

Face Recognition I

CSE 40537/60537 Biometrics

Daniel Moreira
Spring 2020

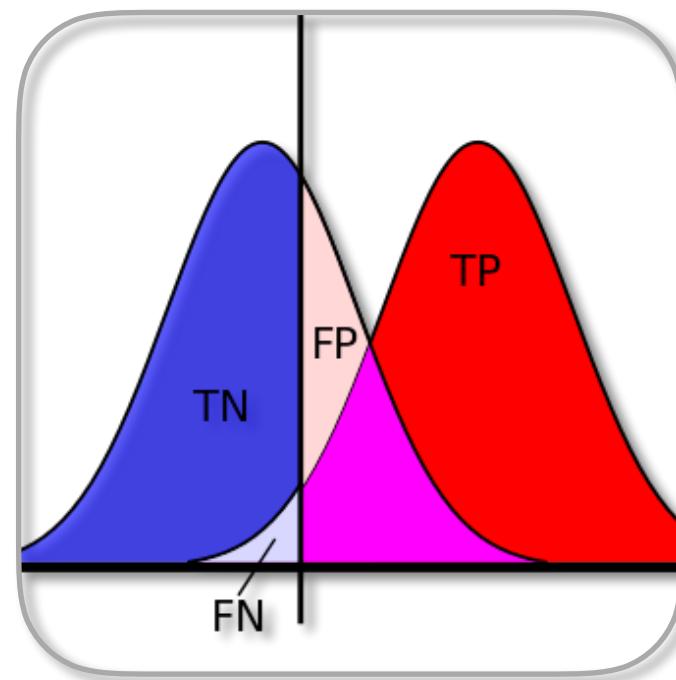


Today you will...

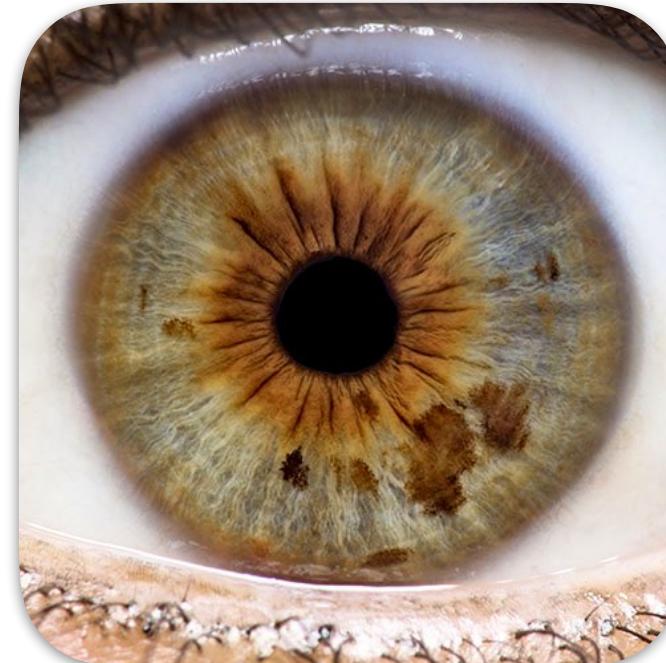
Get to know
Reasons to use faces for recognition.
How faces compare to fingerprints.

Course Overview

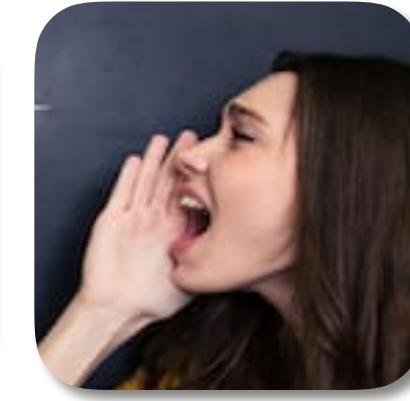
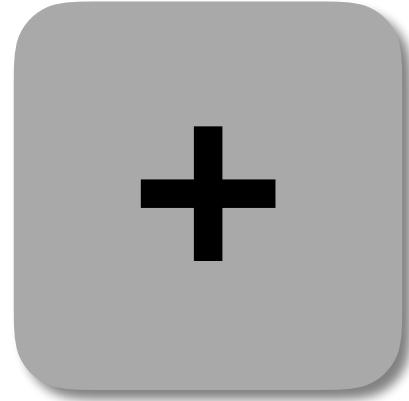
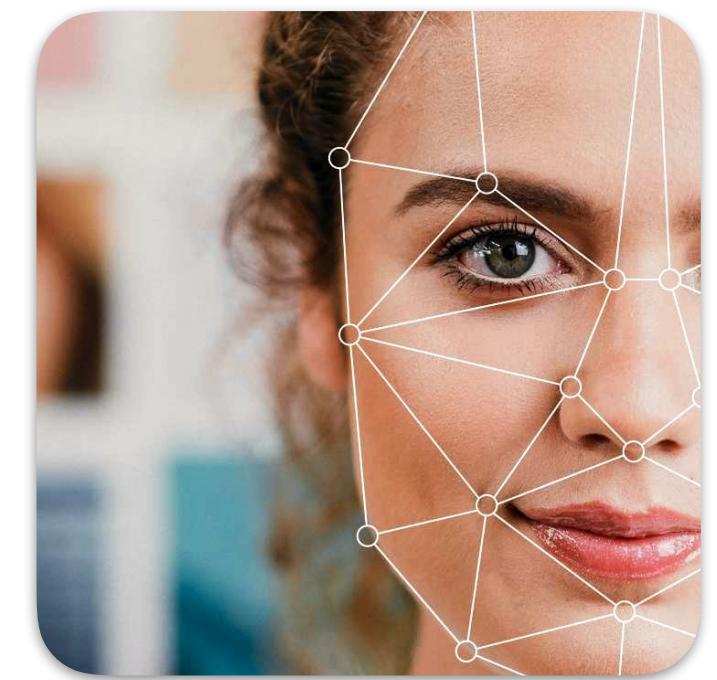
Content



Basics
Concepts
Metrics
Metric implementation



Core Traits (3)
Concepts
Baseline implementation
Data collection
Evaluation
Attacks
Assignments



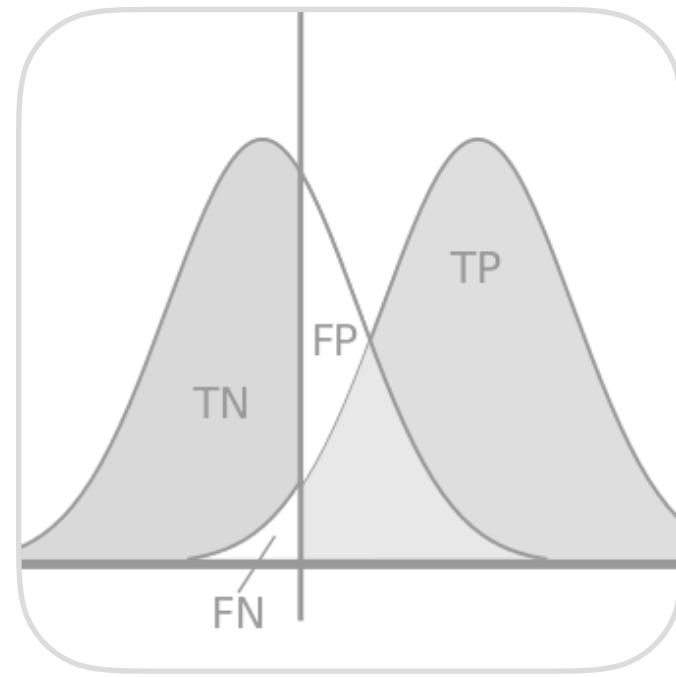
Alternative Traits and Fusion Concepts



Invited Talks (2)
State of the art
Future work

Course Overview

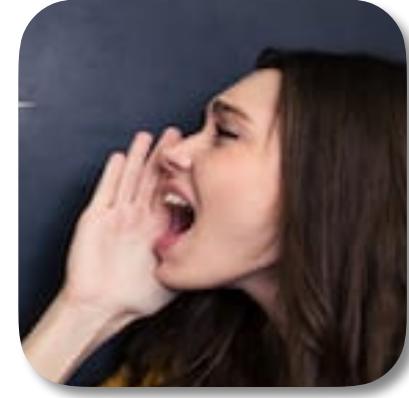
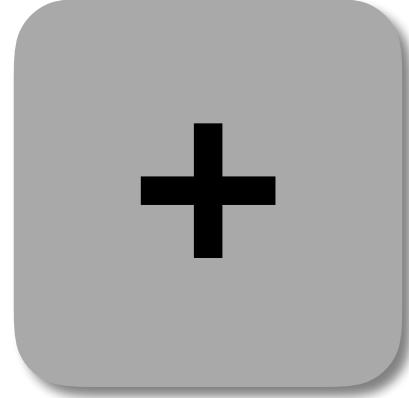
Content



Basics
Concepts
Metrics
Metric implementation



Core Traits (3)
Concepts
Baseline implementation
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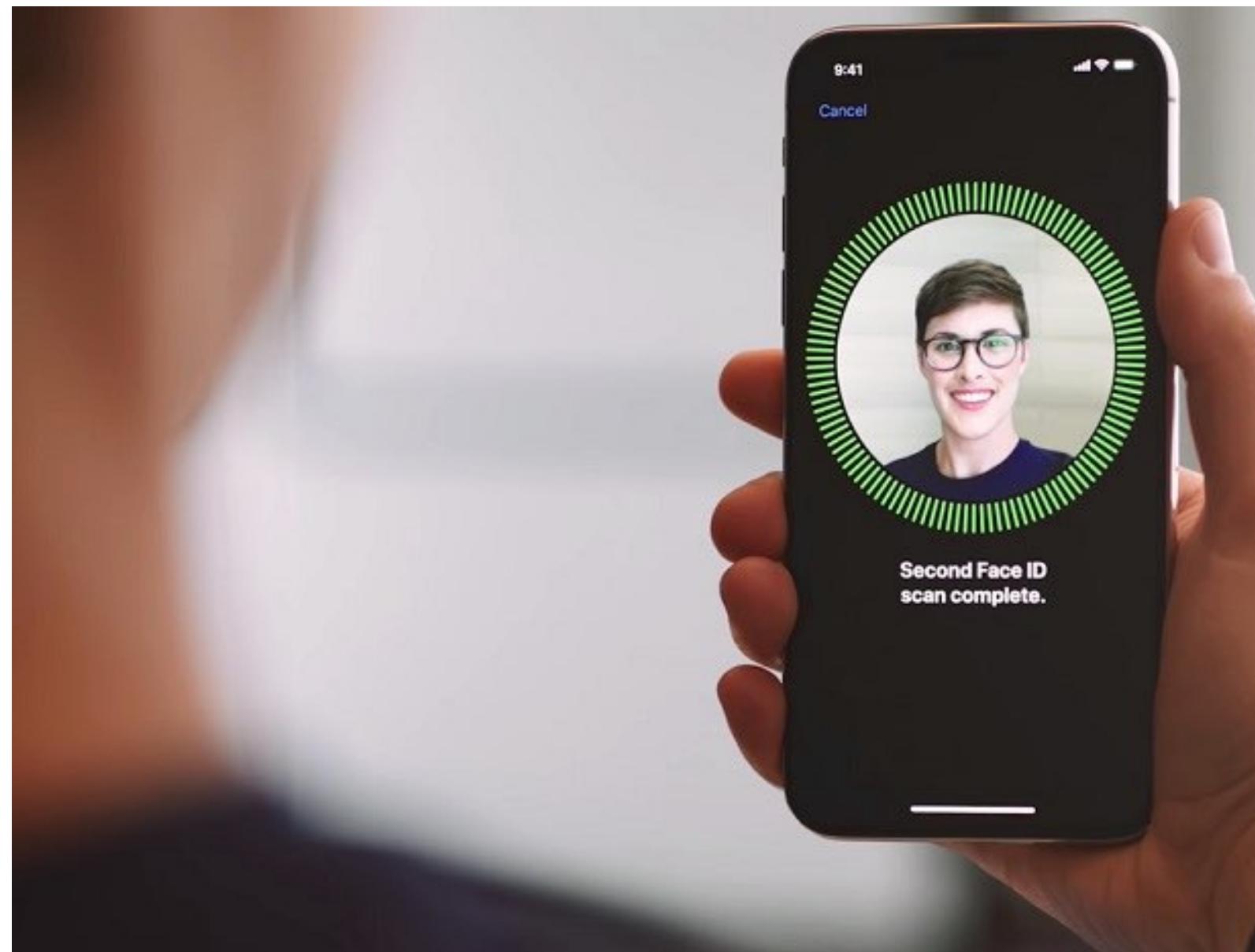
Alternative Traits and Fusion Concepts



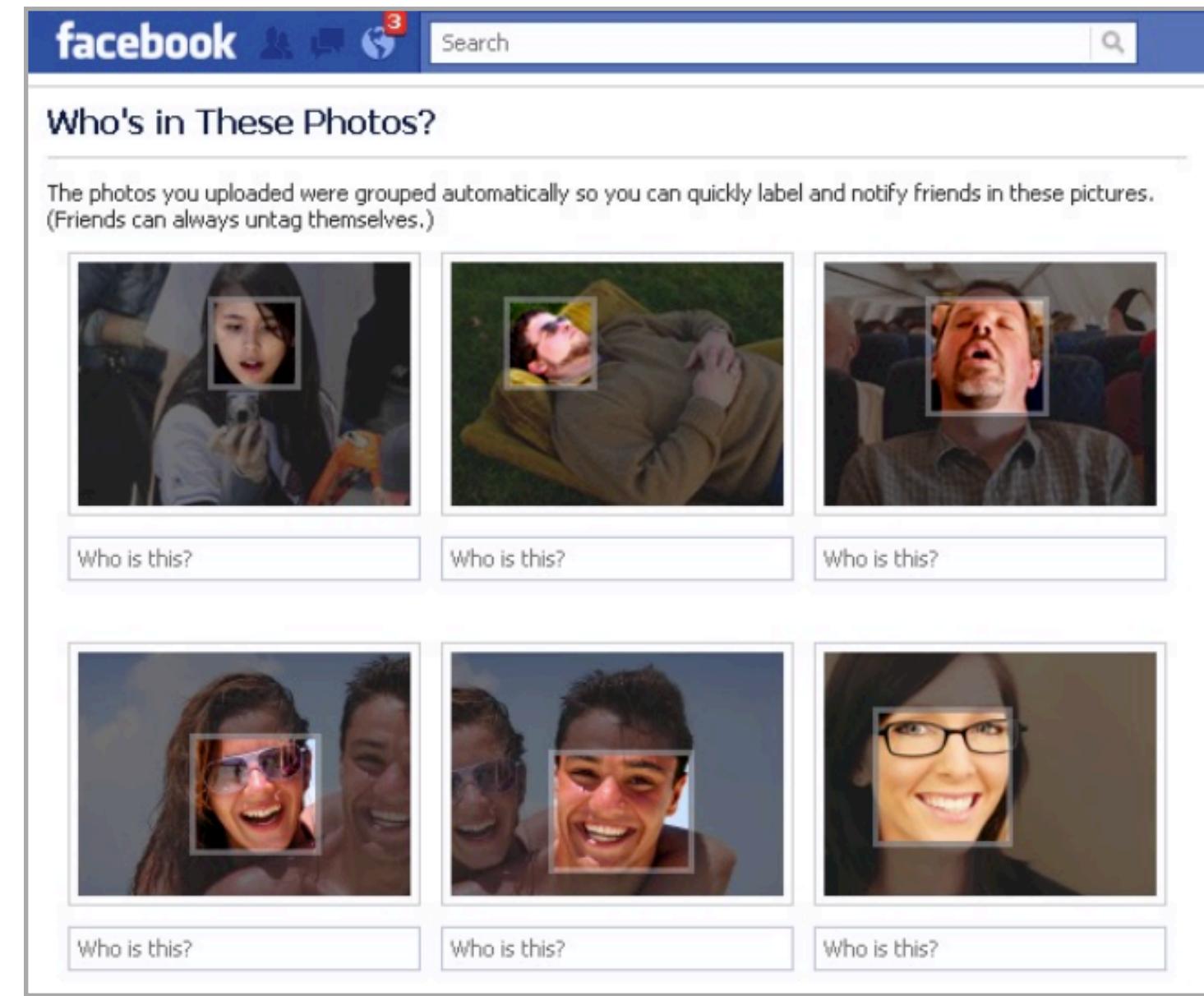
Invited Talks (2)
State of the art
Future work

Why Faces?

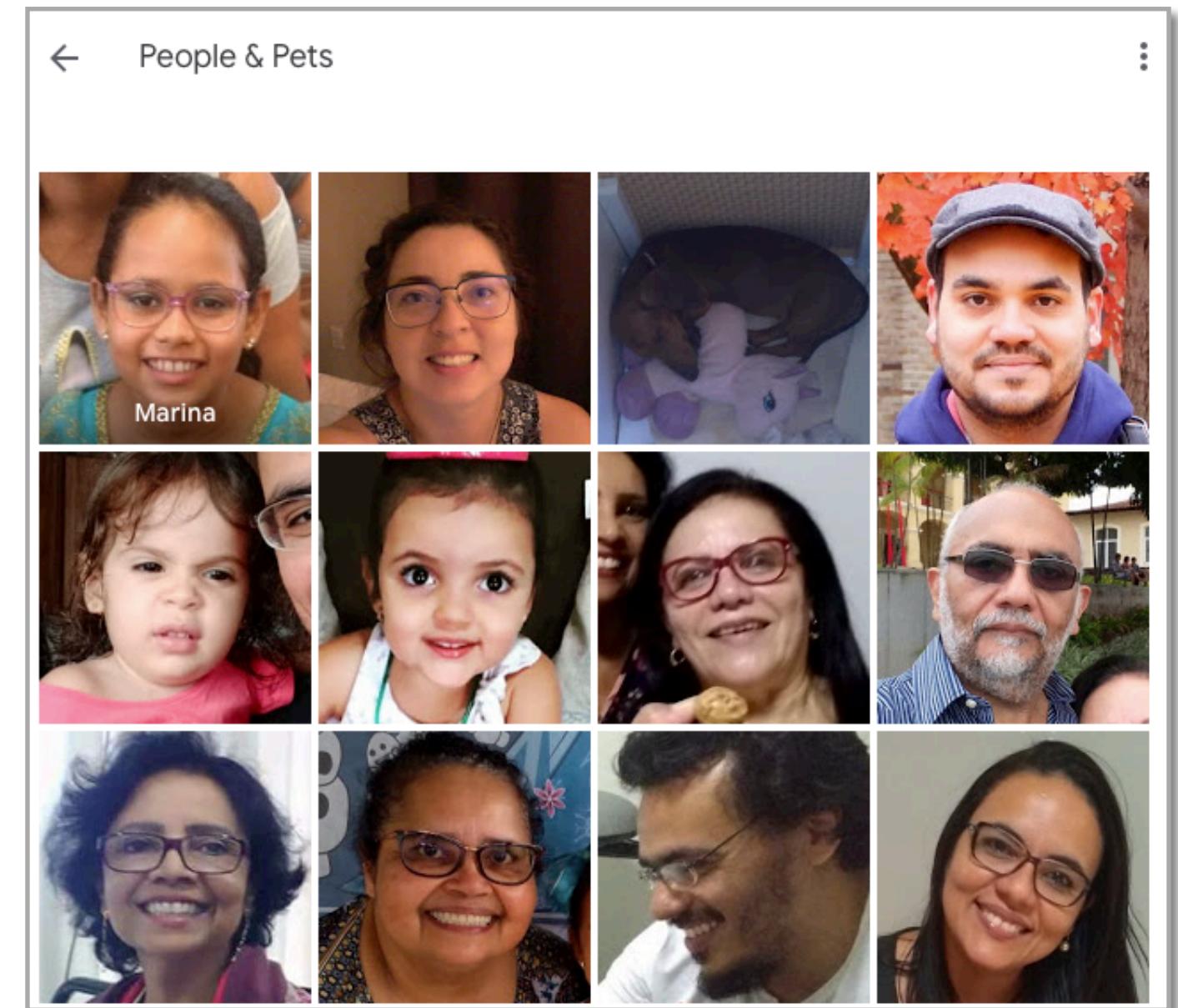
Face recognition is a reality



Personal devices



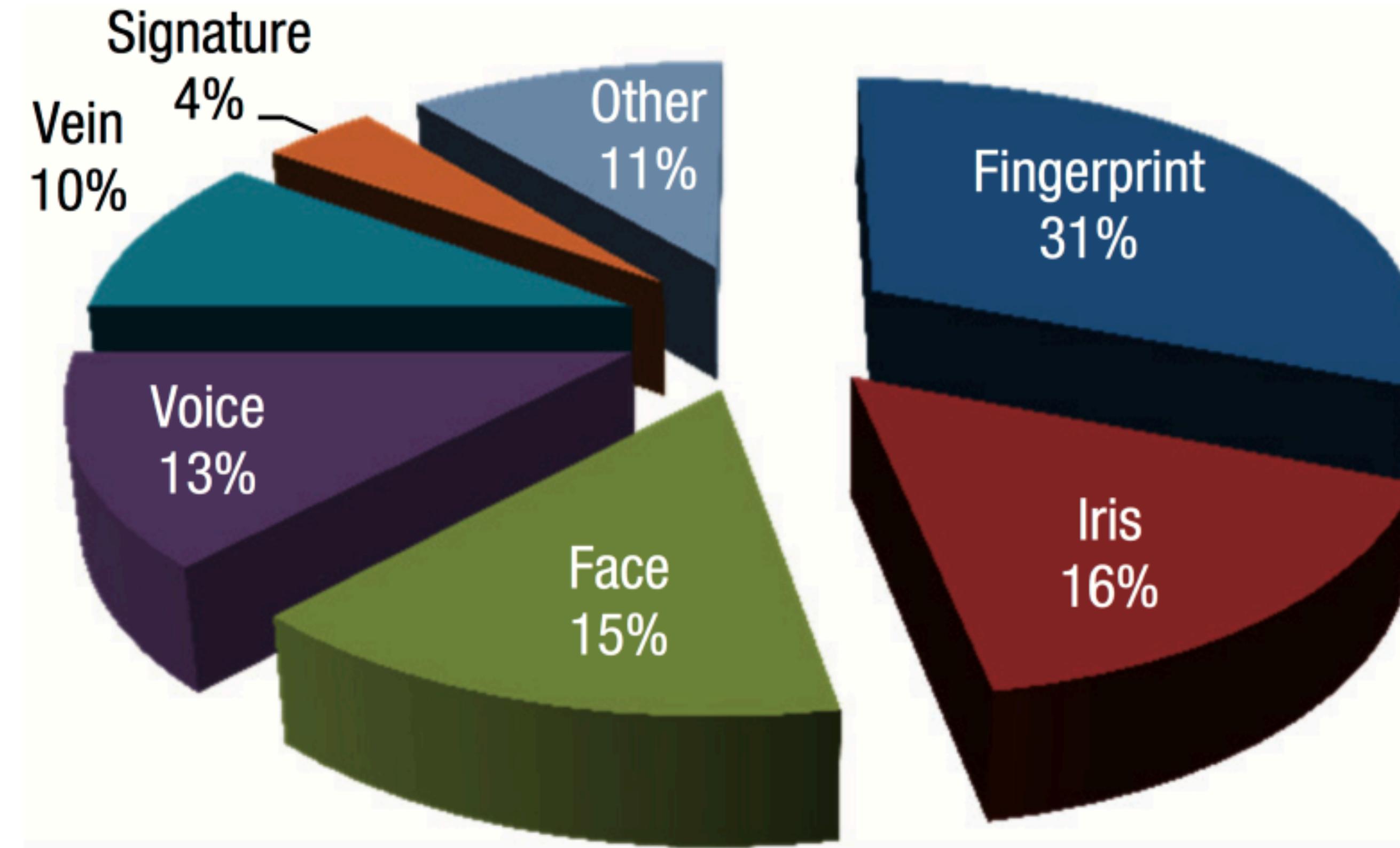
Facebook



Google Photos

Why Faces?

Market



Source: Mani and Nadeski, *Processing solutions for biometric systems*, Texas Instruments, 2015

Why Faces?

Face recognition is an innate ability

Temporal cortex

Active in monkey's brains
when they are presented with faces.

Prosopagnosia

Lost ability to recognize faces
when the temporal cortex is damaged.
Affected folks can still recognize objects.



Why Faces?



Who is she?



How different from
the other one?

Why Faces?



Who is she?



How different from
the other one?

Why Faces?

Margaret Thatcher Illusion
Peter Thompson



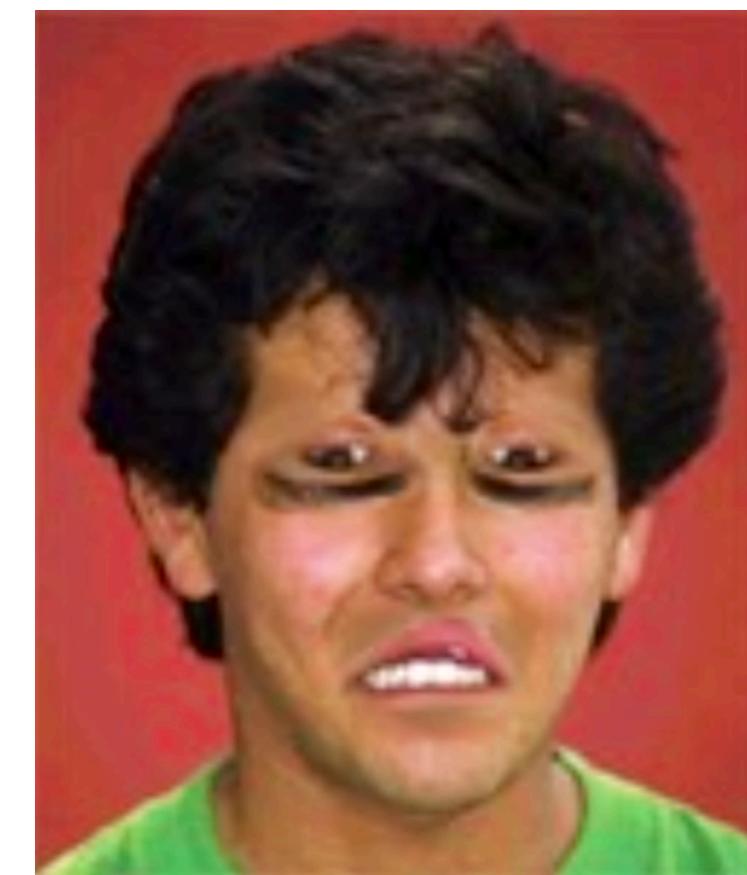
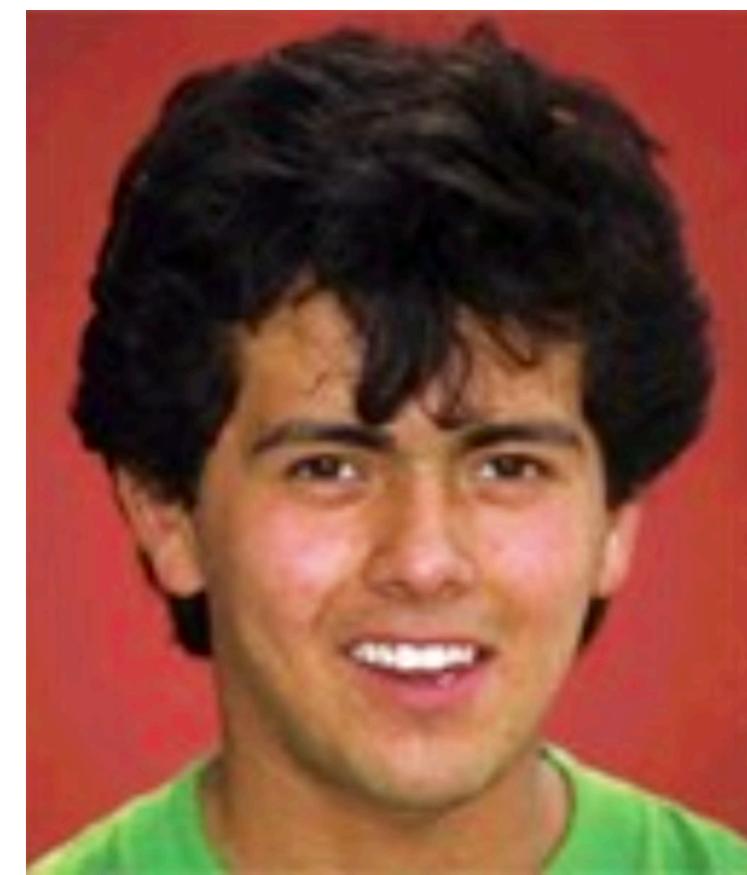
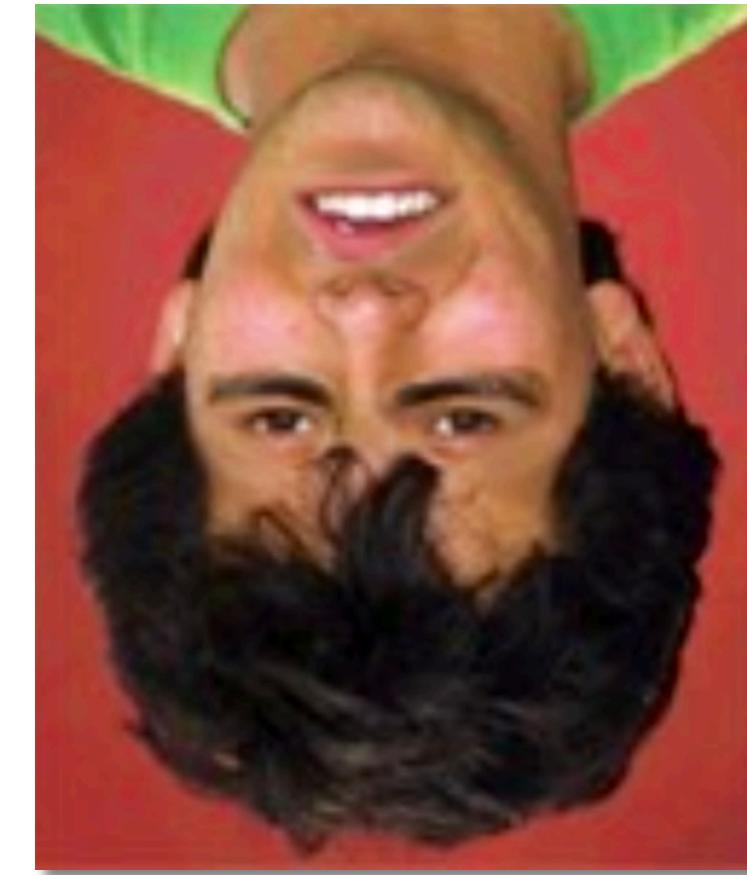
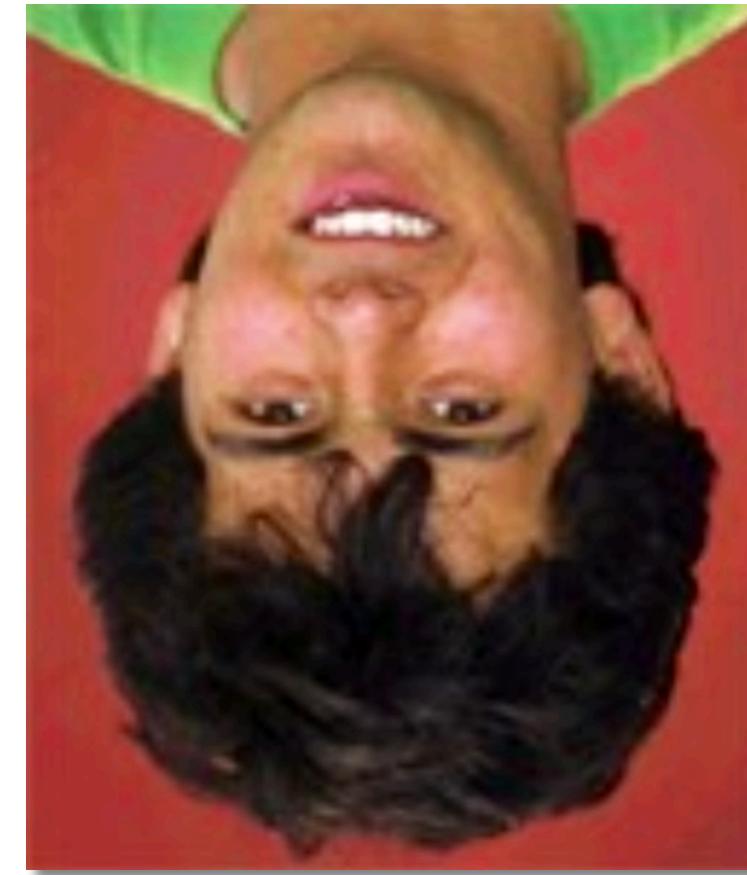
Who is she?



How different from
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Why Faces?

[https://faculty.washington.edu/
chudler/java/faces.html](https://faculty.washington.edu/chudler/java/faces.html)



Why Faces?

Face recognition is an innate ability

Facial Pareidolia

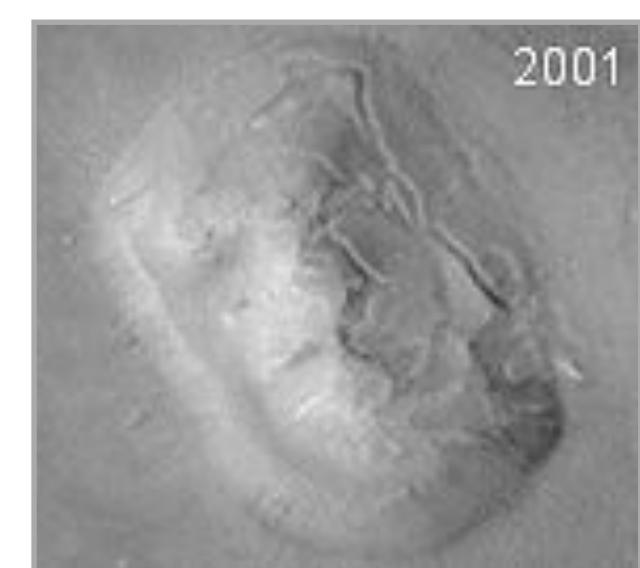
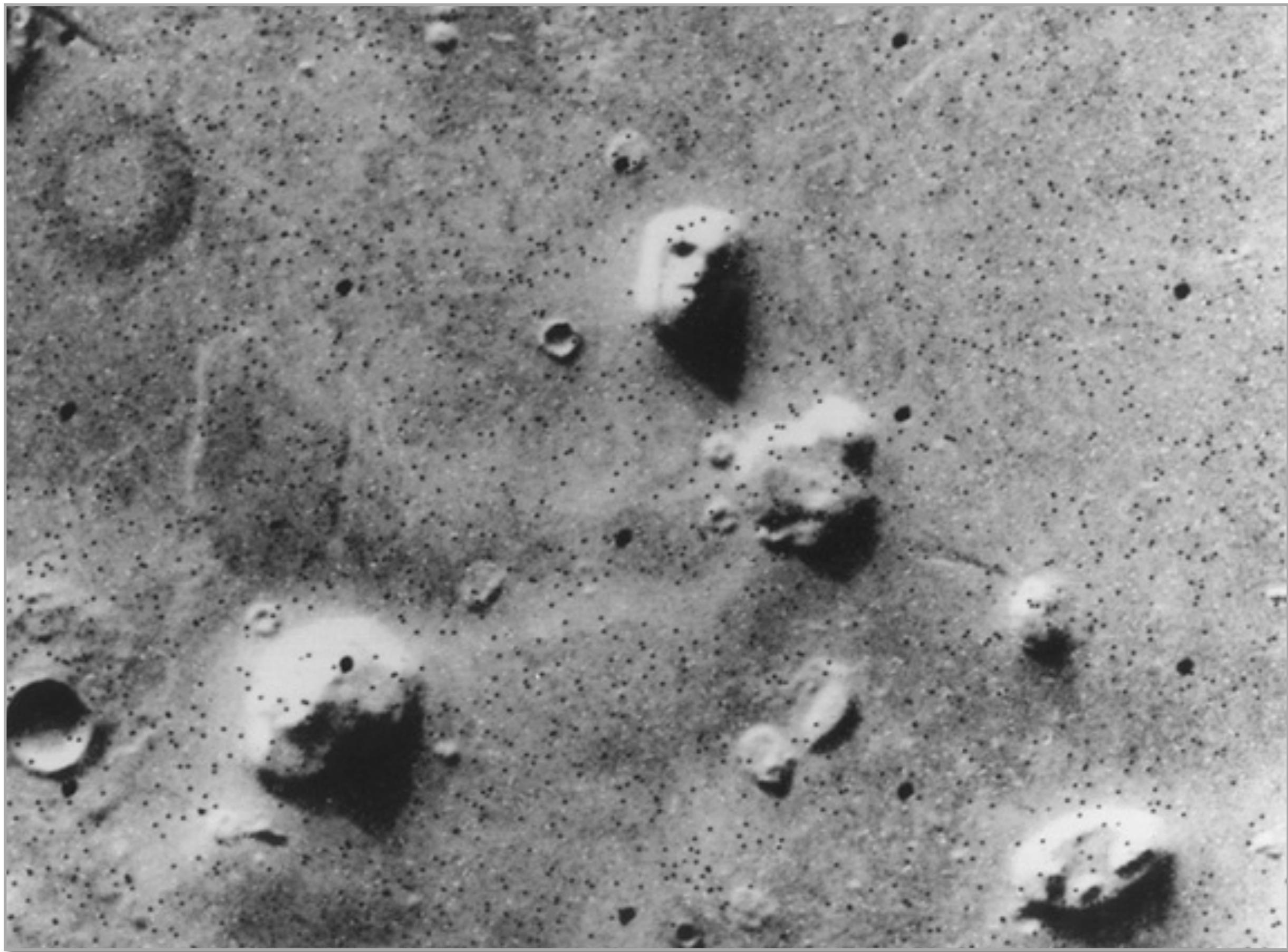
It is natural for us to perceive faces on random places.



+Dunken K Bliths

Why Faces?

Source: <http://www.space.com/17191-face-on-mars.html>



Why Faces?

Slave's Market
Salvador Dali



Why Faces?

Slave's Market
Salvador Dali



**Perceptual
Rivalry**



Voltaire's Bust
Jean-Antoine Houdon

Why Faces?



The Fruit Basket
Giuseppe Arcimboldo



The Gardener
Giuseppe Arcimboldo

**Perceptual
Rivalry**

Why Faces?



The Fruit Basket
Giuseppe Arcimboldo



The Gardener
Giuseppe Arcimboldo

Perceptual
Rivalry

Fingerprints vs. Faces

Universality (1/8)

Does everybody have the trait?

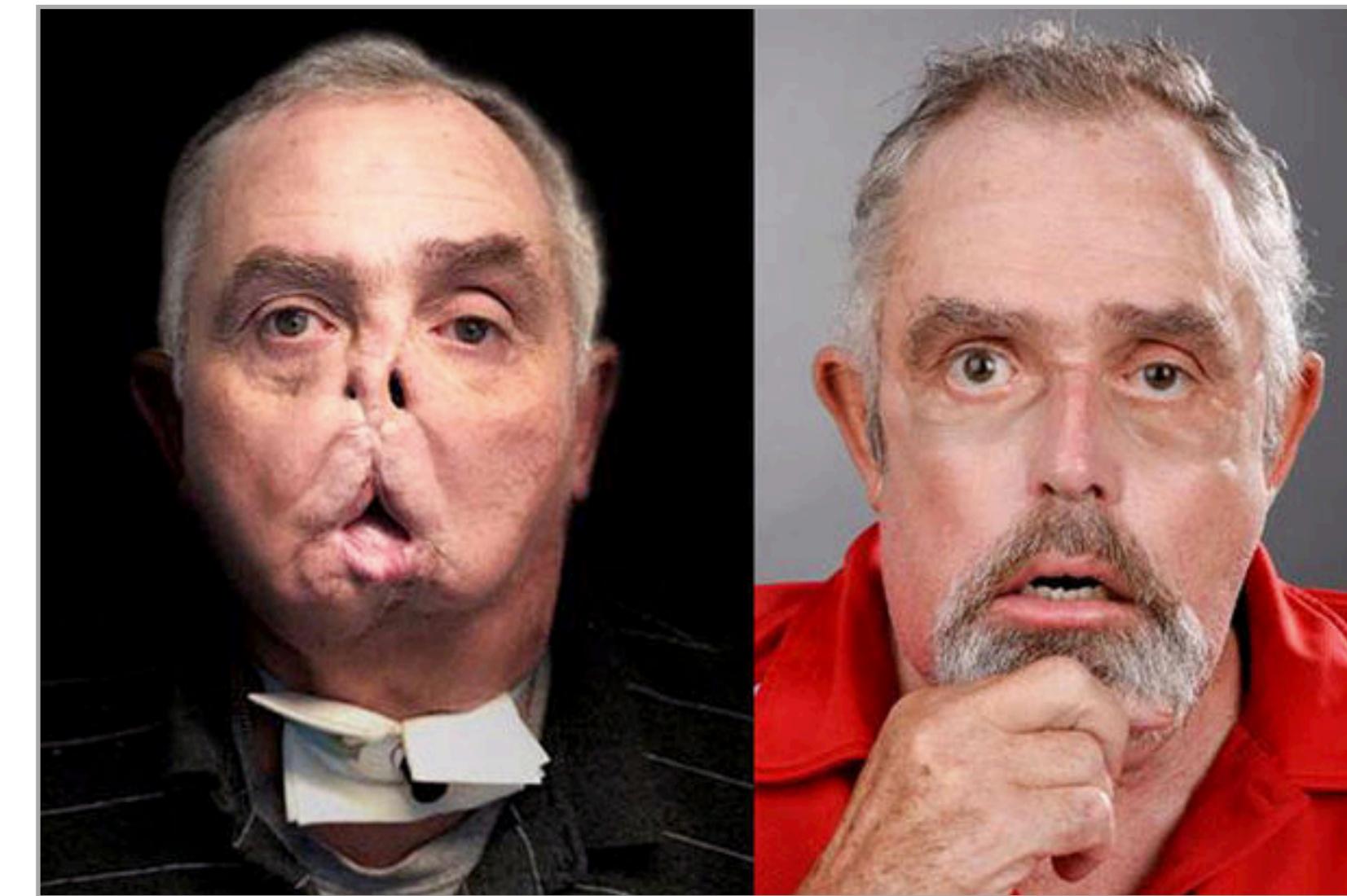
<https://www.smithsonianmag.com/science-nature/adermatoglyphia-genetic-disorder-people-born-without-fingerprints-180949338/>



The image shows a screenshot of a Smithsonian Magazine article. The title is "Adermatoglyphia: The Genetic Disorder Of People Born Without Fingerprints". Below the title is a photograph of four fingers (two from each hand) placed on a green textured surface. The fingers appear smooth and lack the typical ridges and grooves of normal fingerprints. A caption below the photo reads: "The finger pads of a person with adermatoglyphia are entirely smooth. (Photo by Sprecher et. al.)". The article is written by Joseph Stromberg and published on January 14, 2014.

Adermatoglyphia

<https://www.cbsnews.com/pictures/amazing-face-transplants-graphic-images/>



Face transplants

Fingerprints vs. Faces

Uniqueness (2/8)

How likely two or more individuals will present the same trait?

Source: John Daugman
Lecture Notes, 2018



Galton's probability of 2 people presenting the same fingerprint: 1 in 64 billion.



Identical twins.

Identical Twins?



Identical Twins?

Source: John Daugman
Lecture Notes, 2018



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Lecture Notes, 2018



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Lecture Notes, 2018



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Lecture Notes, 2018



Source: John Daugman
Lecture Notes, 2018



Source: <http://lubbockonline.com/slideshows/051108/277846477/slides4.shtml>



Mother and daughter.

Identical Twins?



Source: John Daugman
Lecture Notes, 2018



Source: John Daugman
Lecture Notes, 2018



Source: [http://lubbockonline.com/
slideshows/051108/277846477/
slide4.shtml](http://lubbockonline.com/slideshows/051108/277846477/)

Mother and daughter.



Source: John Daugman
Lecture Notes, 2018

Unrelated.



Completely
unrelated
subjects.



Source: John Daugman
Lecture Notes, 2018



Fingerprints vs. Faces

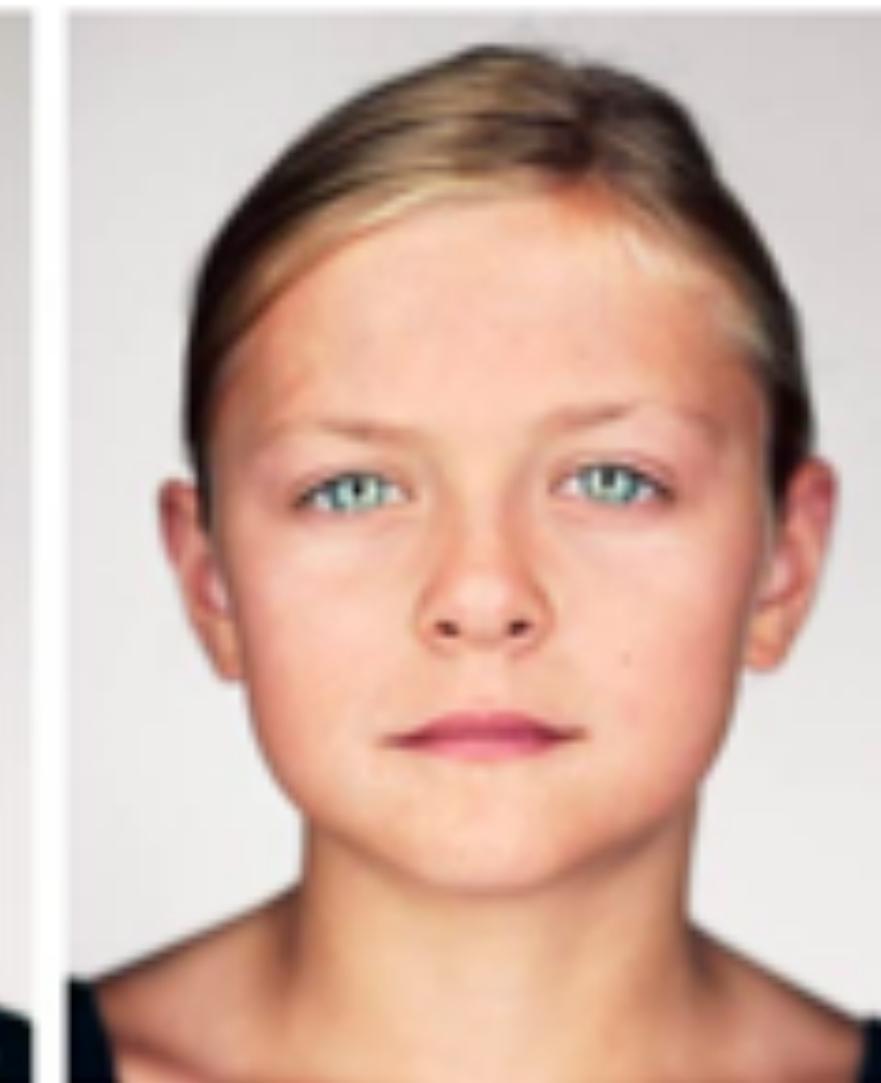
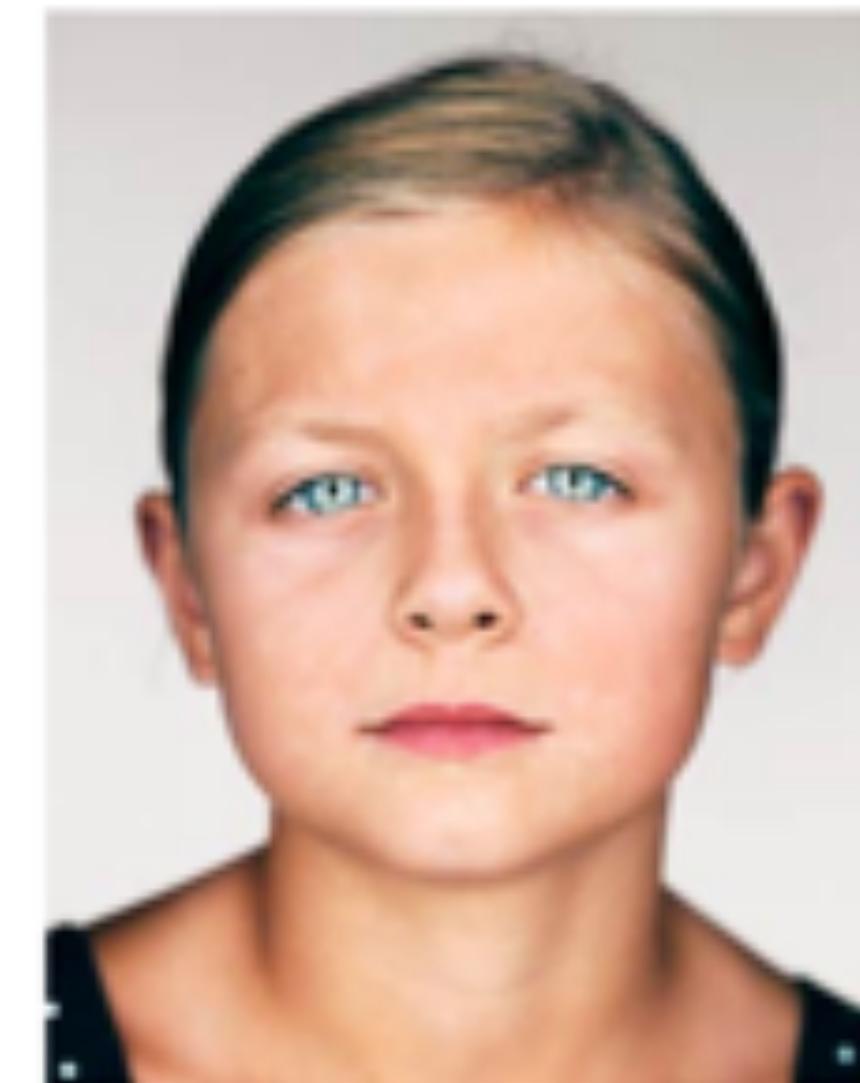
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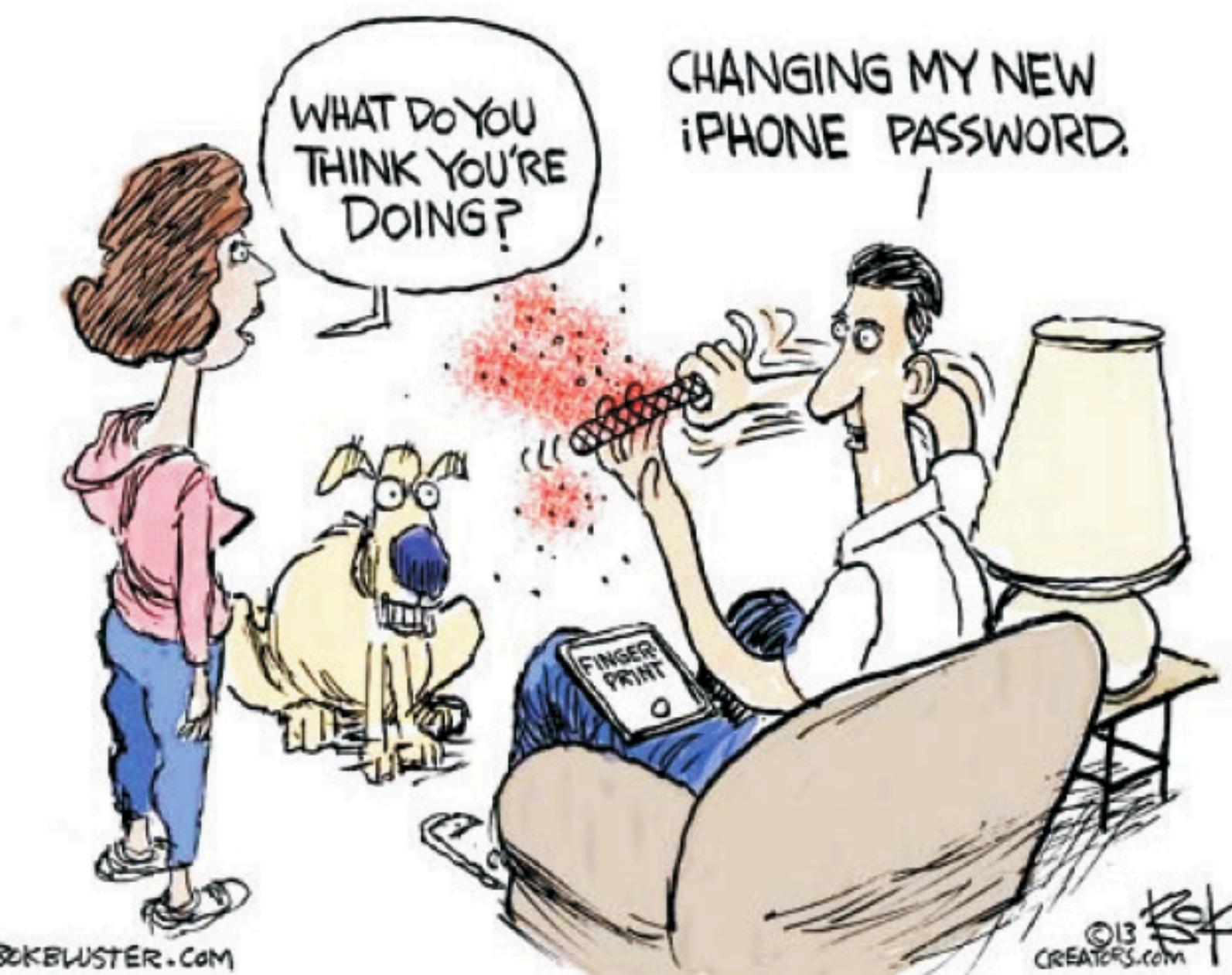


Identical twins.

Fingerprints vs. Faces

Permanence (3/8)

How easily does the trait change?



You cannot easily change your fingerprints.



But your face **will** change.

Fingerprints vs. Faces

Permanence (3/8)

How easily does the trait change?

Aging

Source: Lantinis

A survey of the effects of aging on biometric identity verification
International Journal of Biometrics 2(1), 2010



Fingerprints vs. Faces

Permanence (3/8)

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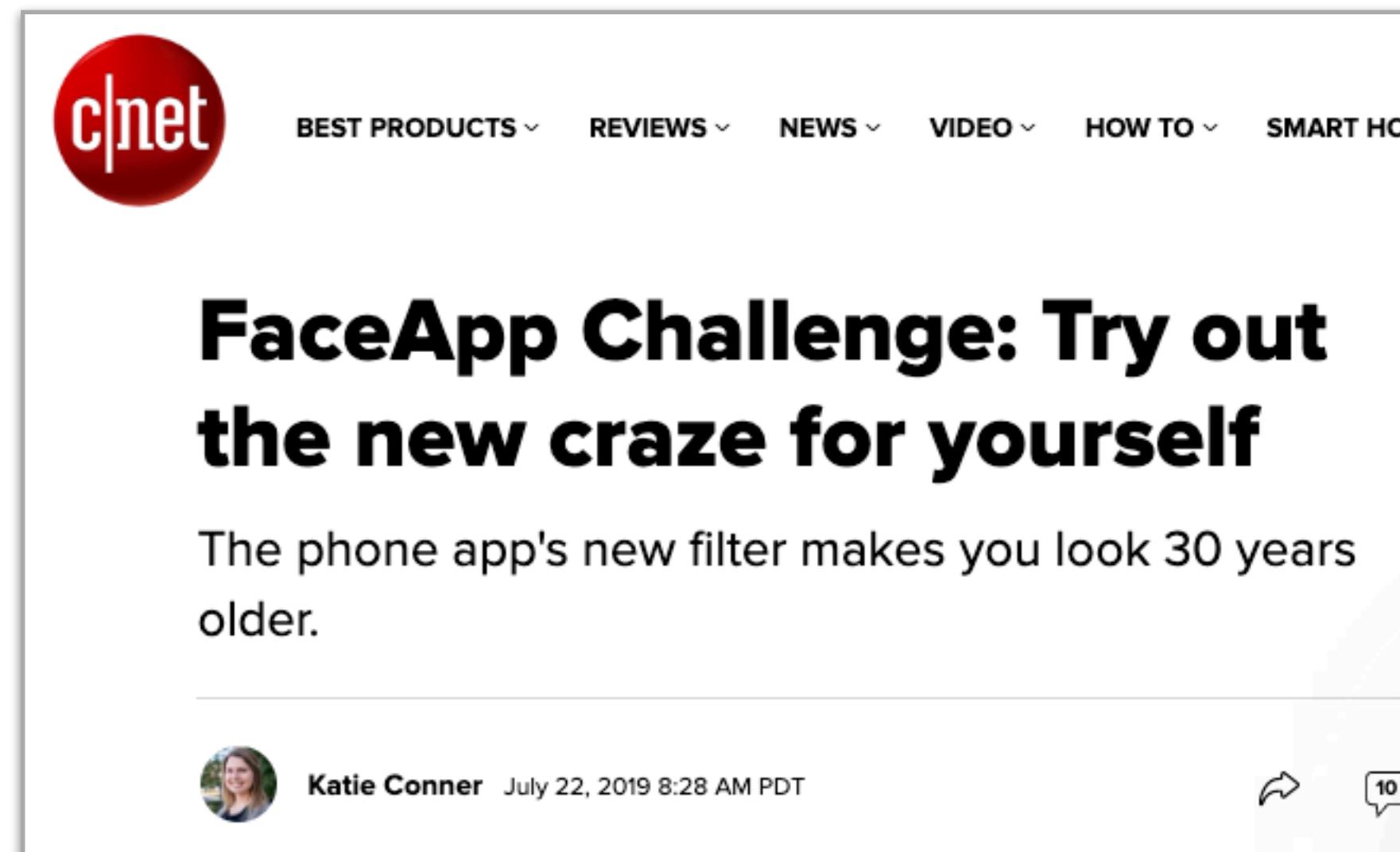
Fingerprints vs. Faces

Permanence (3/8)

How easily does the trait change?

Aging

Will it always be a challenge?



The image shows a screenshot of a CNET news article. The header features the CNET logo in a red circle. Below the logo, there are navigation links: BEST PRODUCTS ▾, REVIEWS ▾, NEWS ▾, VIDEO ▾, HOW TO ▾, and SMART HOME. The main title of the article is "FaceApp Challenge: Try out the new craze for yourself". A subtitle below the title reads, "The phone app's new filter makes you look 30 years older." At the bottom of the article, there is a photo of a woman named Katie Conner, with the caption "Katie Conner July 22, 2019 8:28 AM PDT". There are also sharing icons for social media.



<https://www.cnet.com/how-to/faceapp-challenge-try-out-the-new-craze-for-yourself/>

Fingerprints vs. Faces

Permanence (3/8)

How easily does the trait change?

Aging

Will it be useful?

Madeleine McCann



5 years (real)

9 years (simulated)

Fingerprints vs. Faces

Permanence (3/8)

How easily does the trait change?

Deliberate Changes



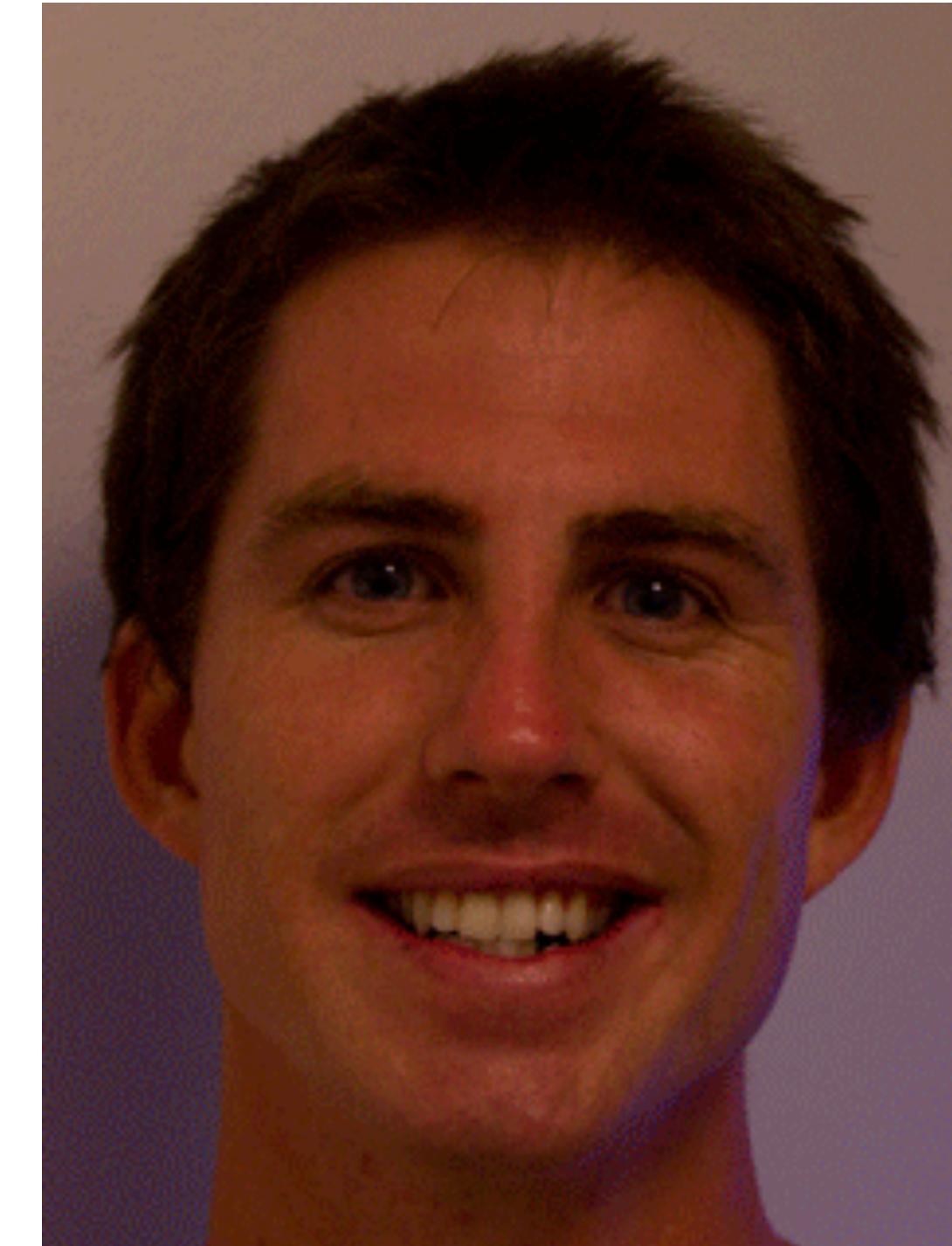
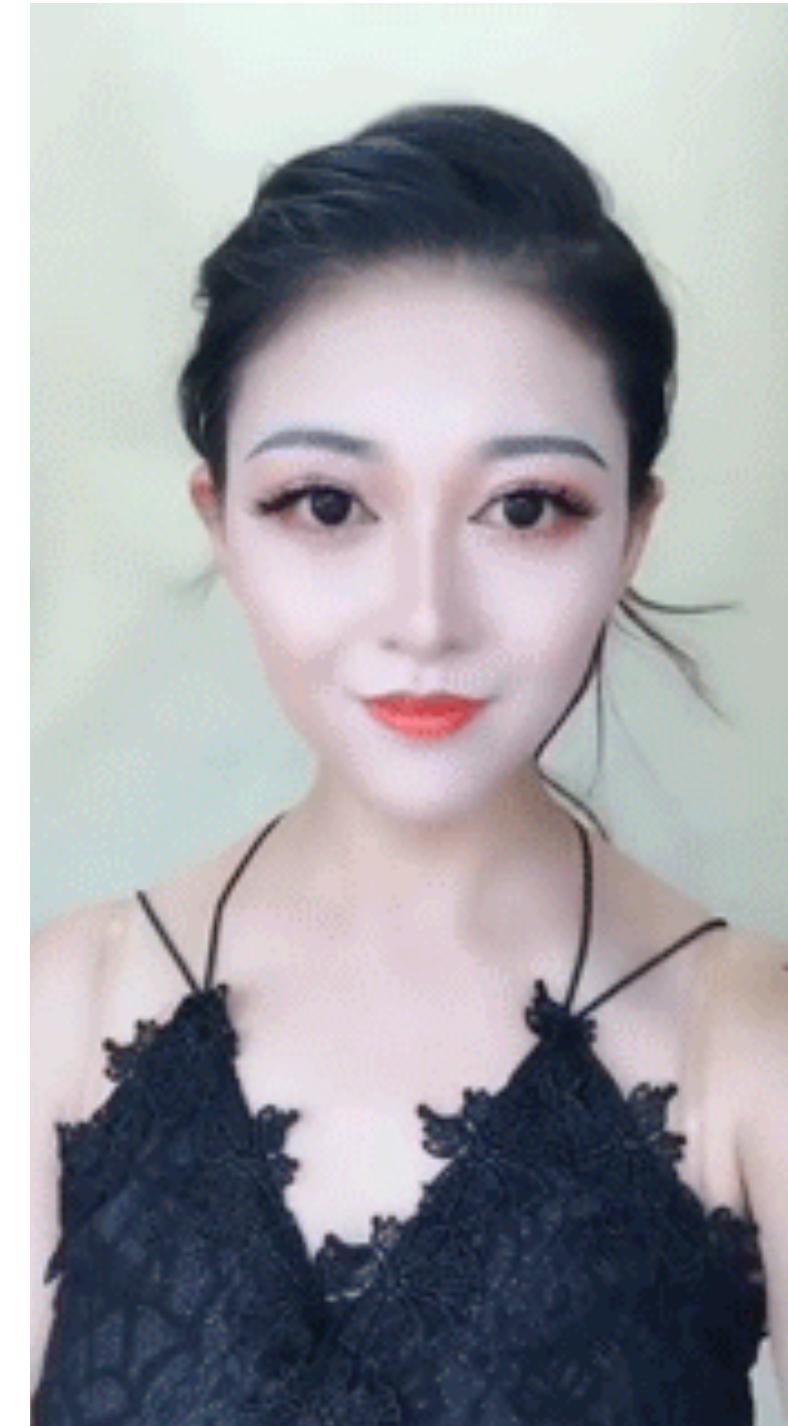
Fingerprints vs. Faces

Permanence (3/8)

How easily does the trait change?

Deliberate Changes

[https://www.youtube.com/
watch?v=Z4nc6OYY3no](https://www.youtube.com/watch?v=Z4nc6OYY3no)

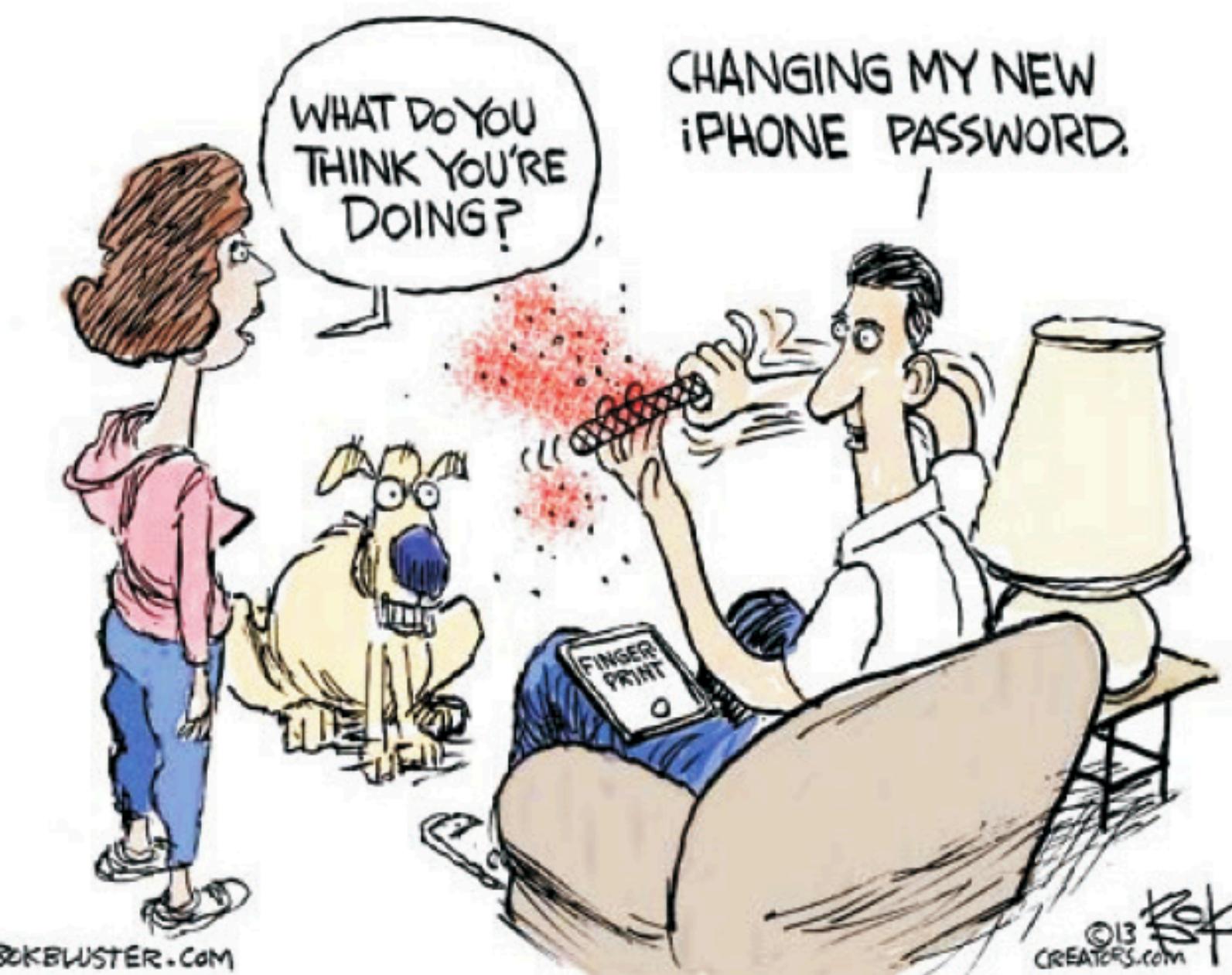




Fingerprints vs. Faces

Permanence (3/8)

How easily does the trait change?



You cannot easily change your fingerprints.

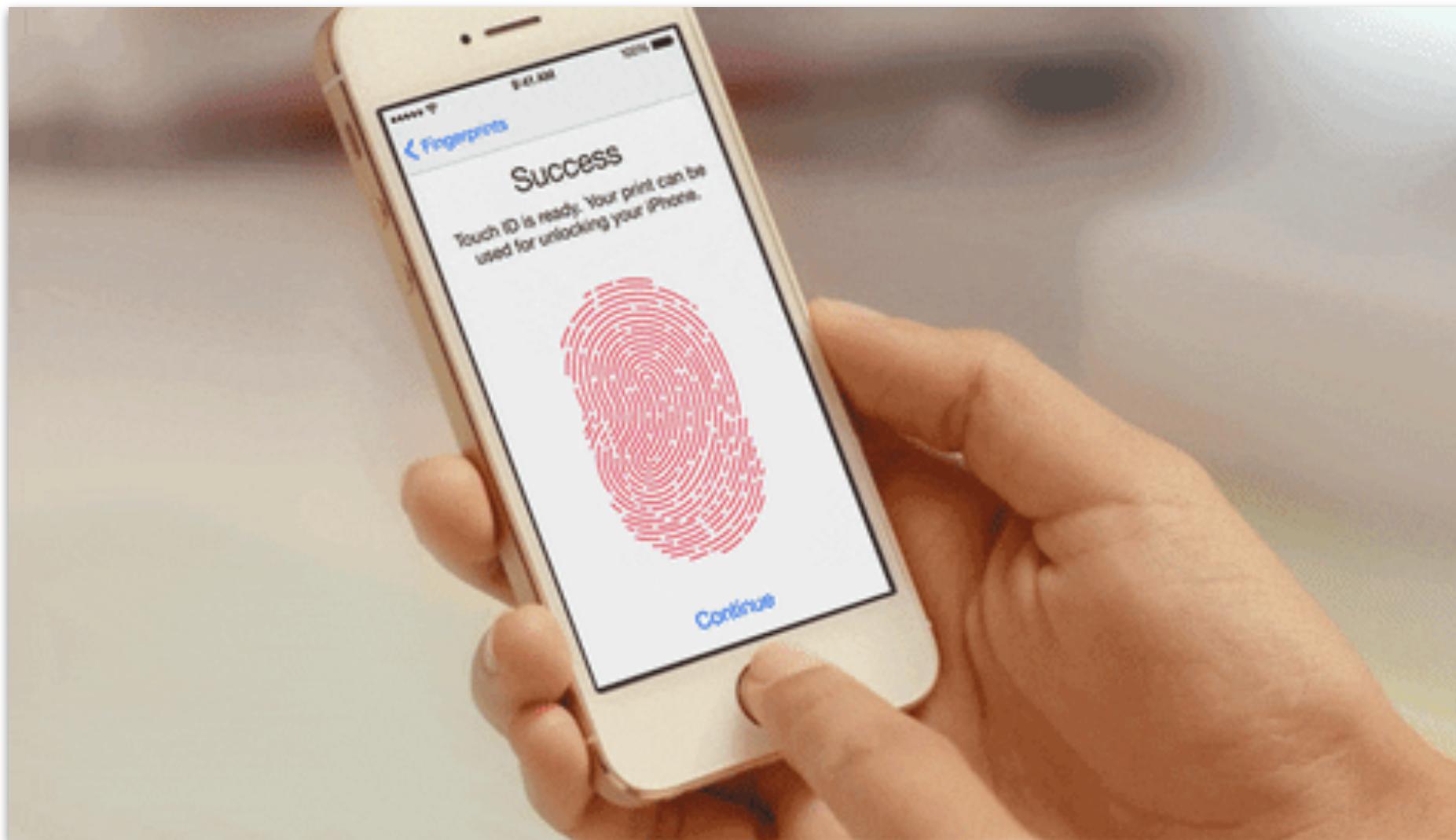


But your face **will** change.

Fingerprints vs. Faces

Measurability (4/8)

How easy is it to acquire and digitize the trait?



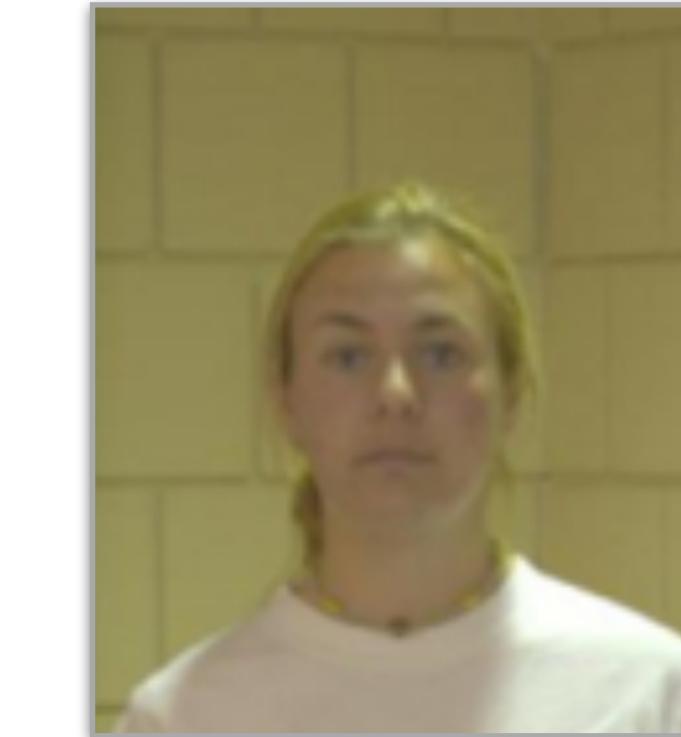
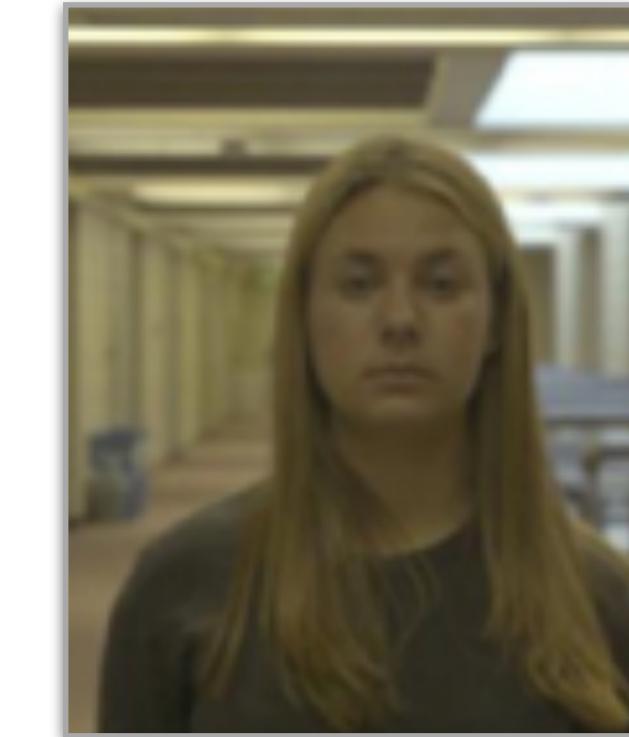
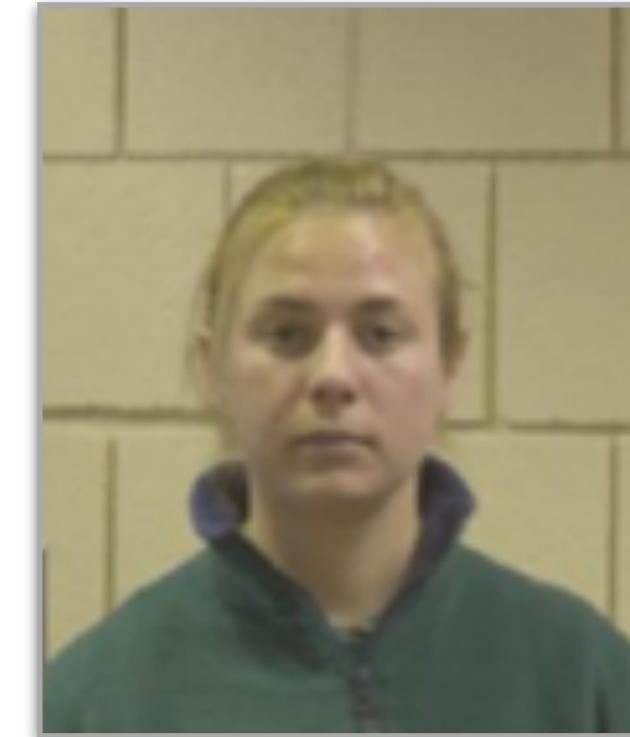
<https://www.youtube.com/watch?v=uQHqZNyXoBQ>

Fingerprints vs. Faces

Measurability (4/8)

How easy is it to acquire and digitize the trait?

Unconstrained Acquisition



<https://www.nist.gov/system/files/documents/itl/iad/ig/05771424.pdf>

Fingerprints vs. Faces

Measurability (4/8)

How easy is it to acquire and digitize the trait?

Large Intra-Class Variation

Different pose, illumination, expression, accessories (e.g.. glasses), resolution.



Hsu
*Face detection and
modeling for recognition*
PhD Thesis, MSU, 2002.

Fingerprints vs. Faces

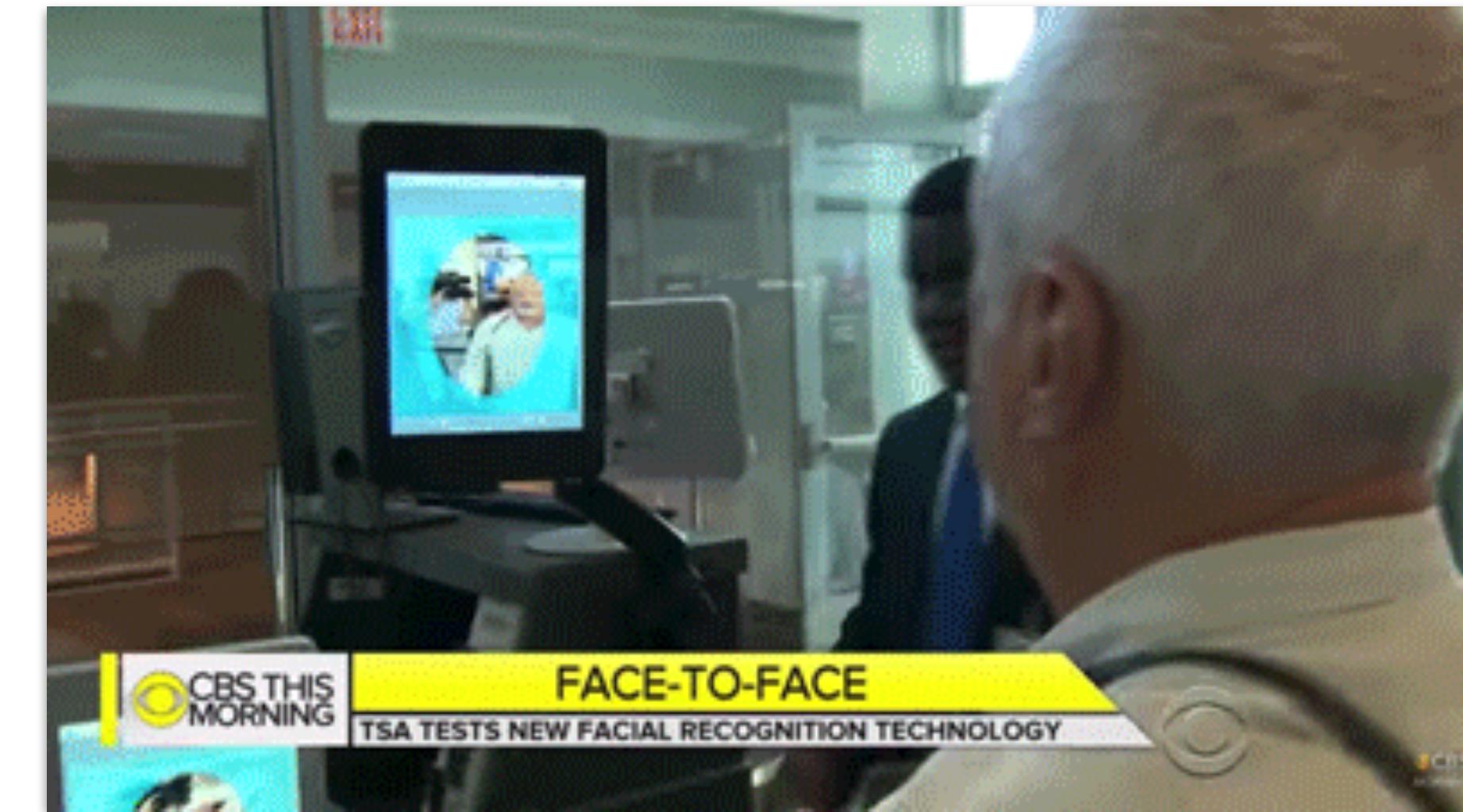


Acceptability (5/8)

Will individuals collaborate during data collection?



<https://www.youtube.com/watch?v=Qt79QAwgi80>



https://www.youtube.com/watch?v=BYN4oF_bi4c

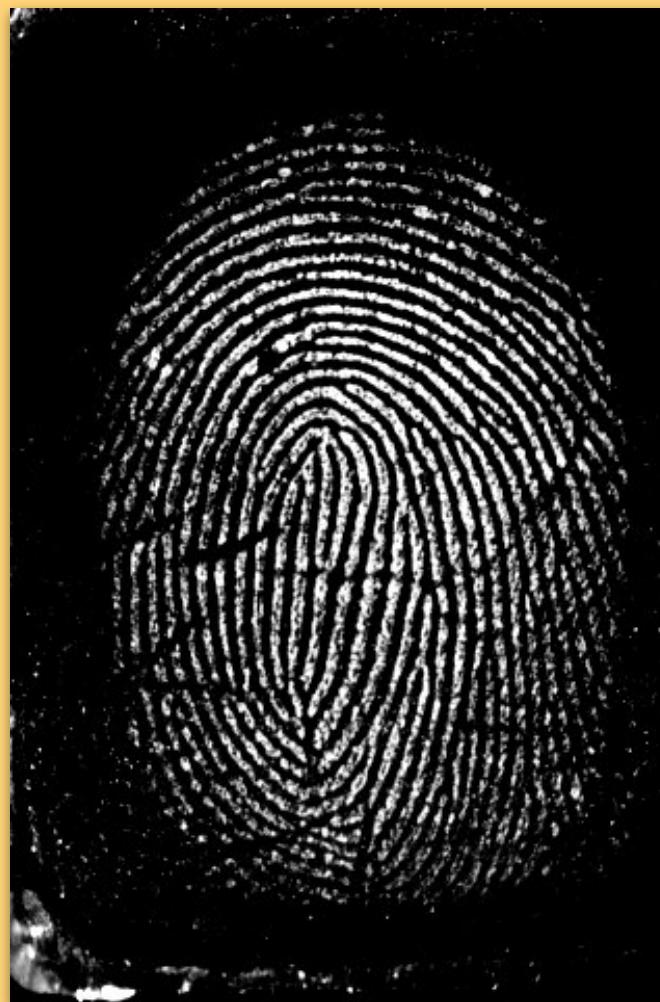
Fingerprints vs. Faces



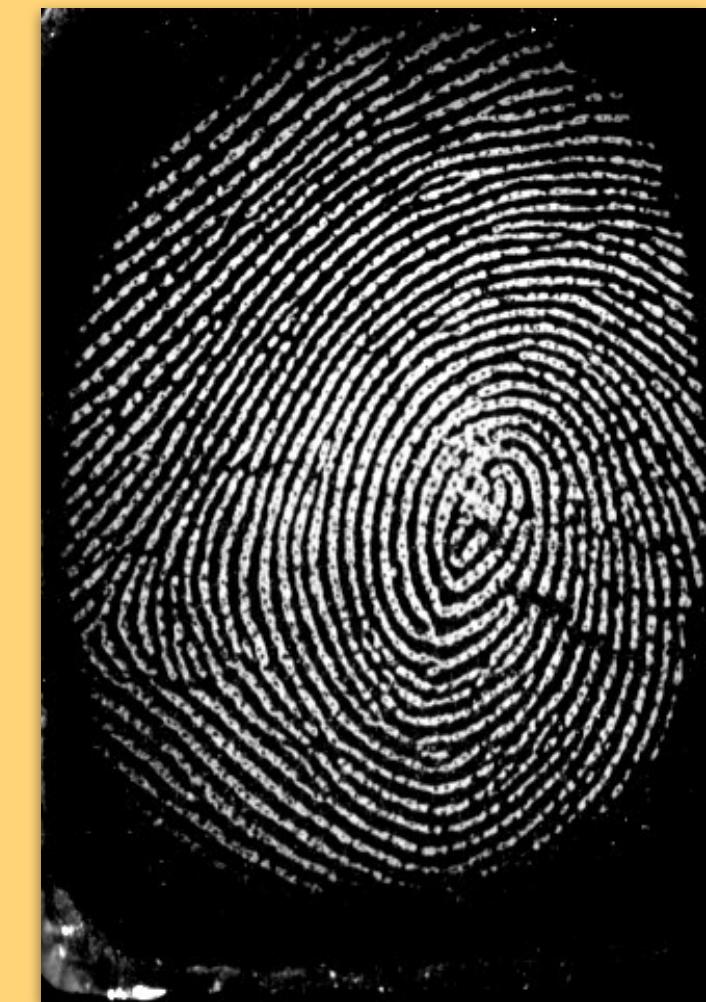
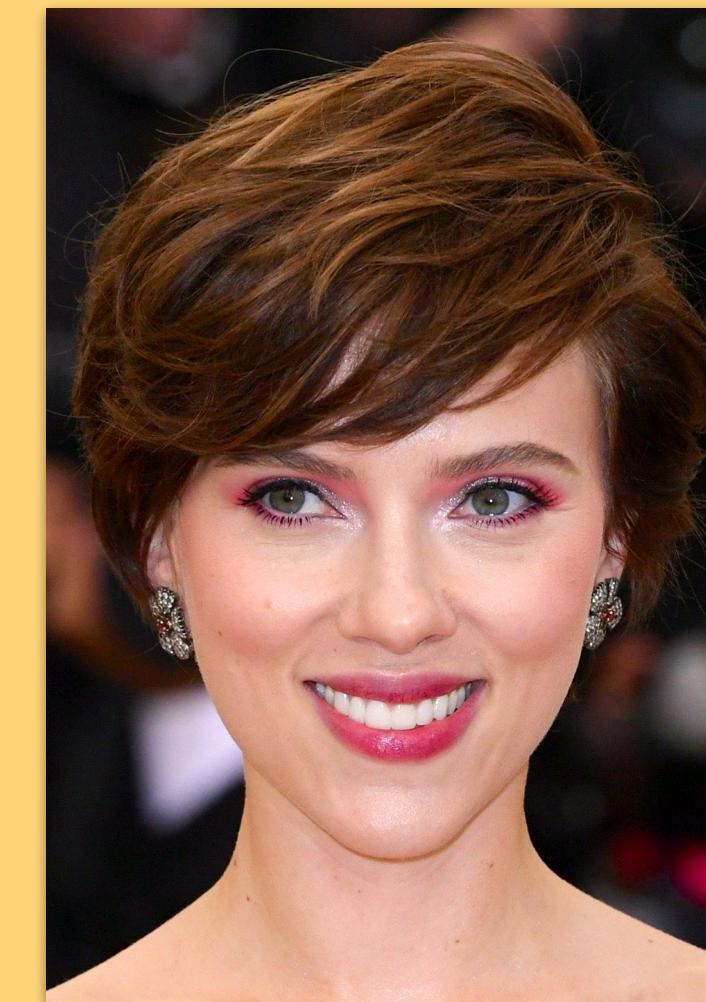
Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns



Robert
Downey Jr.



Scarlet
Johansson

Fingerprints vs. Faces



Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns



**Whose latent fingerprint is this?
Robert's or Scarlet's?**

Is it the fingerprint of a man or woman?
Is it the fingerprint of a younger or older person?

Latent Fingerprint

Fingerprints vs. Faces



Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns



**Whose face is this?
Robert's or Scarlet's?**

No way it is Scarlet's. This is a man.
No way it is Robert. This is an older man.

“Latent Face”

Fingerprints vs. Faces



Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns

Which trait helps to recognize Scarlet quicker?



Latent Fingerprint



“Latent Face”

Fingerprints vs. Faces

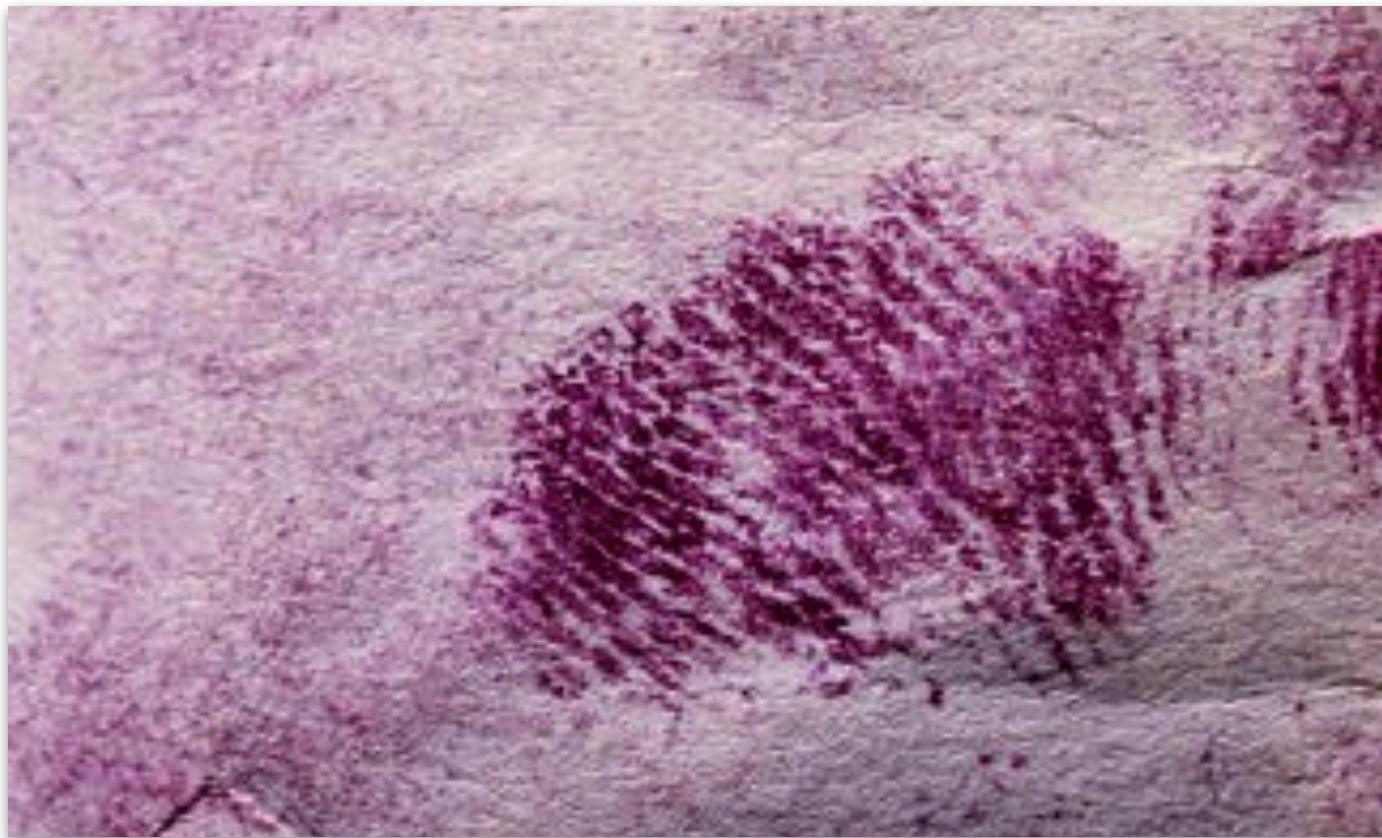


Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns

Which trait favors **covert deployment**?



Latent Fingerprint



“Latent Face”

Fingerprints vs. Faces



Circumvention (6/8)

How easy can the trait be forged or imitated?



<https://www.youtube.com/watch?v=KdycMYILTr0>

We are not there yet!

Fingerprints vs. Faces



Circumvention (6/8)

How easy can the trait be forged or imitated?

Limitations

= WIRED

SUBSCRIBE

CapitalOne

Experience that new-car feeling.

ANDY GREENBERG SECURITY 11.14.2017 07:00 AM

Watch a 10-Year-Old's Face Unlock His Mom's iPhone X

Yes, twins can unlock each other's iPhones. But kids accessing their parents' devices raises different concerns.



<https://www.wired.com/story/10-year-old-face-id-unlocks-mothers-iphone-x/>

Fingerprints vs. Faces



Circumvention (6/8)

How easy can the trait be forged or imitated?

Attacks

Presentation Attack.



<https://www.youtube.com/watch?v=BGgQ9woZQOg>



UNIVERSITY OF
NOTRE DAME

Fingerprints vs. Faces



Accountability (7/8)

How easy is it for the everyman to understand the trait comparison?



Same fingerprint?

You need to know fingerprint features.



Everybody is an expert
in face recognition.

Fingerprints vs. Faces

Performance (8/8)

How good is the trait quantitatively according to objective metrics?

Face Recognition Improvement

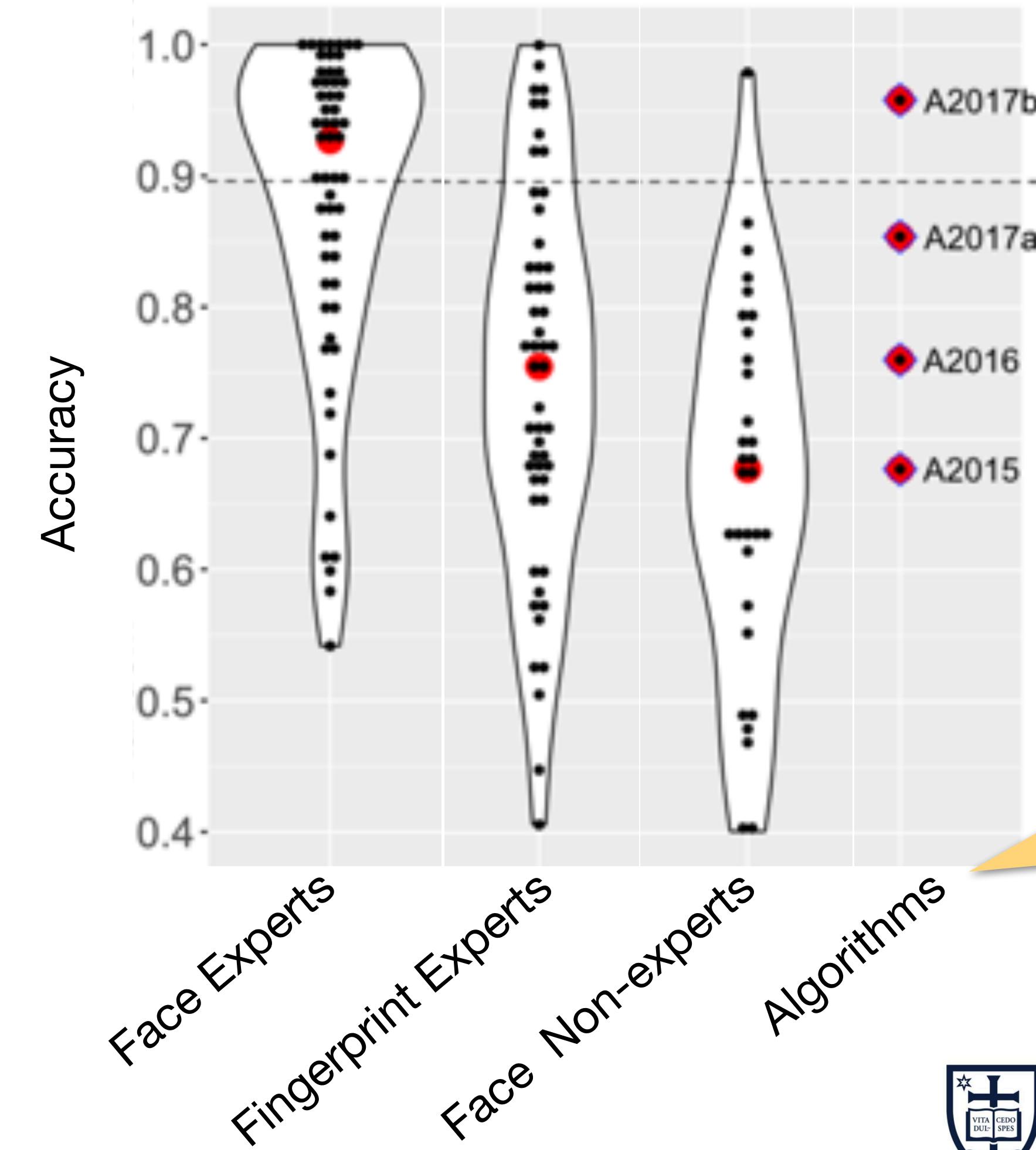
Methods are improving quickly.
Benefits from deep learning.

Publication

Phillips et al.

Face recognition accuracy of forensic examiners, superrecognizers, and face recognition algorithms.

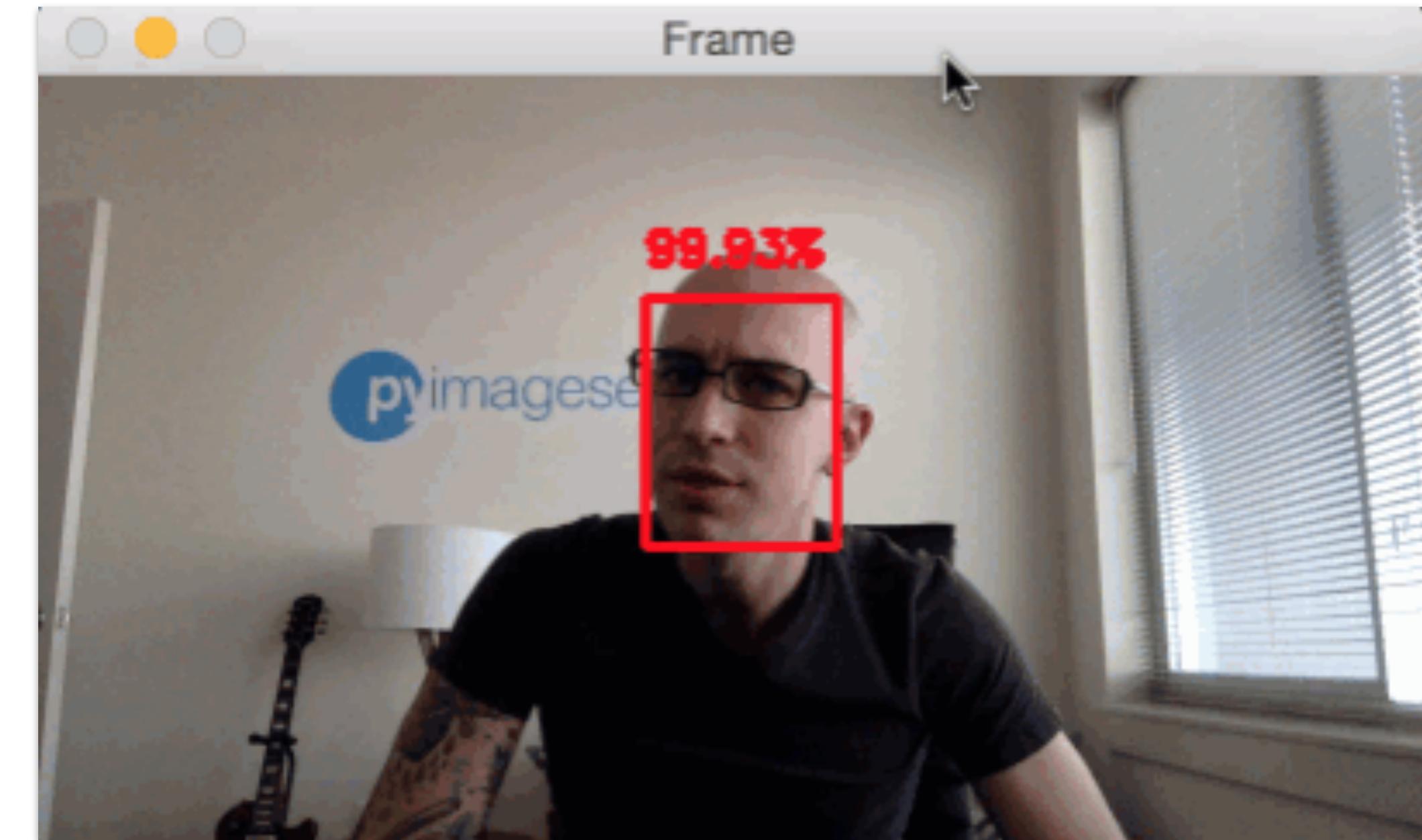
PNAS, 2018



S'up Next?

Face Recognition Pipeline

Face acquisition and
face detection/localization.



<http://insidenothing.blogspot.com/2018/02/face-detection-with-opencv-and-deep.html>

Acknowledgments

This material is heavily based on
Dr. Adam Czajka's and Dr. Walter Scheirer's courses.
Thank you, professors, for kindly allowing me to use your material.

<https://engineering.nd.edu/profiles/aczajka>
<https://www.wjscheirer.com/>