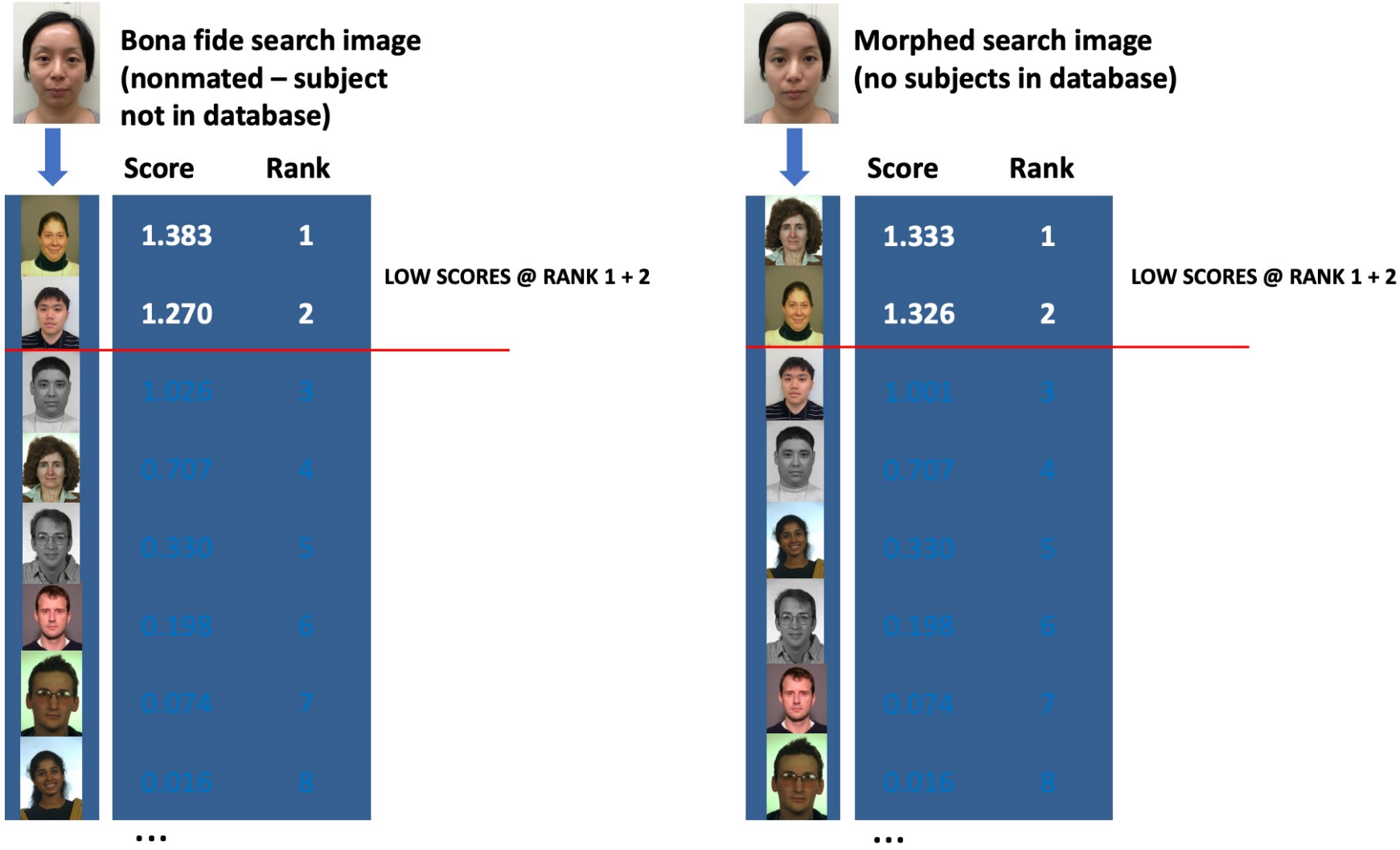
Analysis of rank 1 and 2 similarity scores from 1:N face recognition search for morph detection
SCENARIO: RENEWAL



All databases used in experiments contain bona fide imagery

Image Source: NIST + Public FERET Database

Analysis of rank 1 and 2 similarity scores from 1:N face recognition search for morph detection
SCENARIO: NEW ENROLLMENT

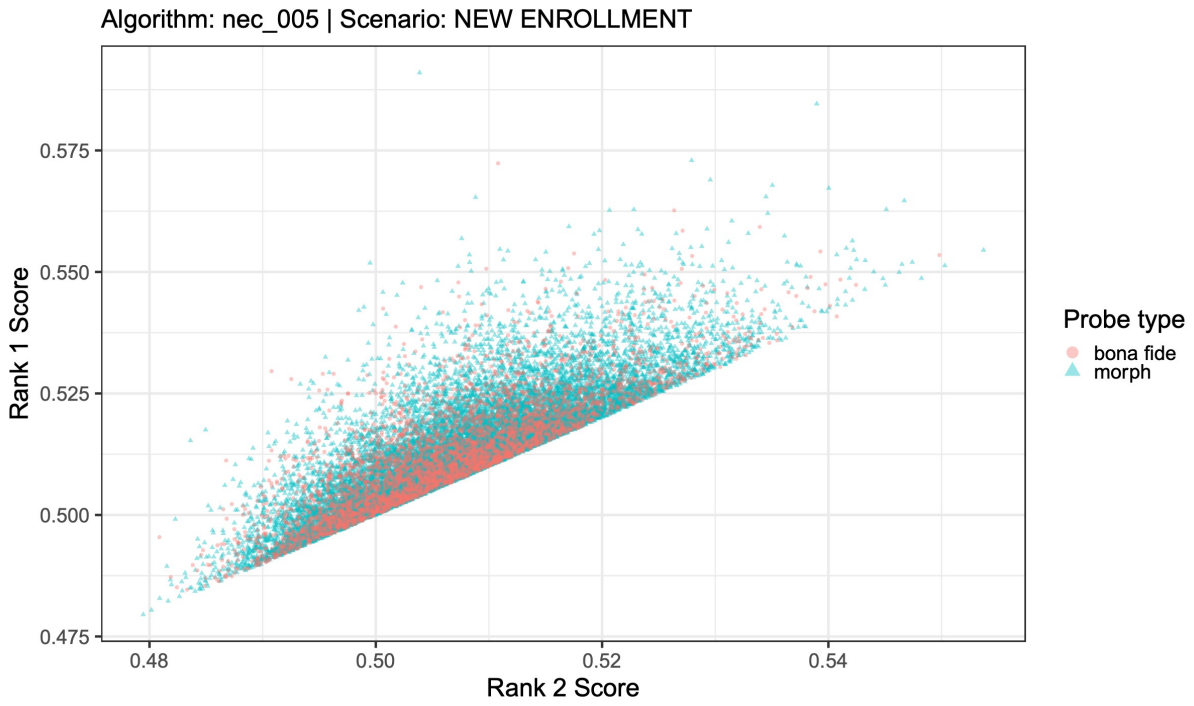


All databases used in experiments contain bona fide imagery

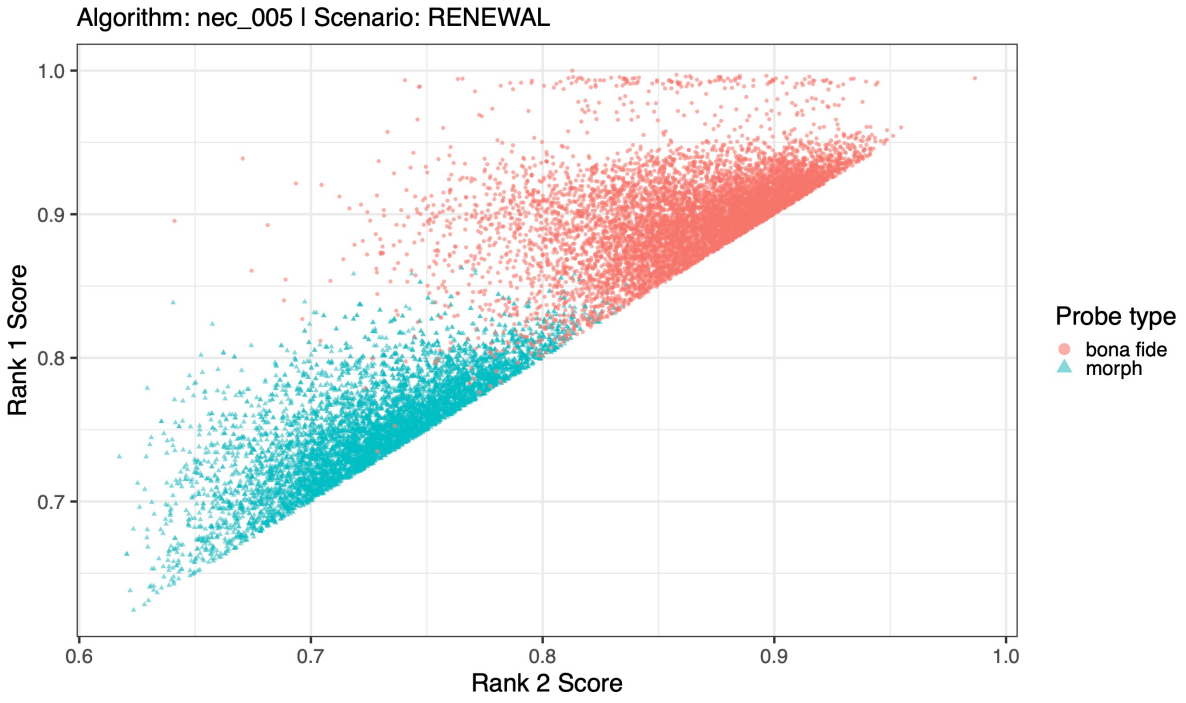
Image Source: NIST + Public FERET Database

Visualization of rank 1 and 2 similarity scores

Scenario: NEW ENROLLMENT
(subjects do not exist in the database)



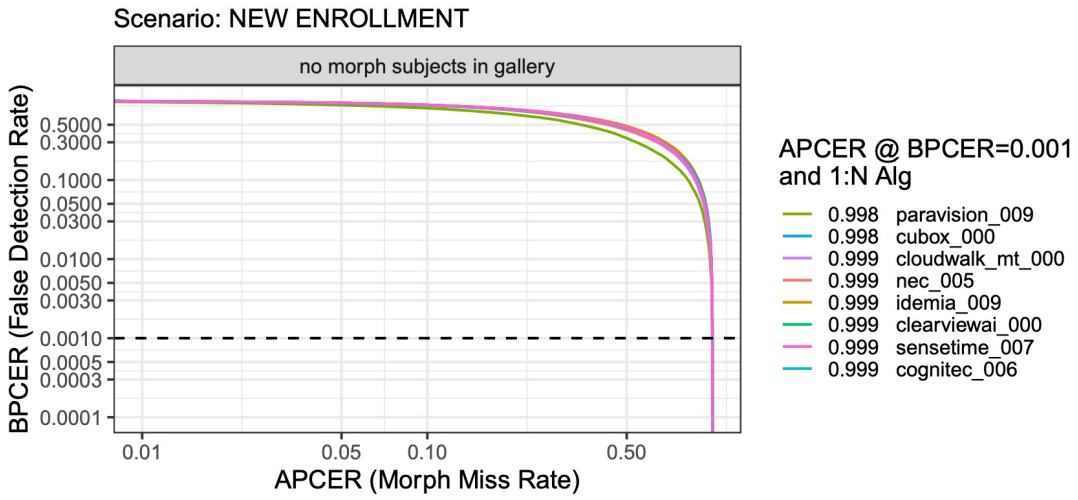
Scenario: RENEWAL
(multiple photos of one or both subjects exist in the database)



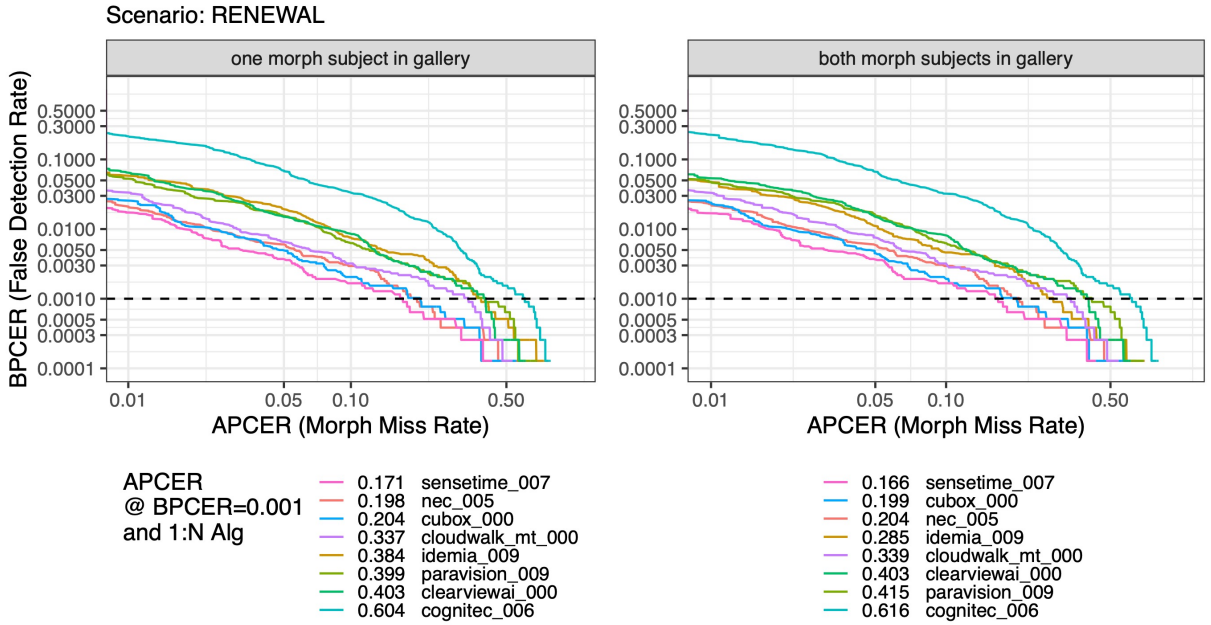
Large separation in score distributions presents detection opportunity!

Proof of concept: Morph detection results from training a morph classifier with rank 1 and 2 scores

Scenario: NEW ENROLLMENT



Scenario: RENEWAL



Morph detection using 1:N face recognition is **not** effective in a new enrollment scenario

Morph detection using 1:N face recognition may be effective in a renewal scenario (low false detection rates attainable)

Source: NISTIR 8430: FRVT Part 4A: MORPH – Utility of 1:N Face Recognition Algorithms for Morph Detection, July 27, 2022

Summary and closing thoughts…

- Modern face recognition is vulnerable to face morphing
- Automated morph detection has made notable progress
- One-to-many face recognition may have utility in morph detection under certain scenarios
- Other potential mitigations
  - Live enrollment (e.g., Norway, Sweden, Germany 2025!)
  - Human involvement remains critical (training + strong secondary verification processes)

Thank you!

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