

Face Recognition I

CSE 40537/60537 Biometrics

Daniel Moreira
Spring 2022

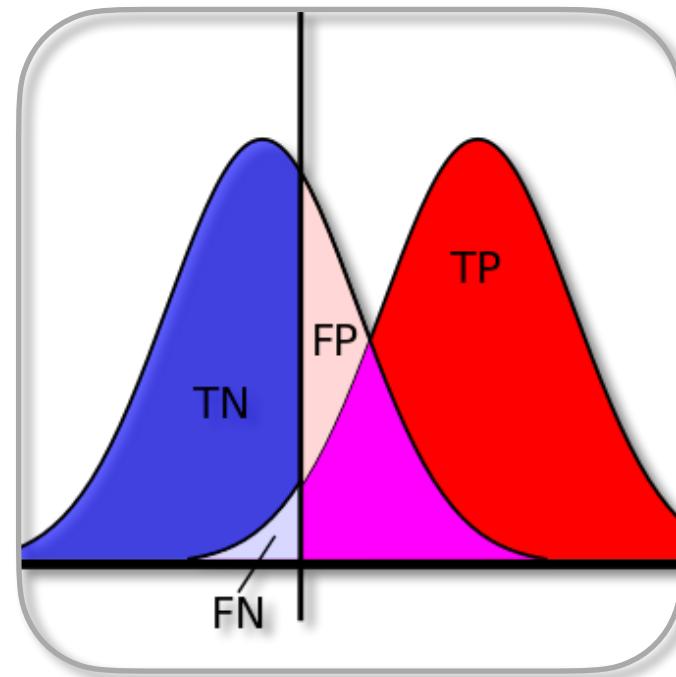


Today you will...

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

Course Overview

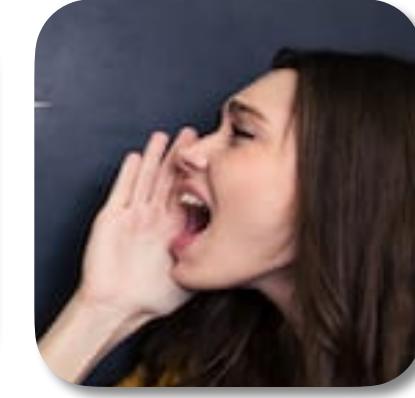
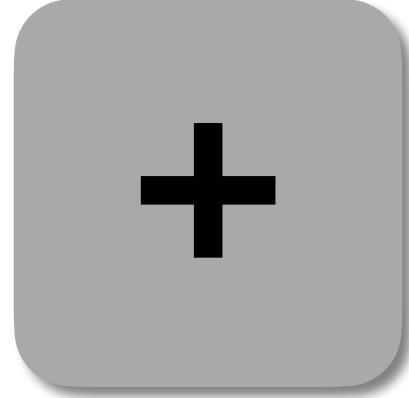
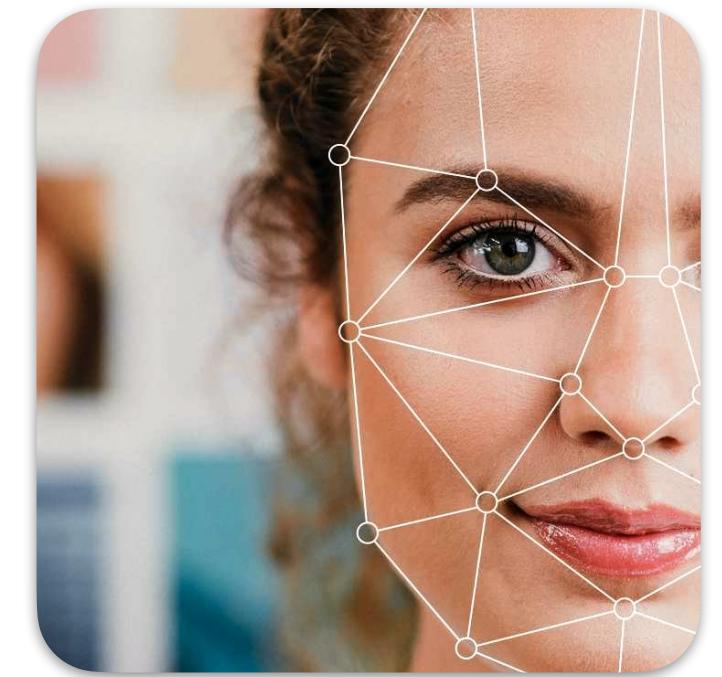
Content



Basics
Concepts
Metrics
Metric implementation



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



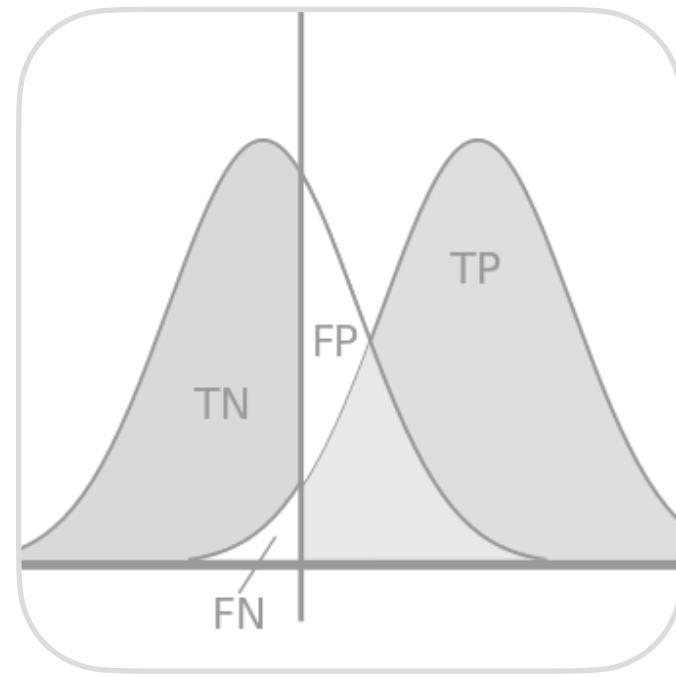
Alternative Traits and Fusion Concepts



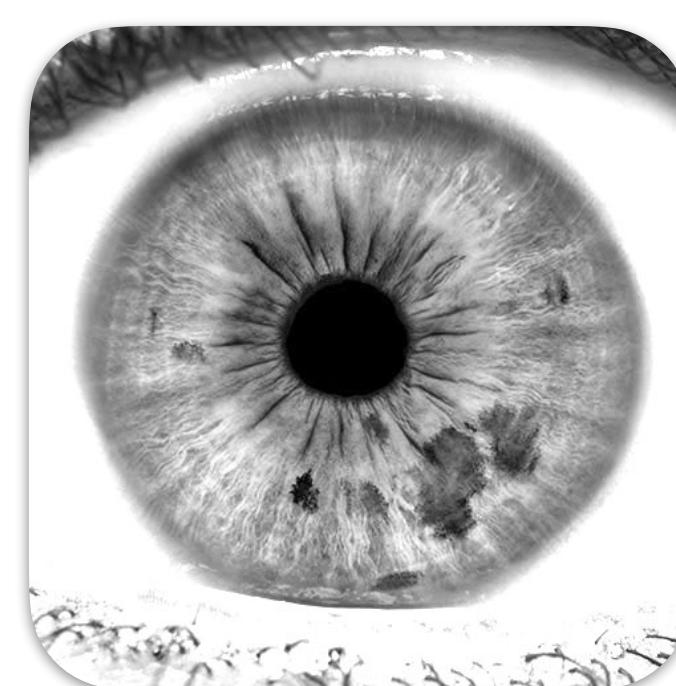
Invited Talks (2)
State of the art
Future work

Course Overview

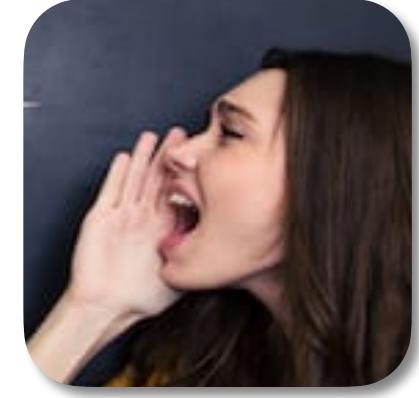
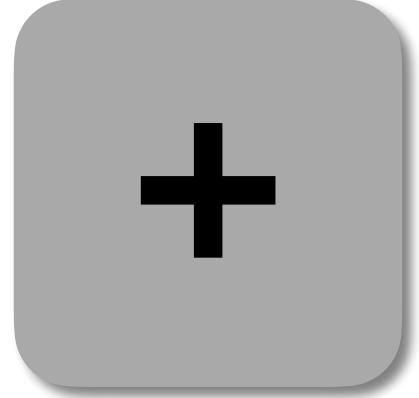
Content



Basics
Concepts
Metrics
Metric implementation



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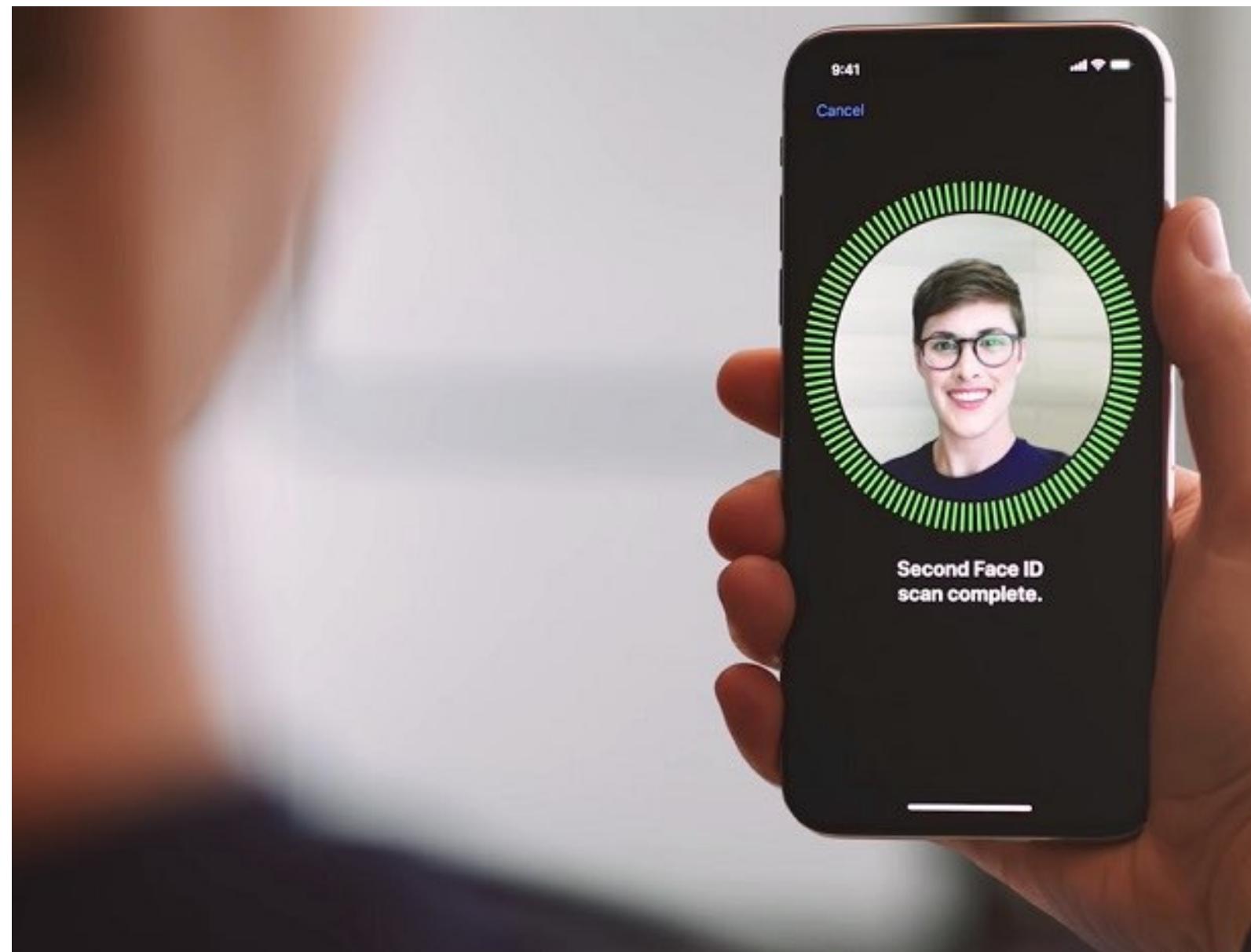
Alternative Traits and Fusion Concepts



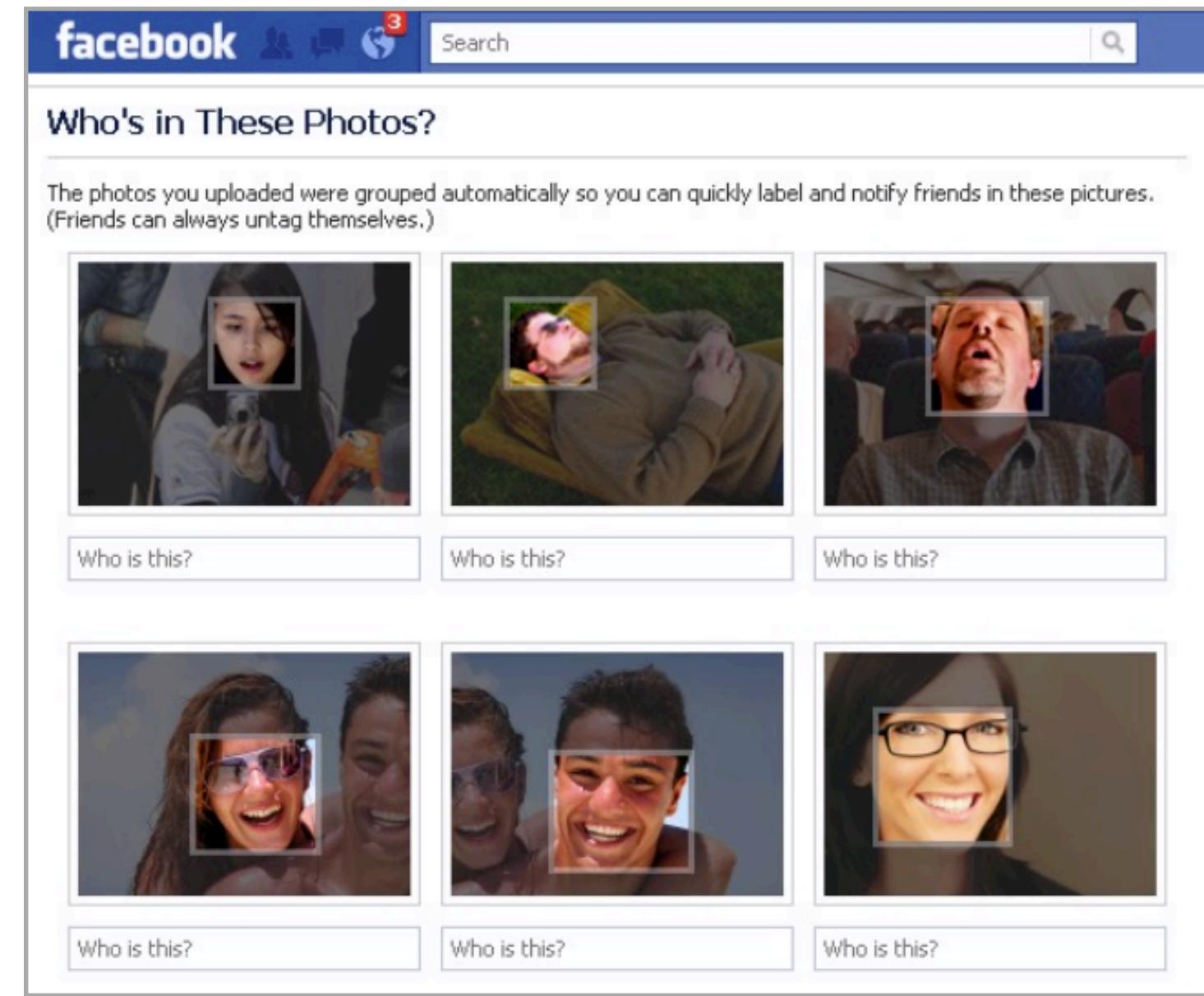
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Why Faces?

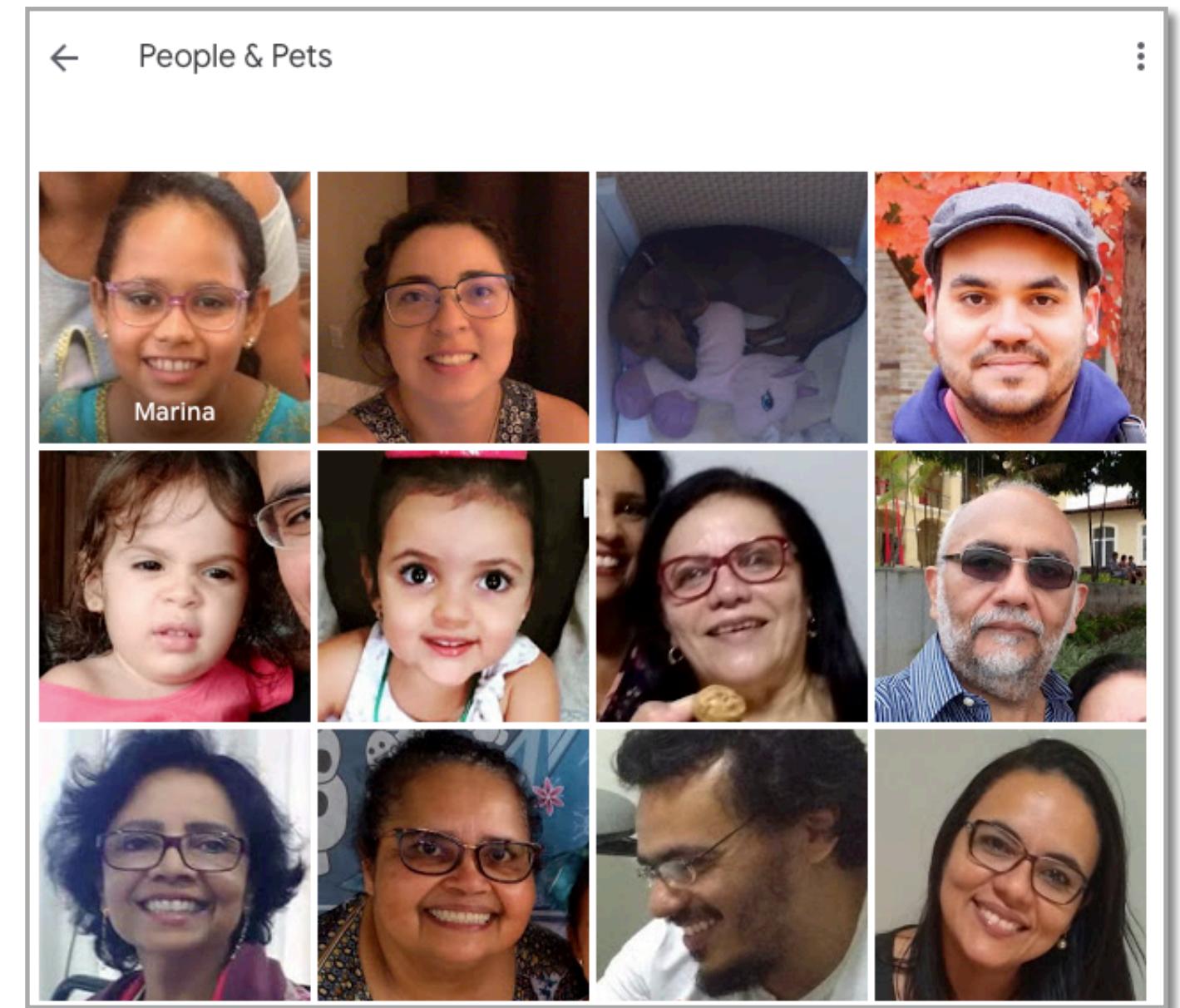
Face recognition is a reality



Personal devices



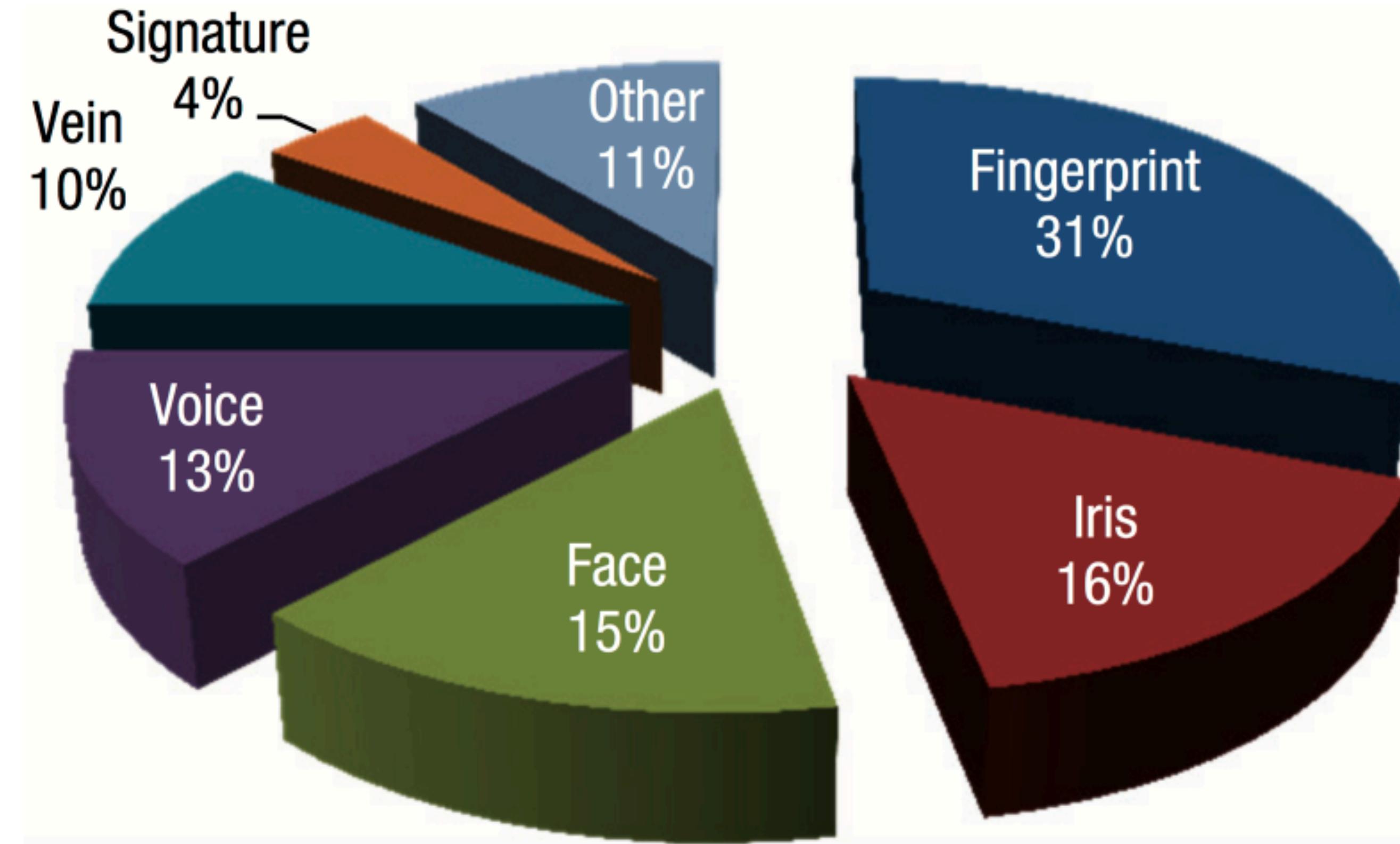
Facebook



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



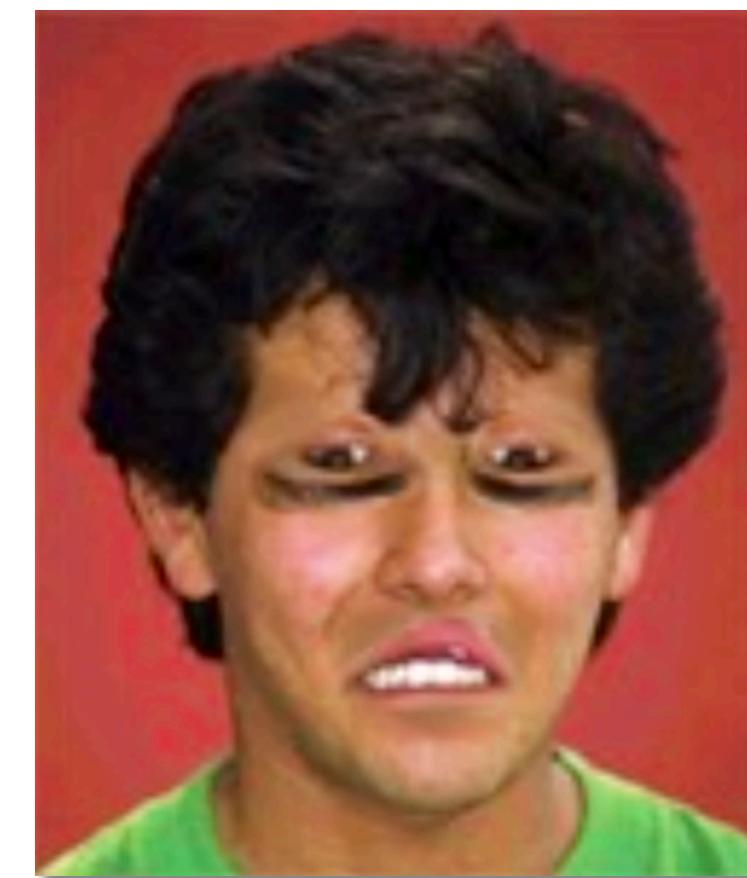
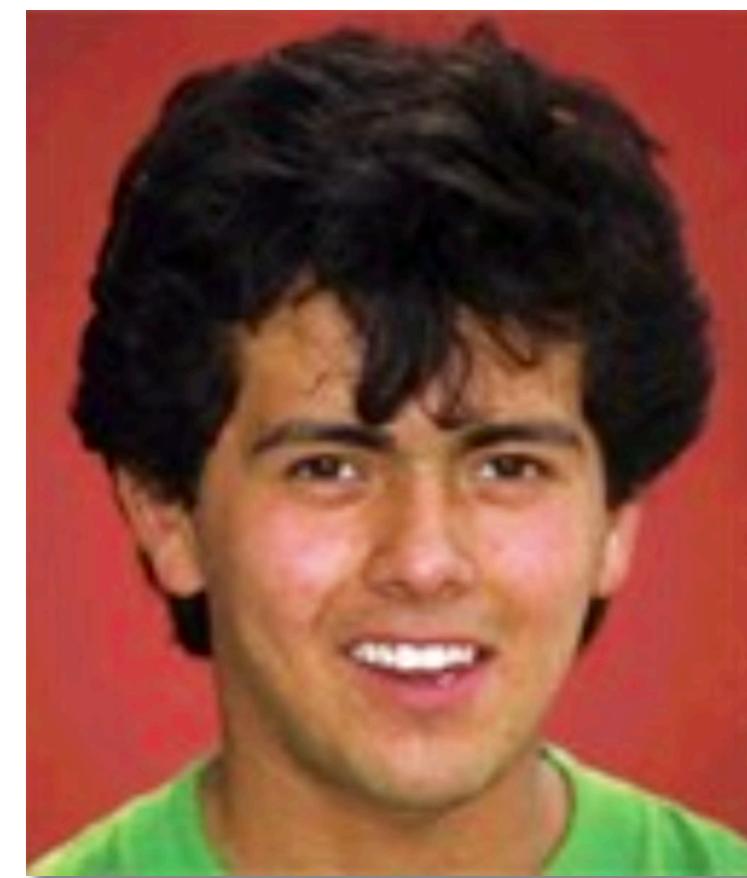
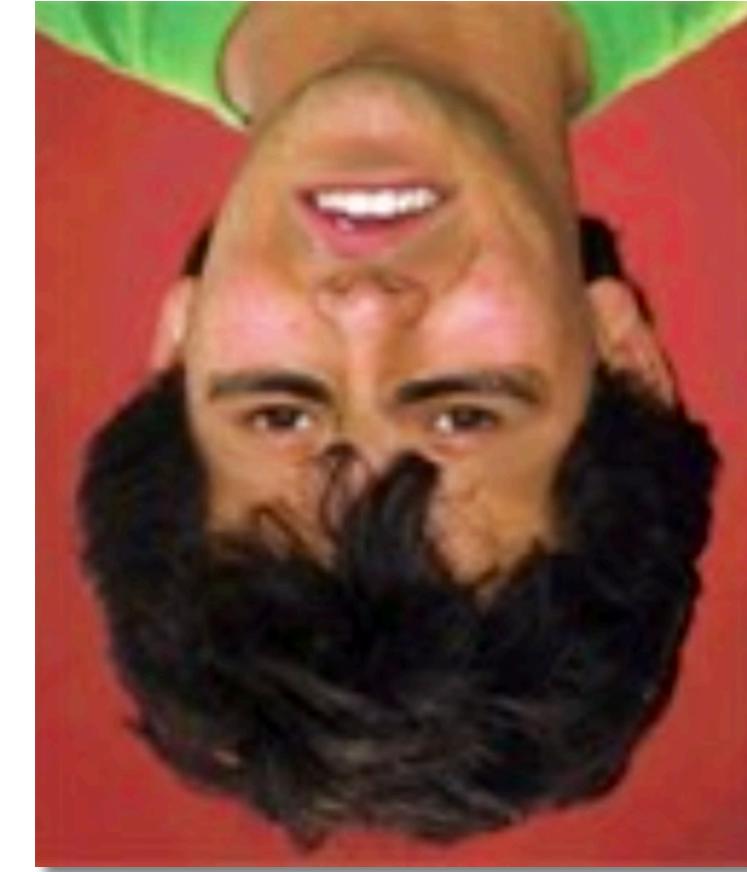
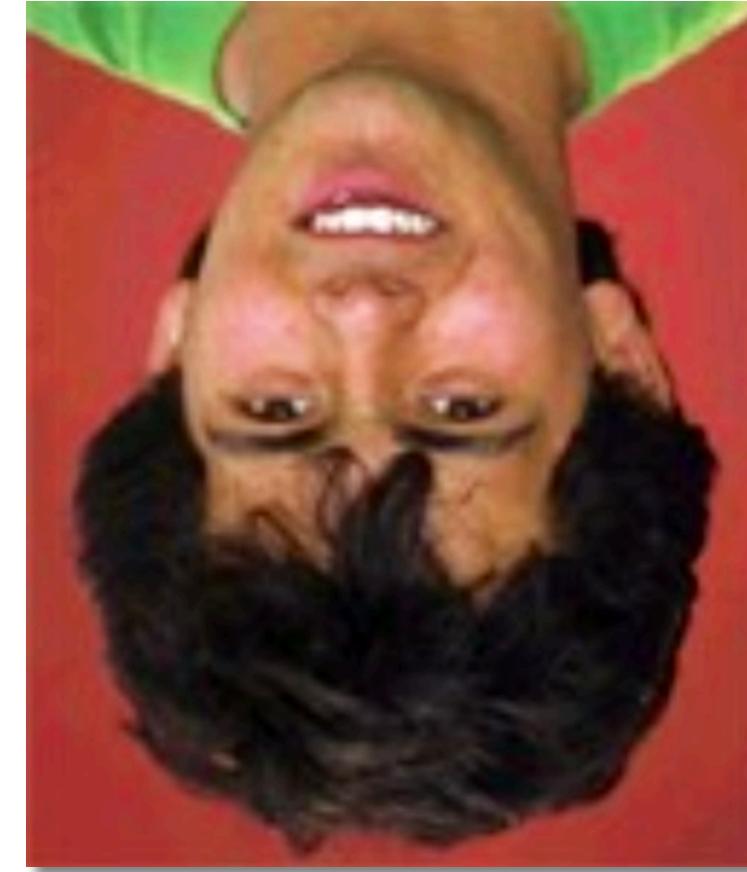
Who is she?



How different from
the other one?

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

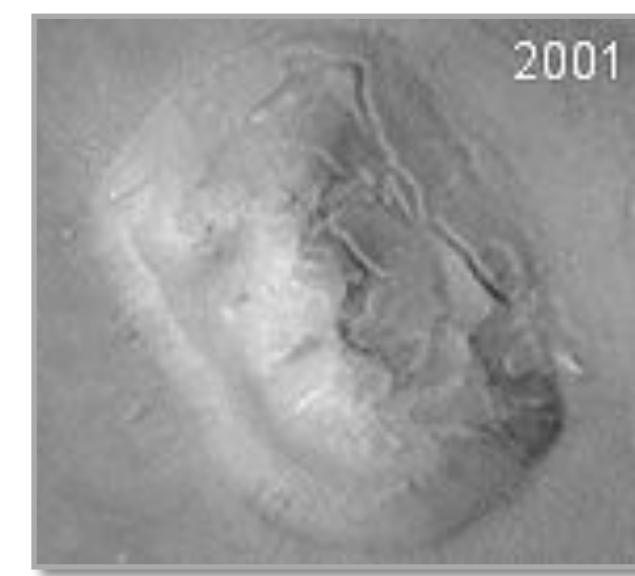
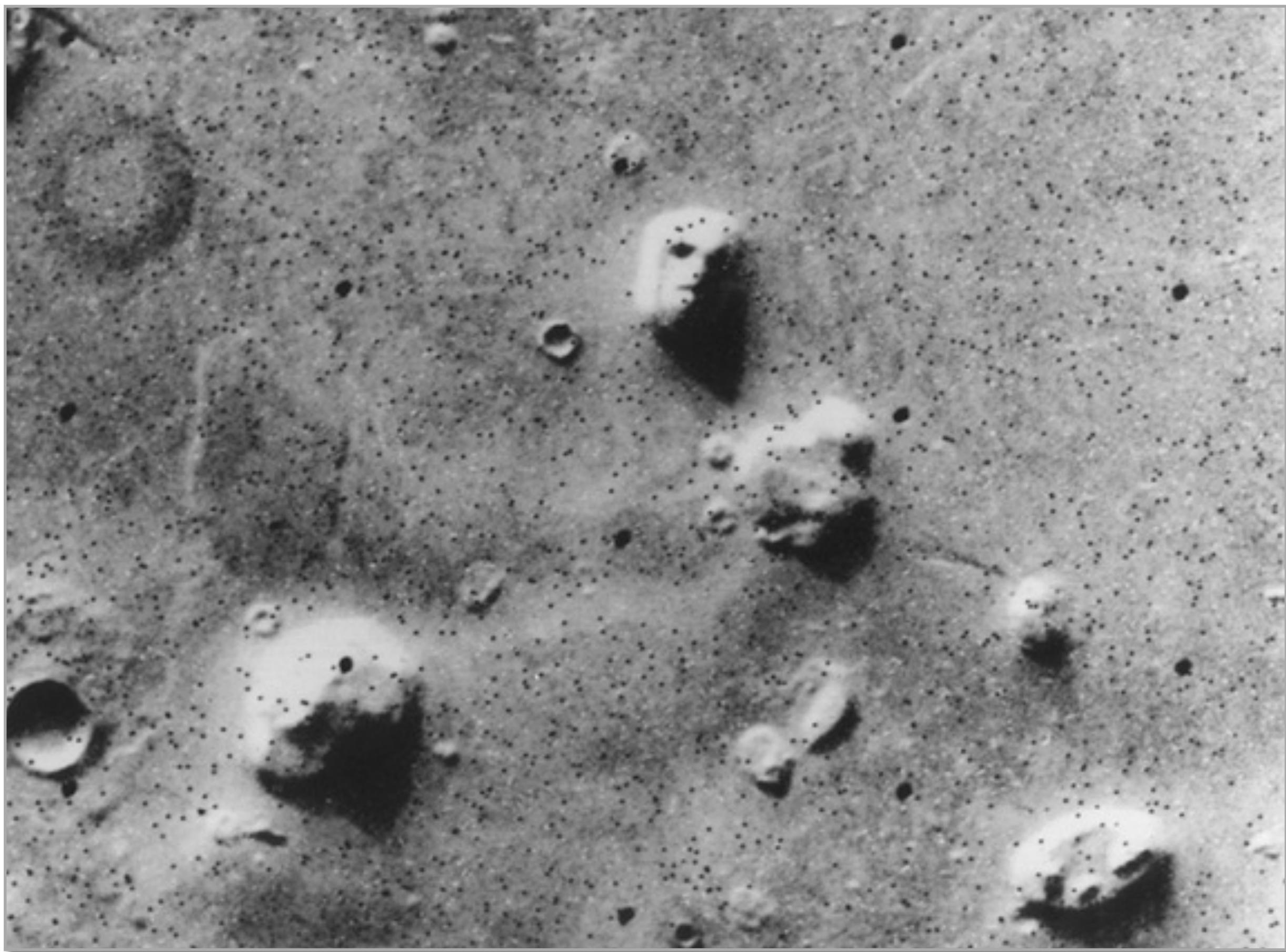
It is natural for us to perceive faces on random places.



+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, Irises vs. Faces

Universality (1/8)

Does everybody have the trait?

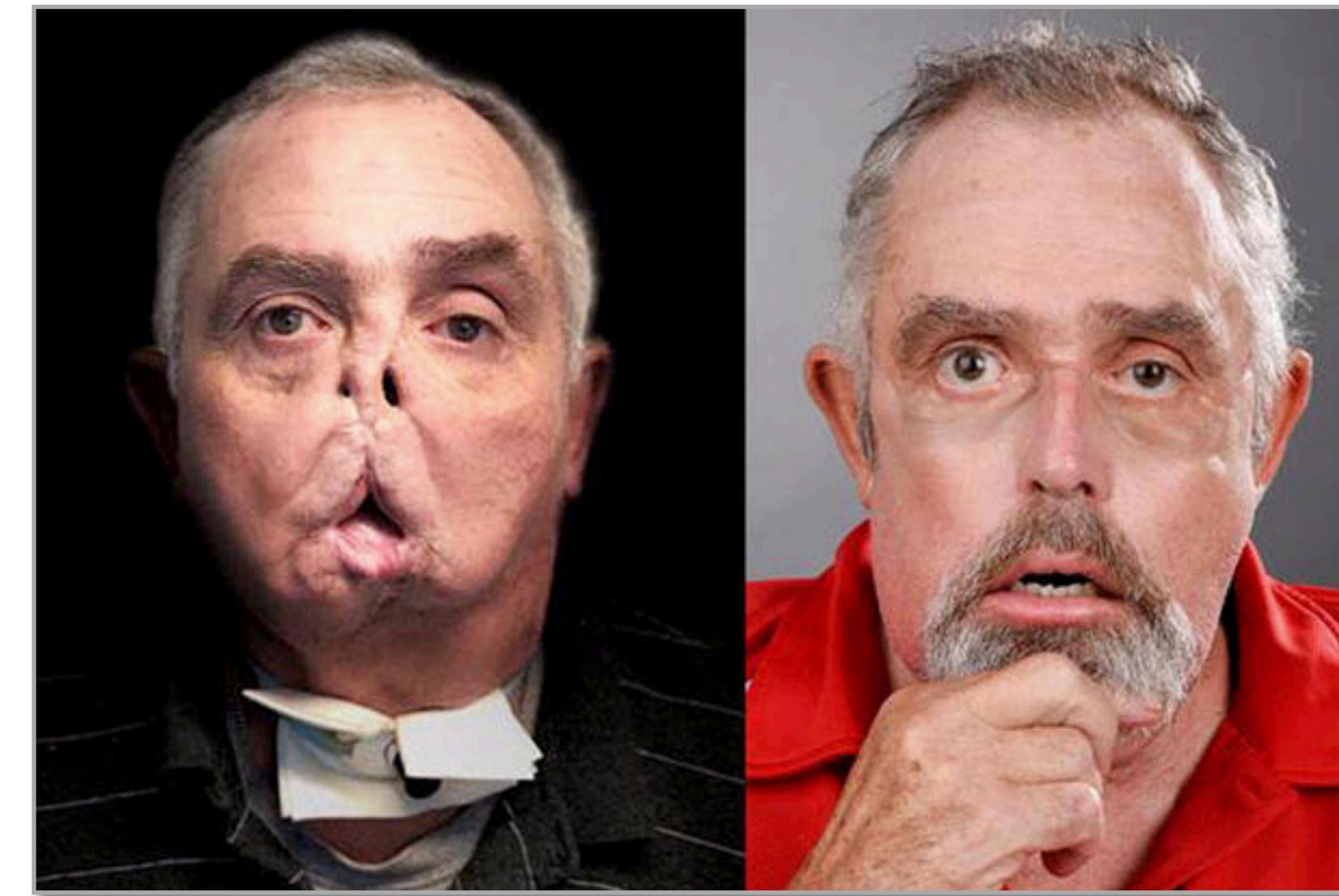
<https://www.smithsonianmag.com/science-nature/adermatoglyphia-the-genetic-disorder-people-born-without-fingerprints-180949338/>

The screenshot shows a magazine page with the header "Smithsonian MAGAZINE" and navigation links for "SUBSCRIBE", "SMARTNEWS", "HISTORY", "SCIENCE", "INGENUITY", "ARTS & CULTURE", and "TRAVEL". The main title is "Adermatoglyphia: The Genetic Disorder Of People Born Without Fingerprints". Below the title is a short text: "The extremely rare disease causes no problems—apart from occasional difficulties with the authorities". A large image shows three fingers with smooth skin on a green textured surface. A caption below the image reads: "The finger pads of a person with adermatoglyphia are entirely smooth. (Photo by Sprecher et. al.)". The author's name, "By Joseph Stromberg", and the date, "JANUARY 14, 2014", are also visible.

Adermatoglyphia



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



Face transplants

Fingerprints, Irises vs. Faces

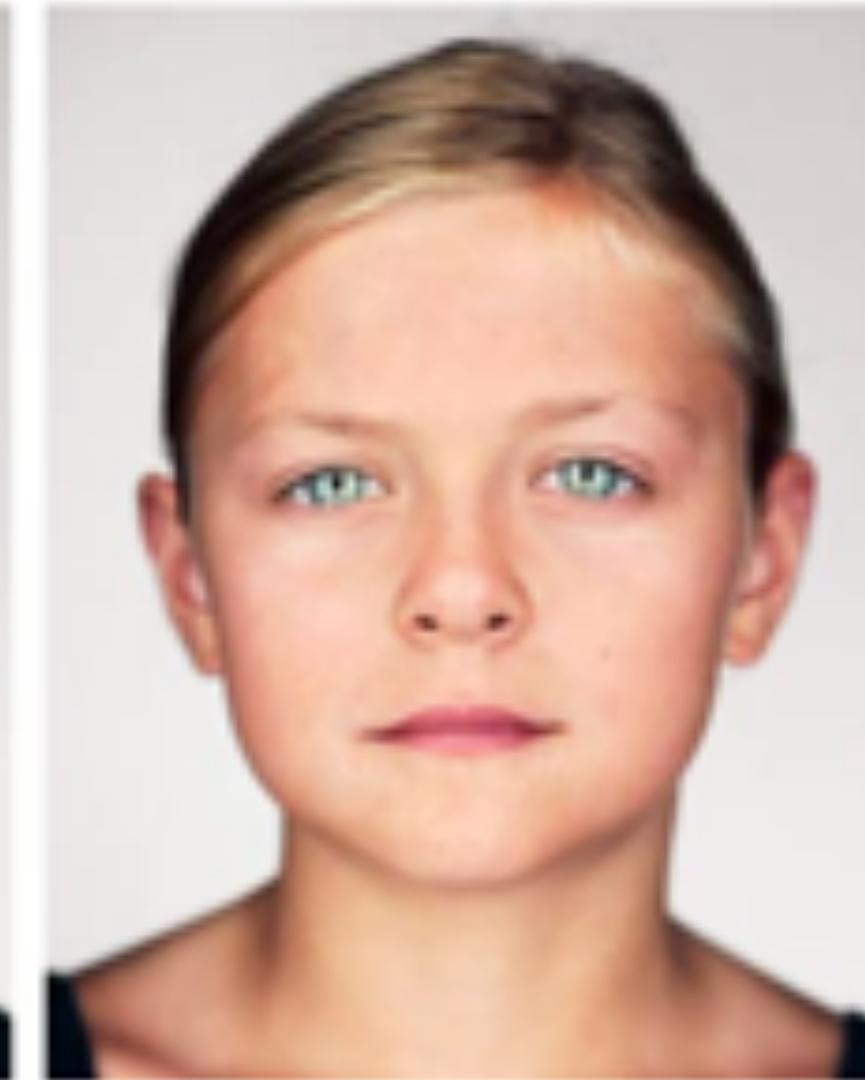
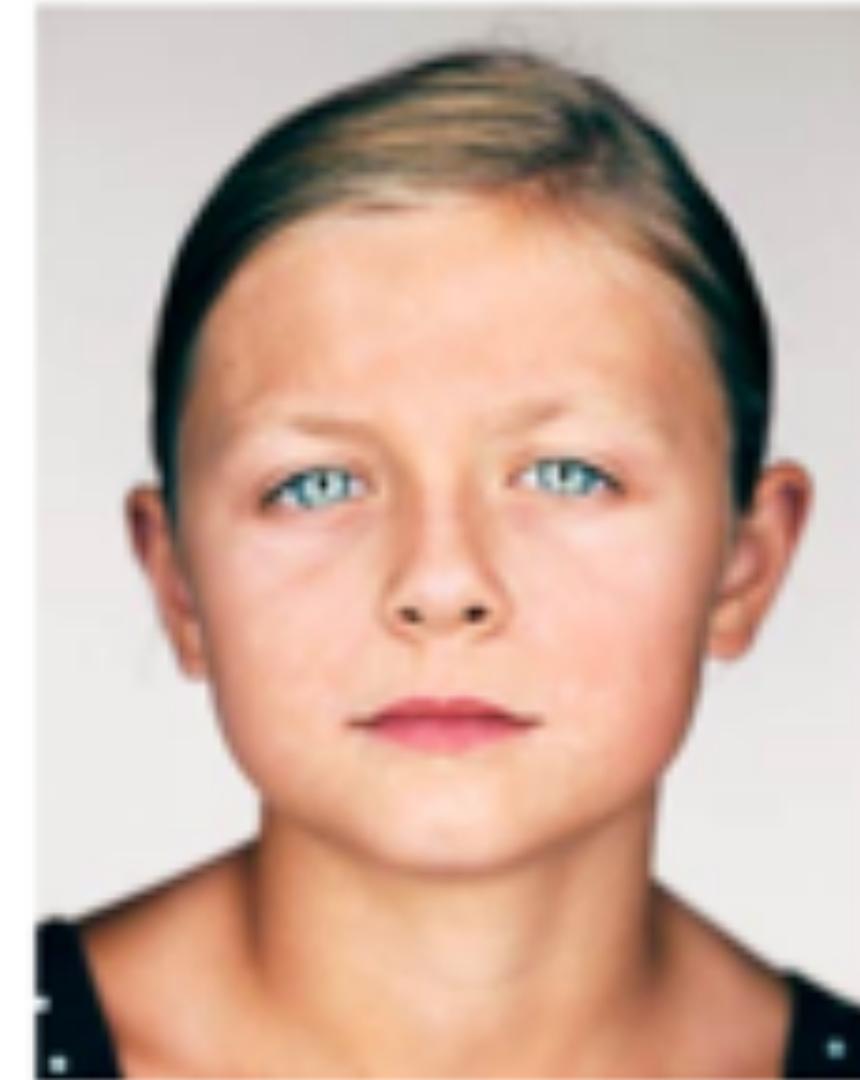
Uniqueness (2/8)

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



Identical Twins?

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Lecture Notes, 2018



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Lecture Notes, 2018



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Source: John Daugman
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/
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slide4.shtml

Mother and daughter.



Source: John Daugman
Lecture Notes, 2018

Unrelated.



Completely
unrelated
subjects.



Source: John Daugman
Lecture Notes, 2018



Fingerprints, Irises vs. Faces

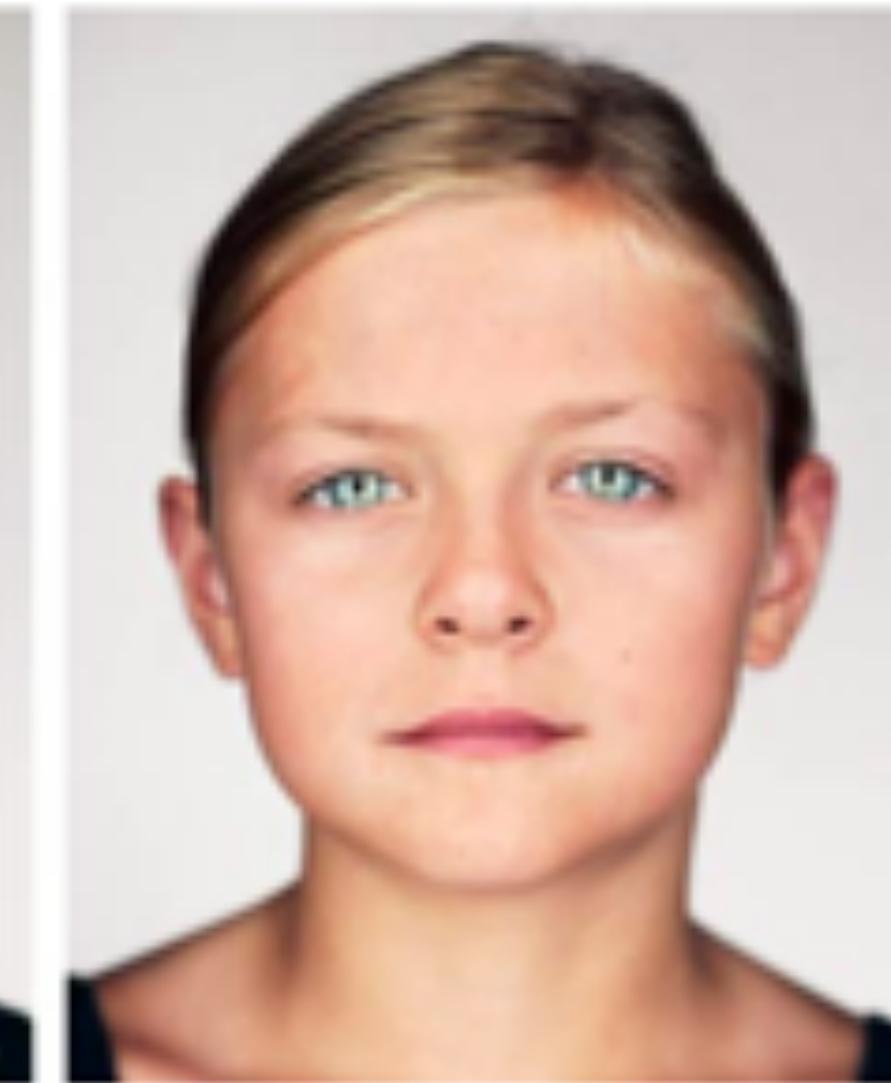
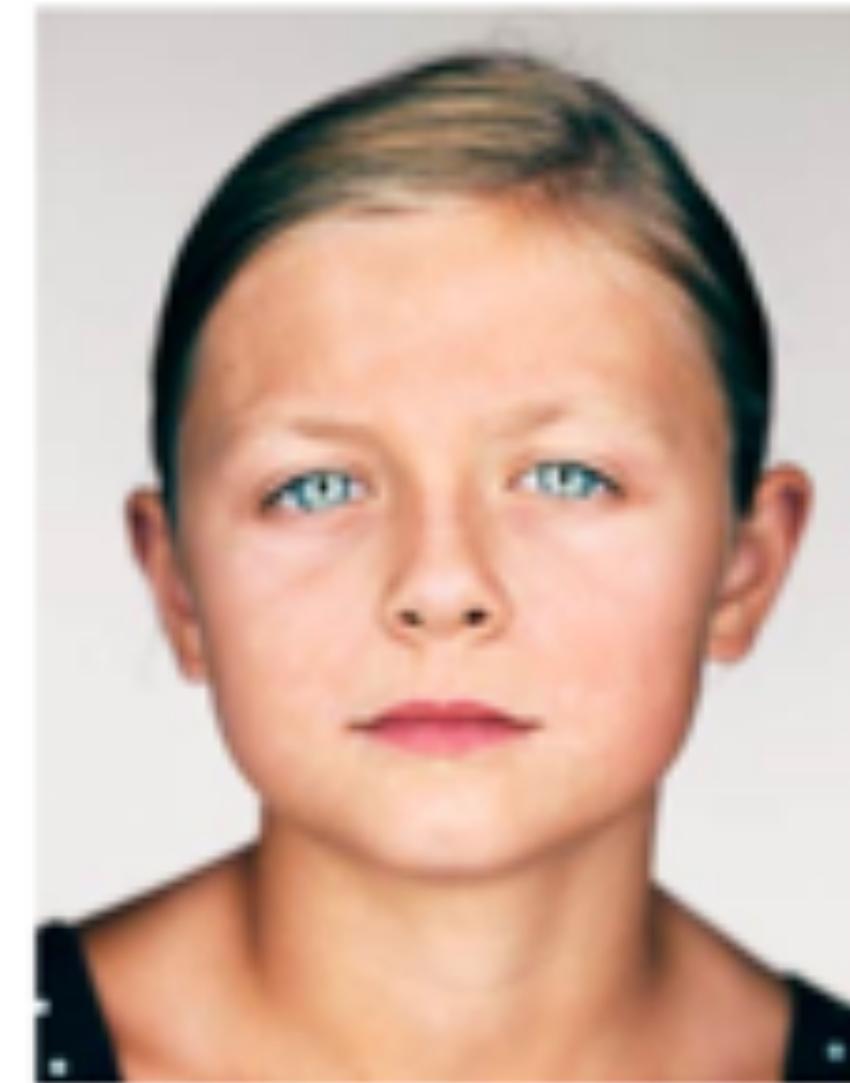
Uniqueness (2/8)

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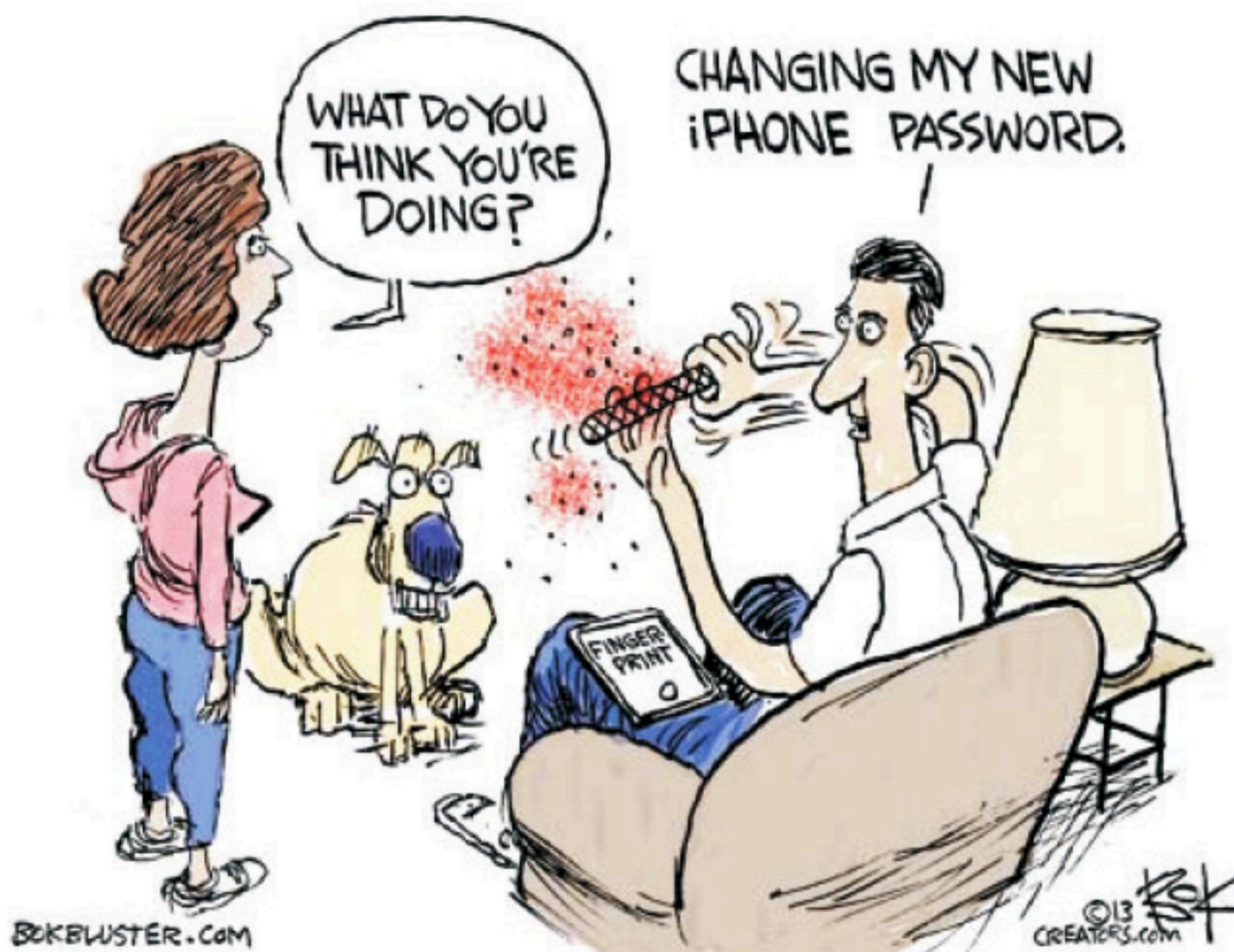


Identical twins.

Fingerprints, Irises vs. Faces

Permanence (3/8)

How easily does the trait change?



You cannot easily change your fingerprints.



But your face **will** change.

Fingerprints, Irises 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, Irises vs. Faces

Permanence (3/8)

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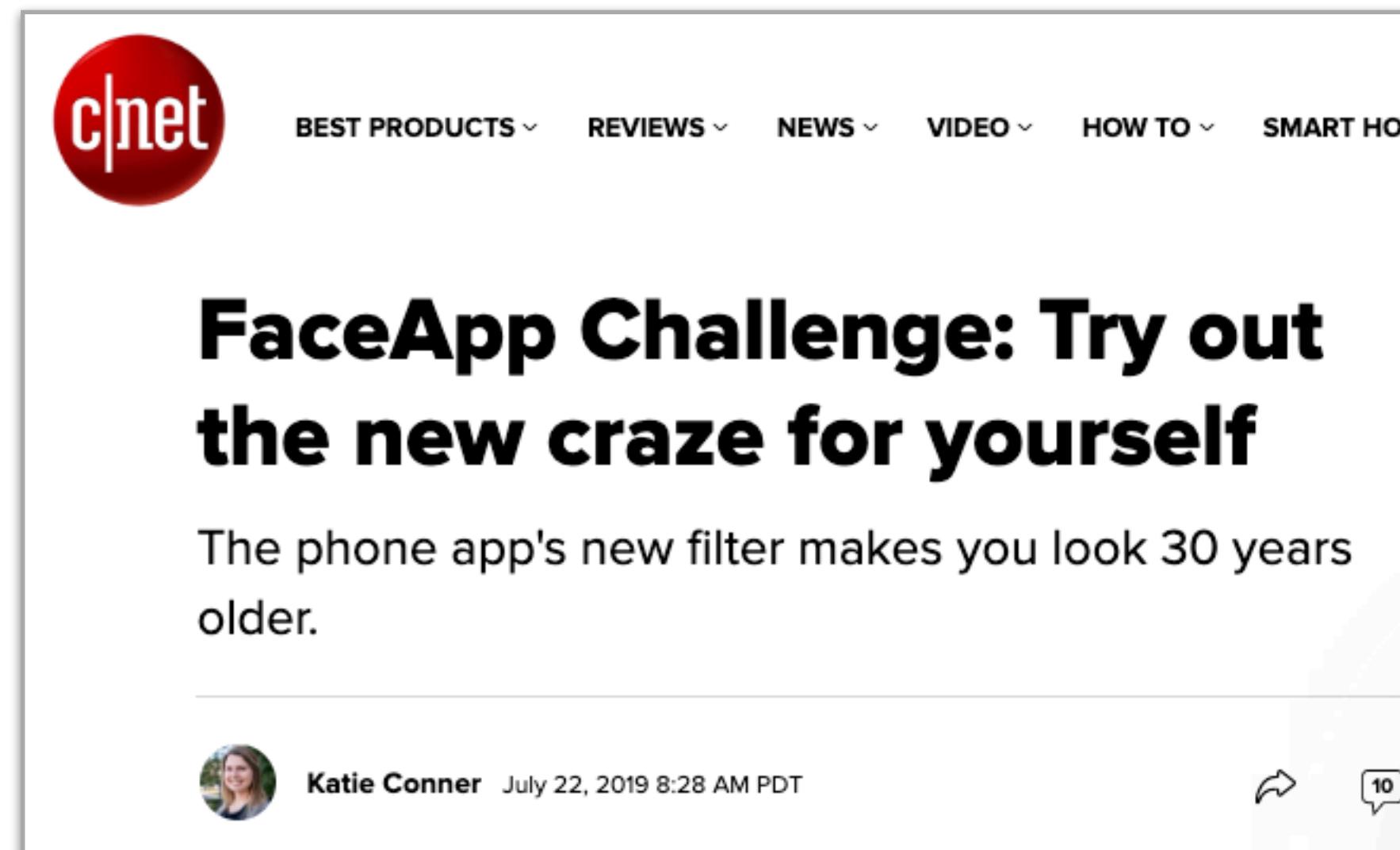
Fingerprints, Irises vs. Faces

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 and a comment count of "10".



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

Fingerprints, Irises 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, Irises vs. Faces

Permanence (3/8)

How easily does the trait change?

Deliberate Changes



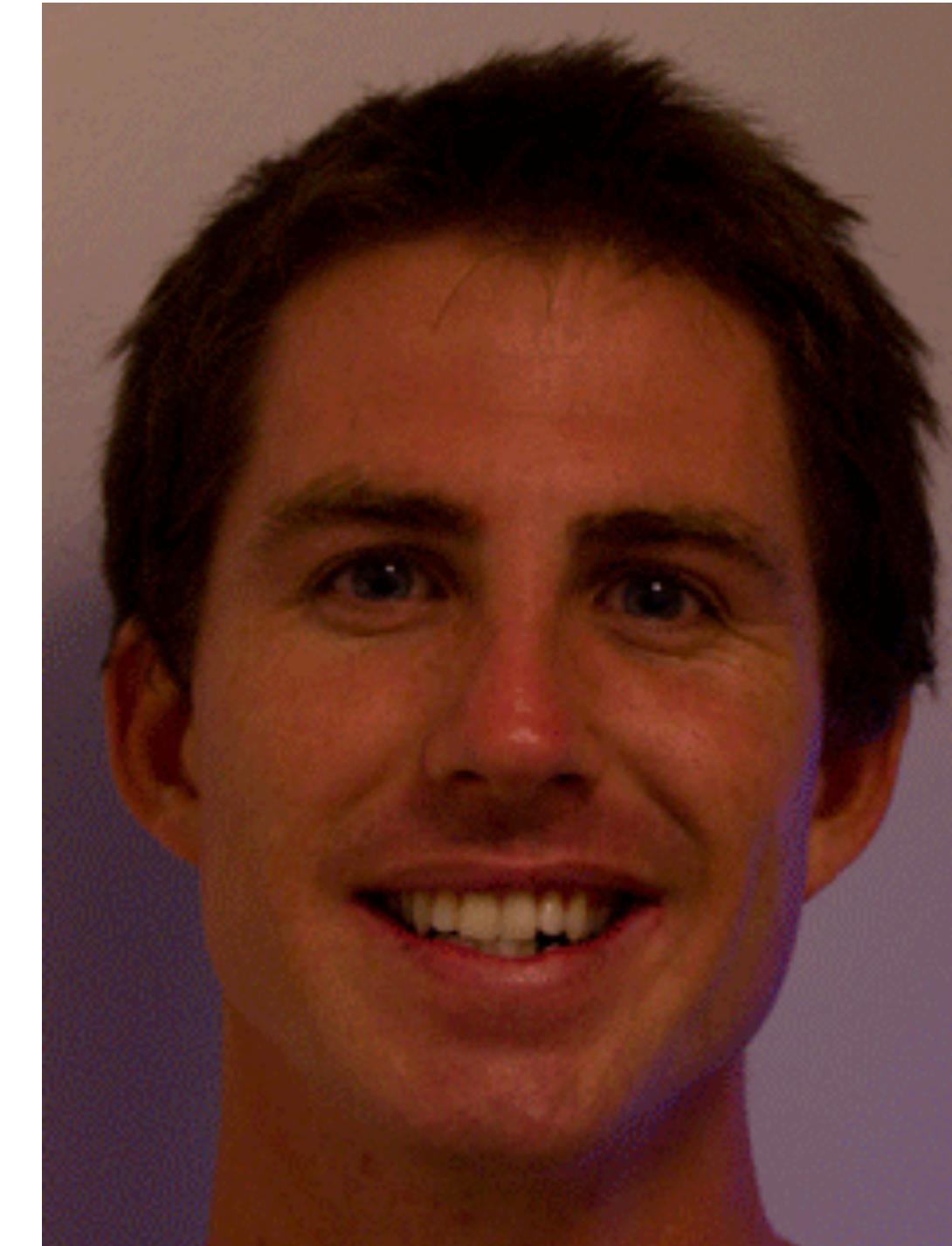
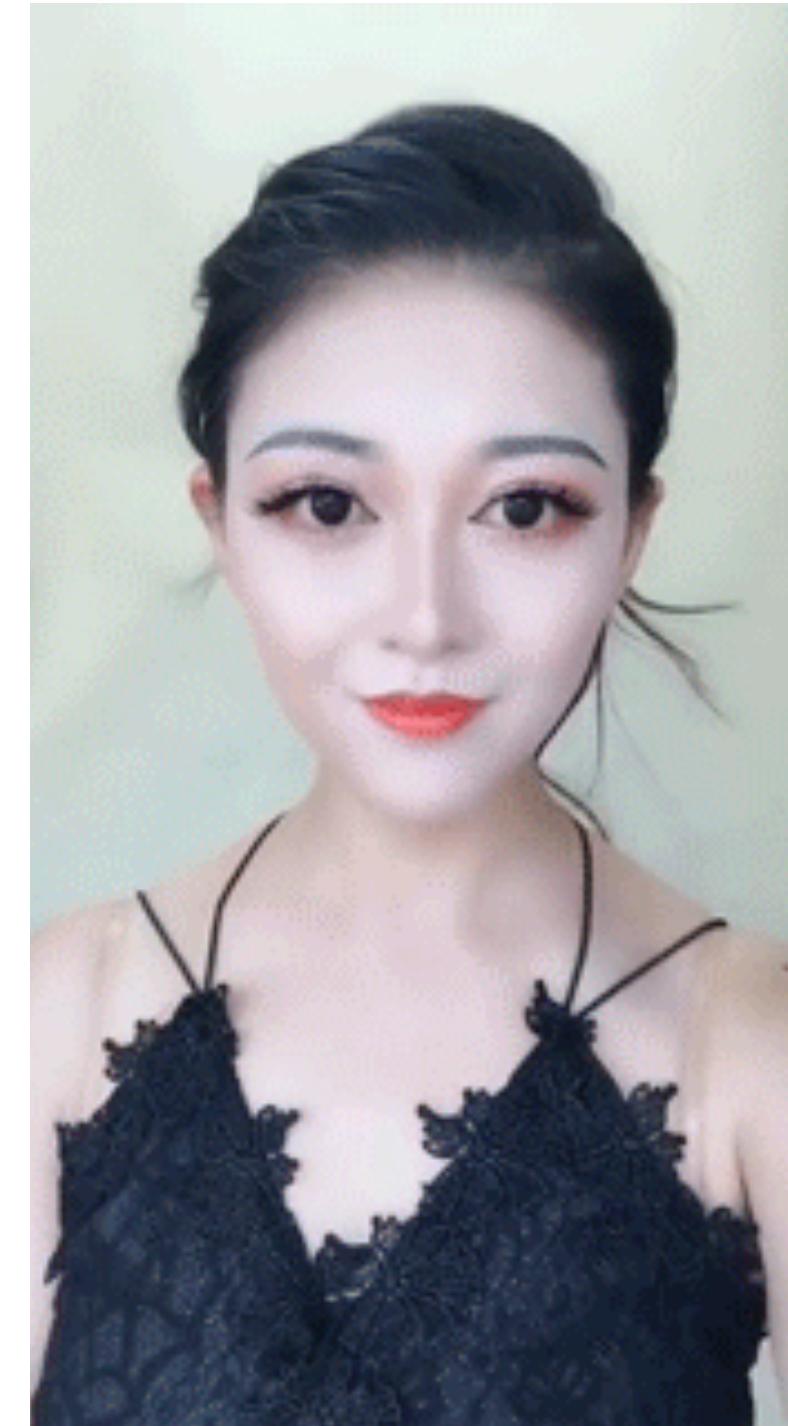
Fingerprints, Irises vs. Faces

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)

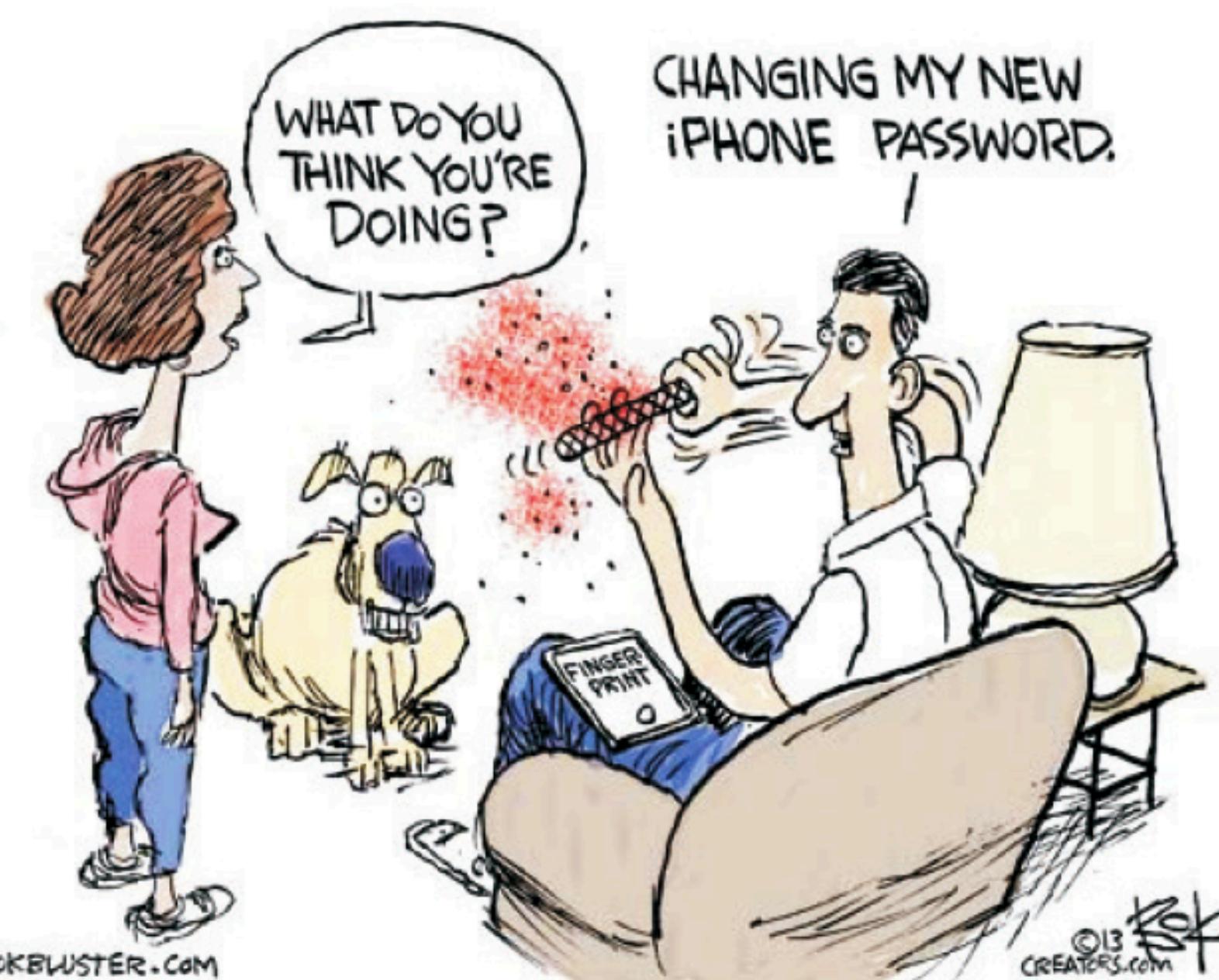




Fingerprints, Irises vs. Faces

Permanence (3/8)

How easily does the trait change?



You cannot easily change your fingerprints.

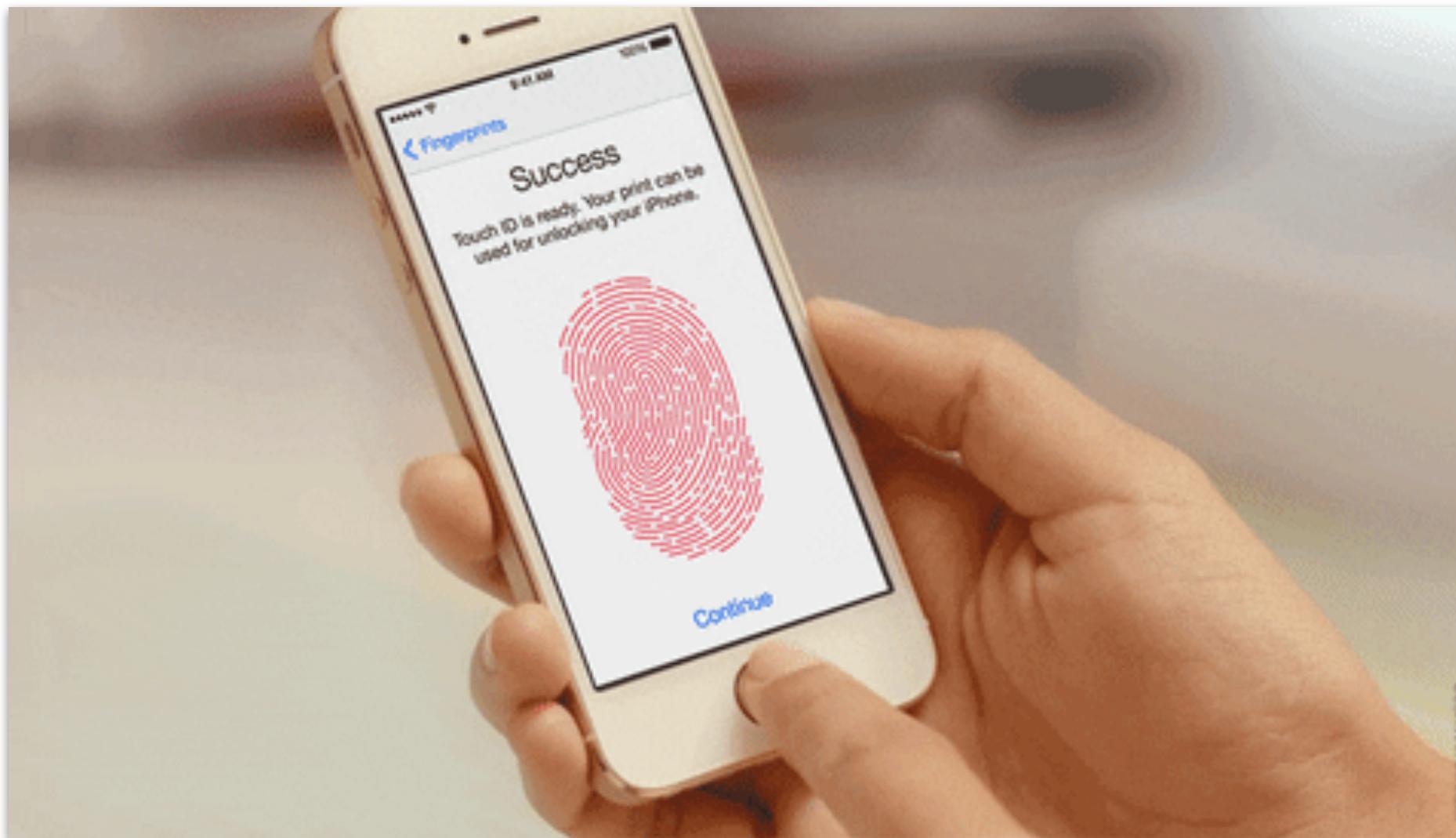


But your face **will** change.

Fingerprints, Irises vs. Faces

Measurability (4/8)

How easy is it to acquire and digitize the trait?



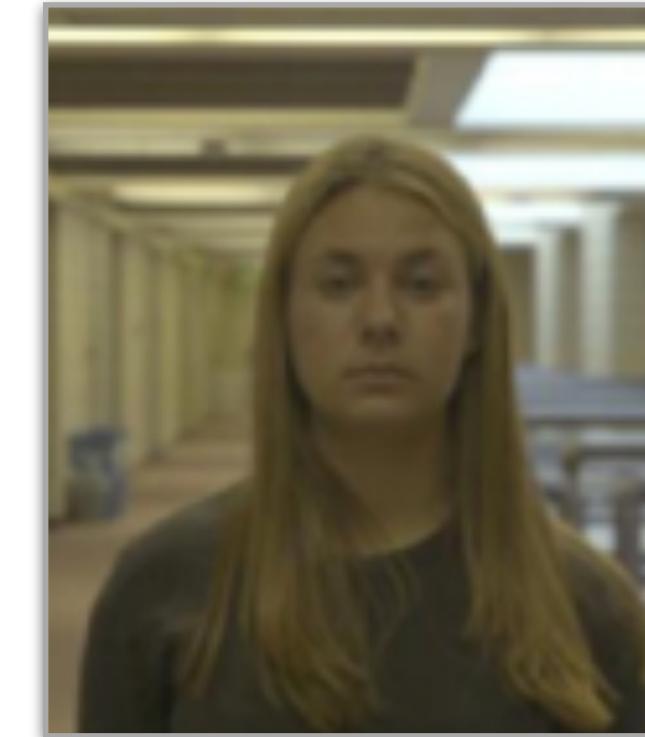
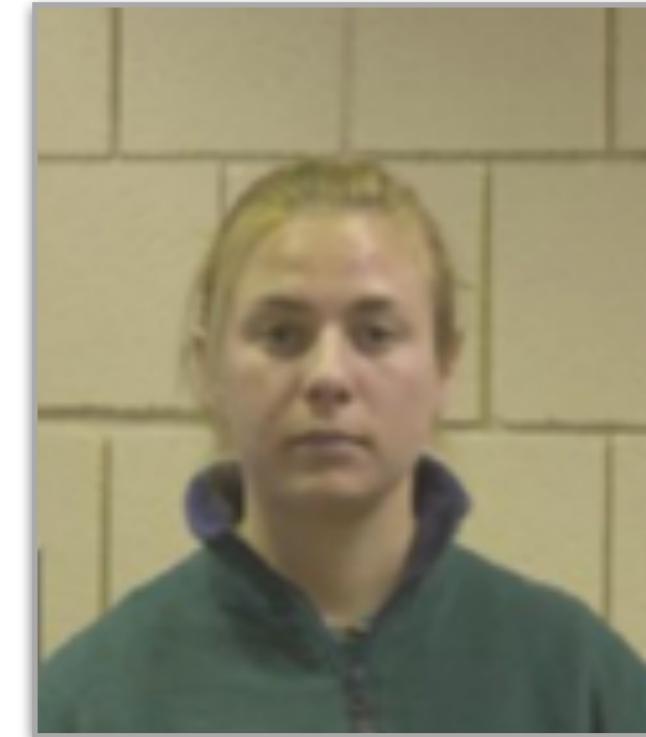
<https://www.youtube.com/watch?v=uQHqZNyXoBQ>

Fingerprints, Irises 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, Irises 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, Irises 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, Irises vs. Faces

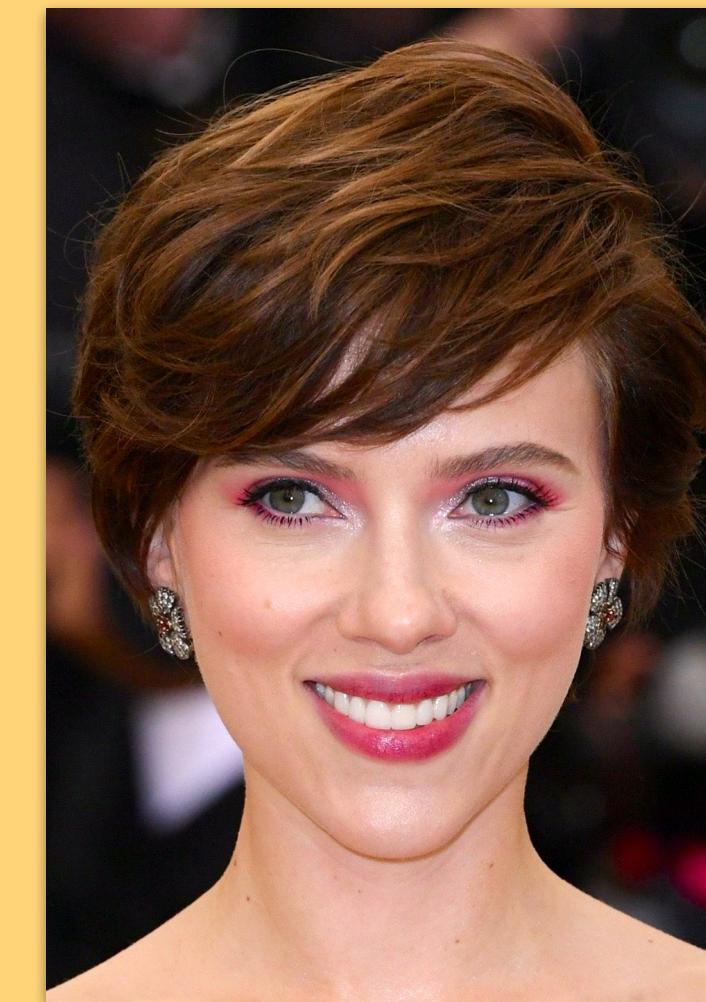
Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns



Robert
Downey Jr.



Scarlet
Johansson

Fingerprints, Irises 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, Irises 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, Irises vs. Faces

Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns

Which trait helps to recognize Scarlet quicker?



Latent Fingerprint



“Latent Face”

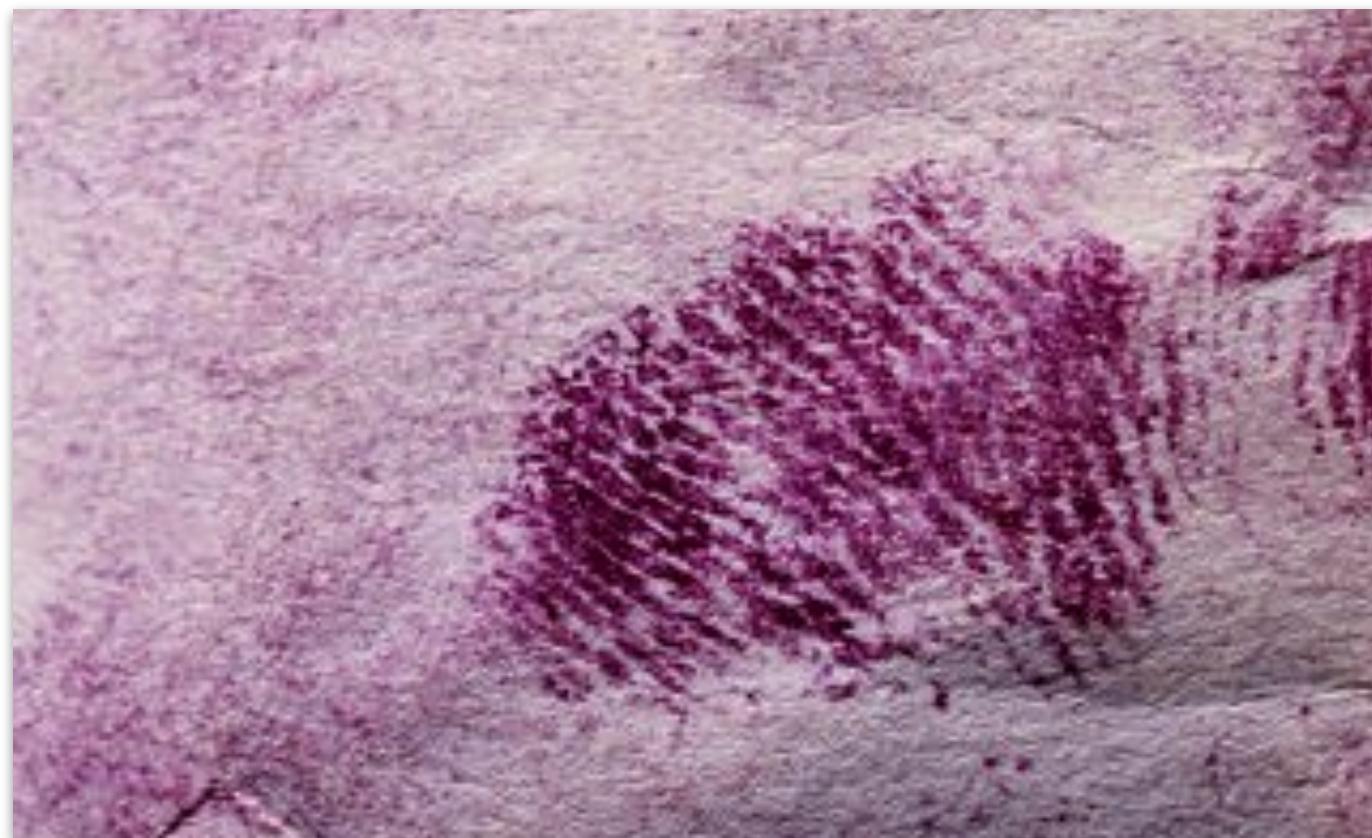
Fingerprints, Irises vs. Faces

Acceptability (5/8)

Will individuals collaborate during data collection?

Privacy Concerns

Which trait favors **covert deployment**?



Latent Fingerprint



“Latent Face”

Fingerprints, Irises vs. Faces



Circumvention (6/8)

How easy can the trait be forged or imitated?



<https://www.youtube.com/watch?v=KdycMYILT0>

We are not there yet!

Fingerprints, Irises 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, Irises vs. Faces

Circumvention (6/8)

How easy can the trait be forged or imitated?

Attacks

Presentation Attack.



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

Fingerprints, Irises 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, Irises vs. Faces



Performance (8/8)

How good is the trait quantitatively according to objective metrics?

Face Recognition Improvement

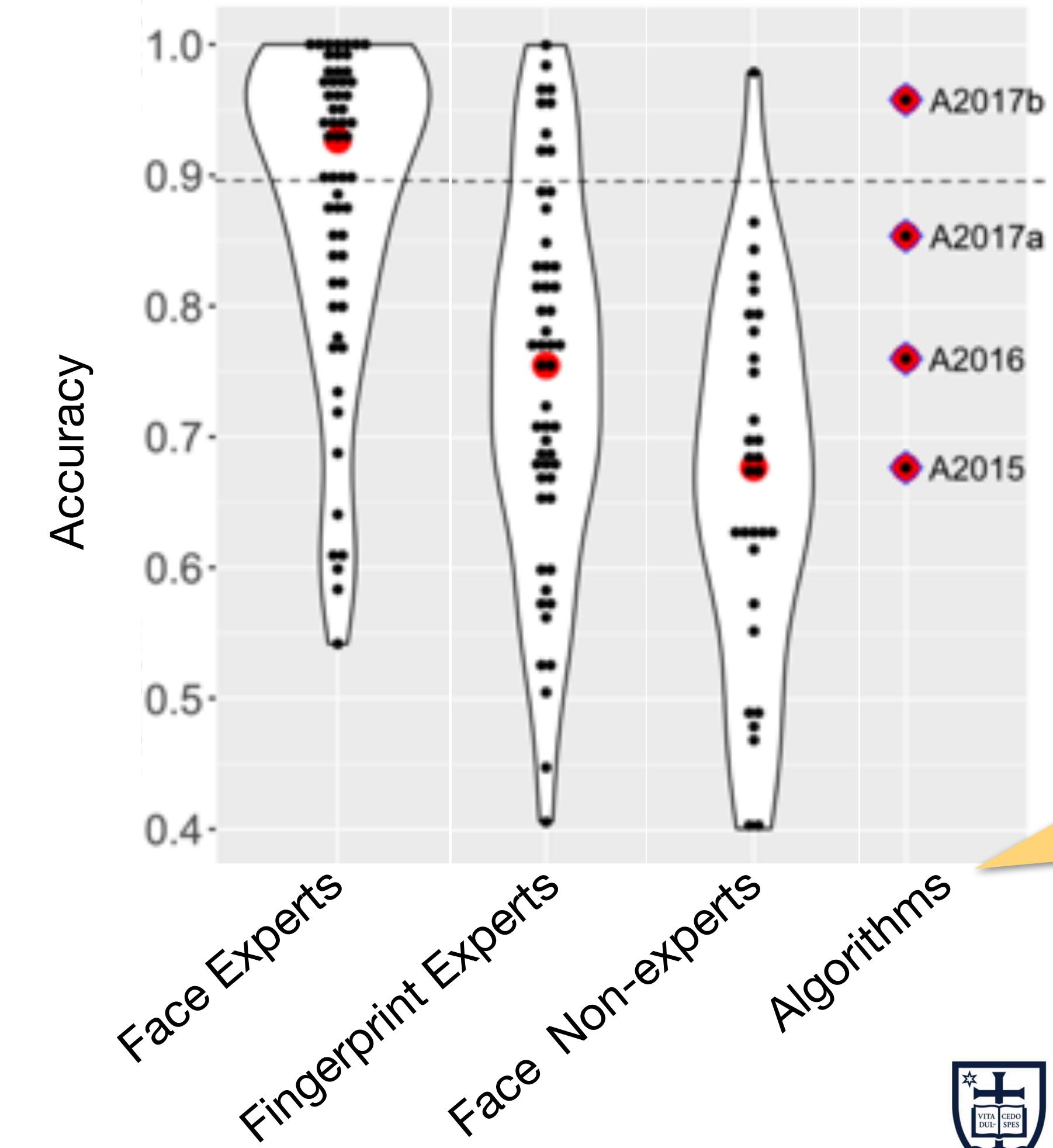
Methods are improving quickly.
Benefits from deep learning.

Publication

Phillips et al.

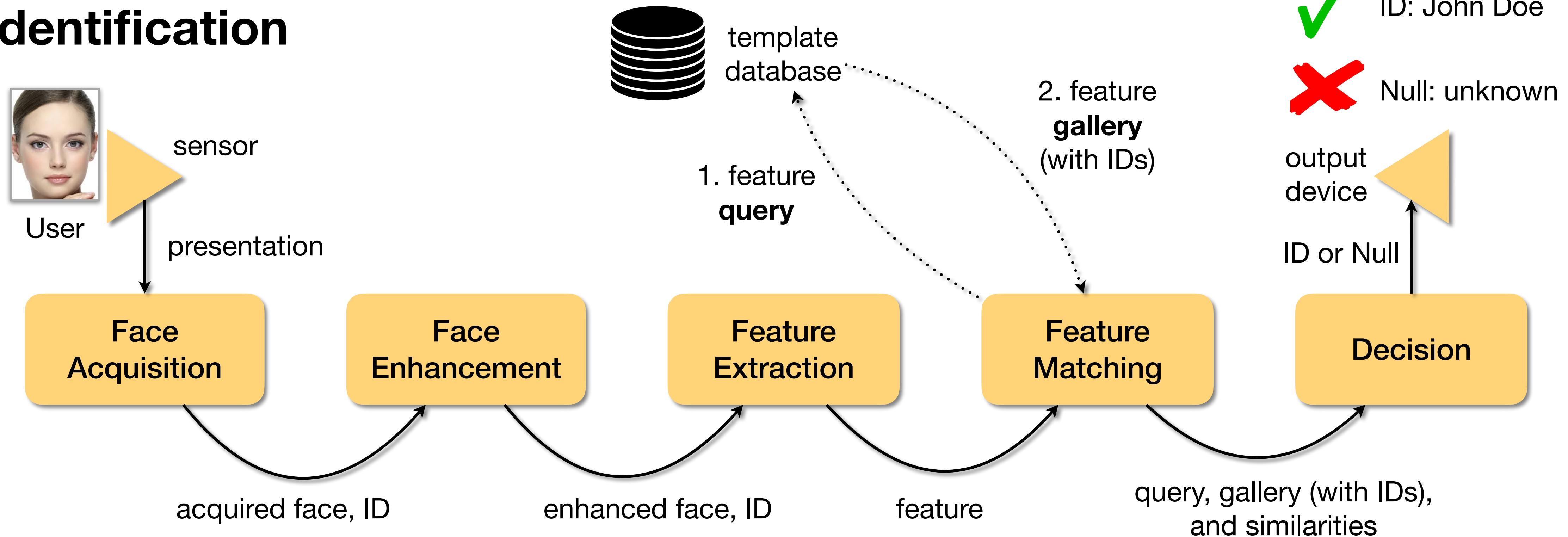
Face recognition accuracy of forensic examiners, superrecognizers, and face recognition algorithms.

PNAS, 2018



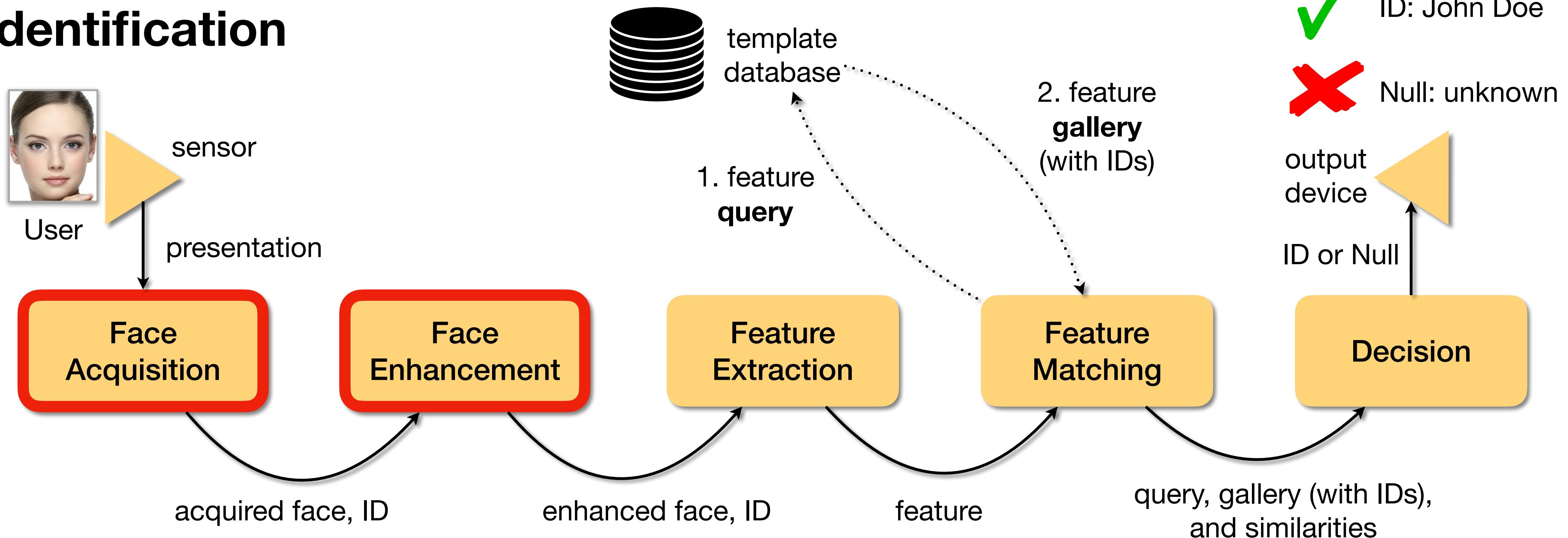
Face Recognition

Identification



Face Recognition

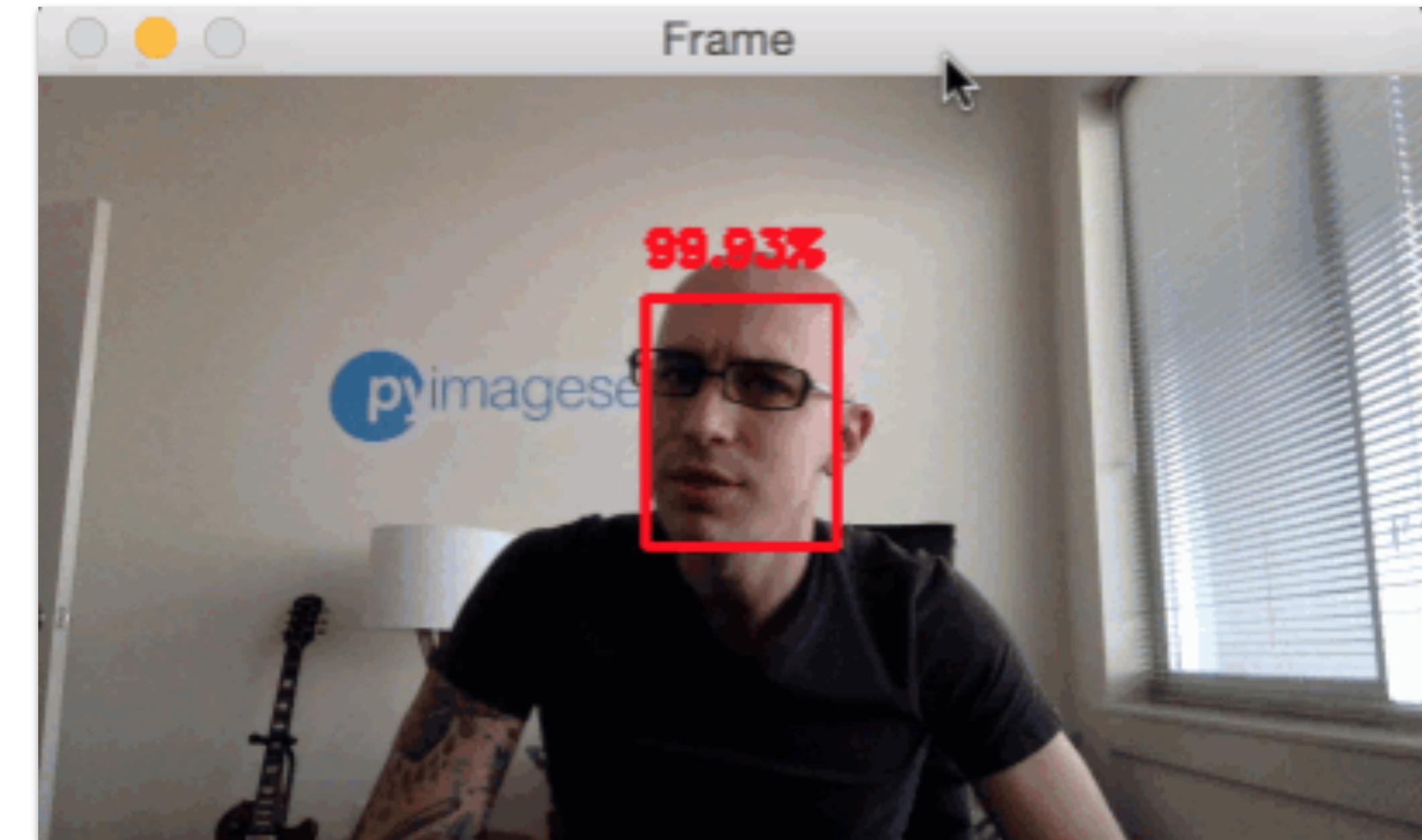
Identification



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>