

Biometrics: Q & A

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Biometric Winter School, Shenzhen

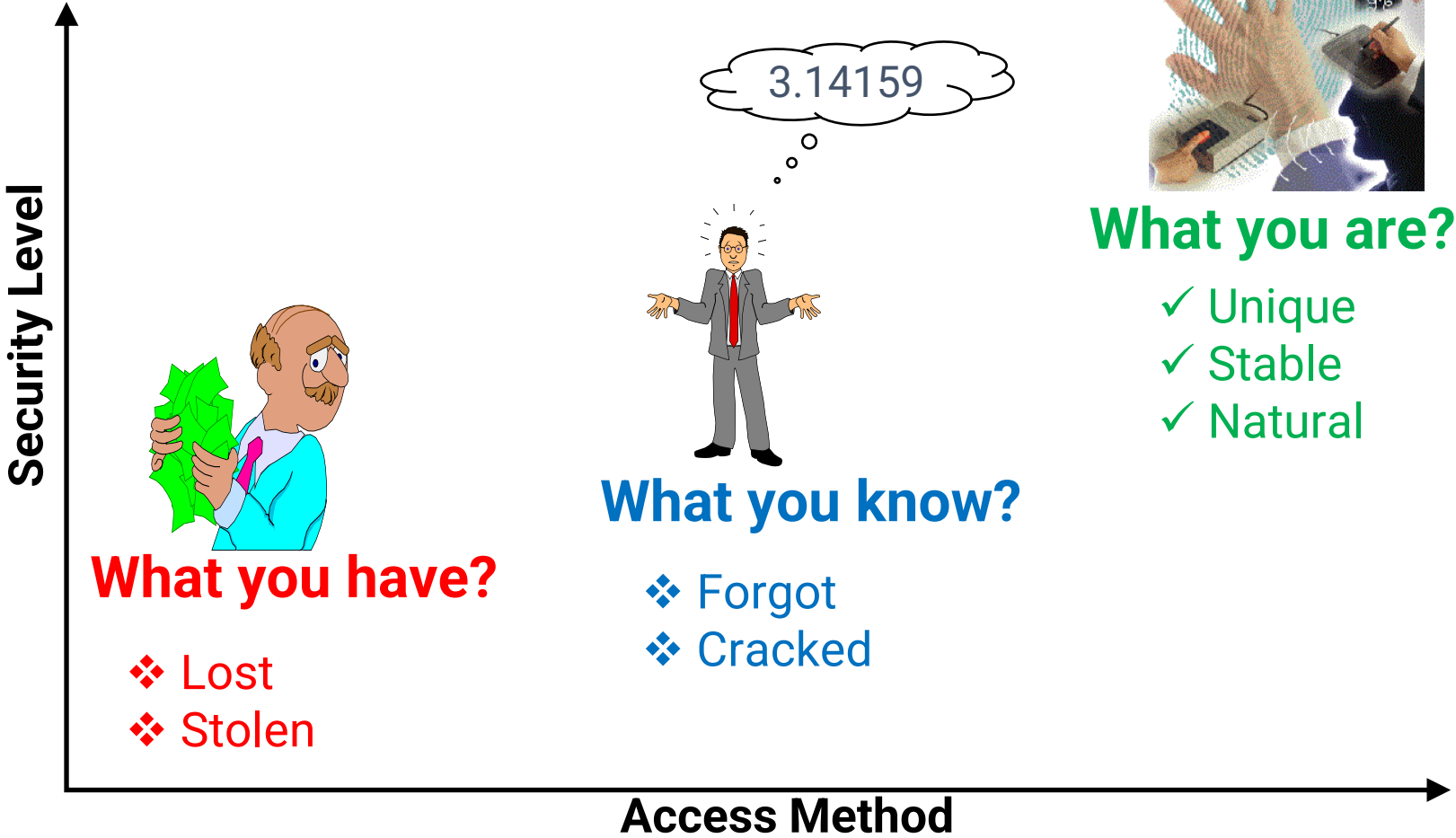
January 10, 2022

What is Biometrics?

- ISO/IEC JTC1 2382-37 (2012): Automated recognition of individuals based on their behavioral and biological characteristics



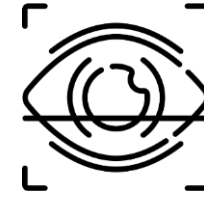
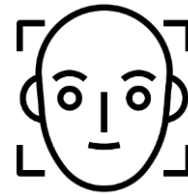
Why Biometrics?



Applications: Border security, access control, civil registration, healthcare, social benefits, banking



Most Popular Biometric Traits



Incheon, South Korea: Smart Entry



Australia: SmartGate



Amsterdam: Privium border passage

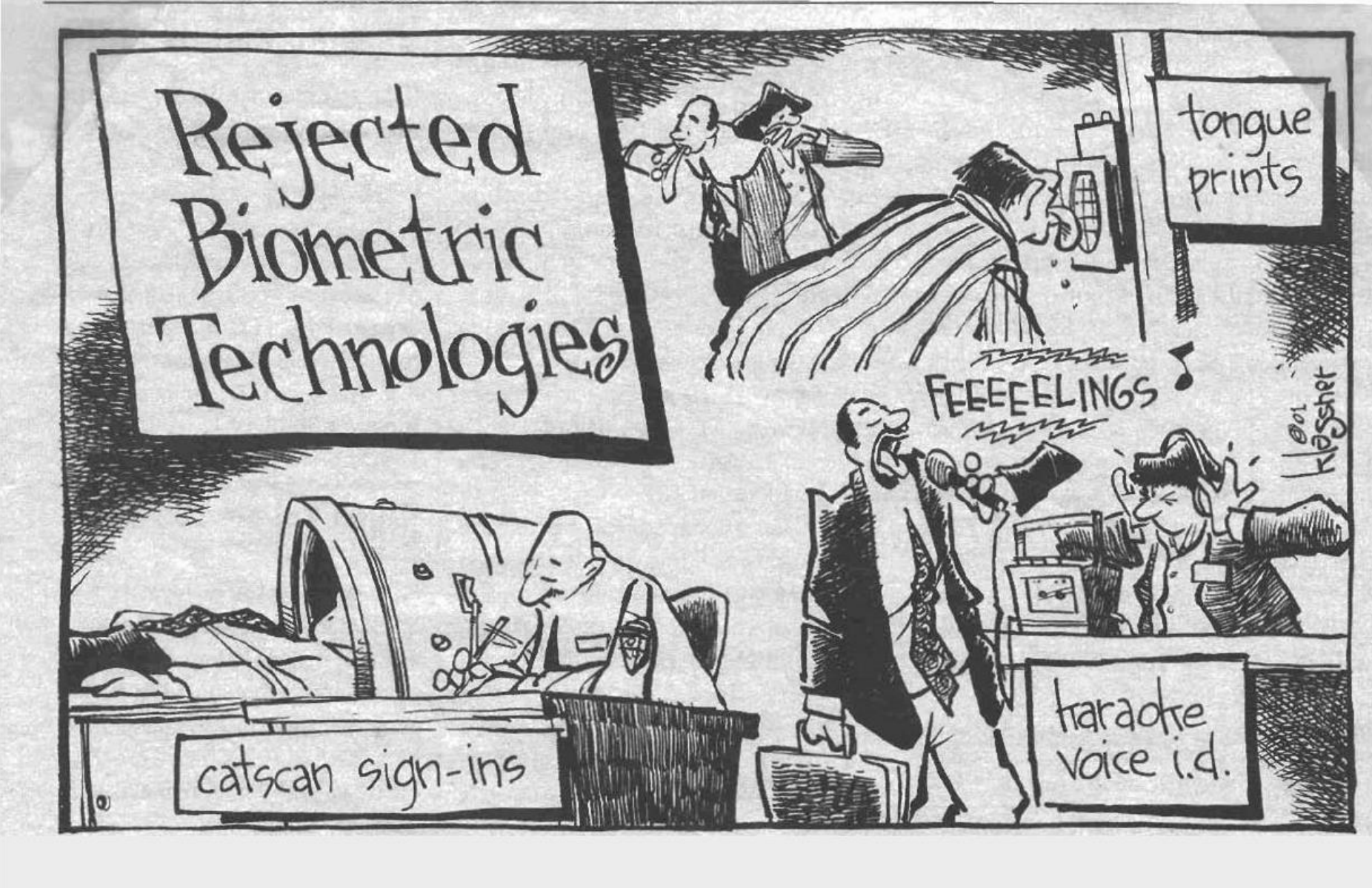
**Satisfy individuality and permanence; show high accuracy in NIST evaluations;
enable fast search (1:N) of large legacy databases**

Amazon One (Palm Print & Vein)



<https://www.theverge.com/2020/10/1/21496673/amazon-one-palm-reading-vein-recognition-payments-identity-verification>

Rejected Traits

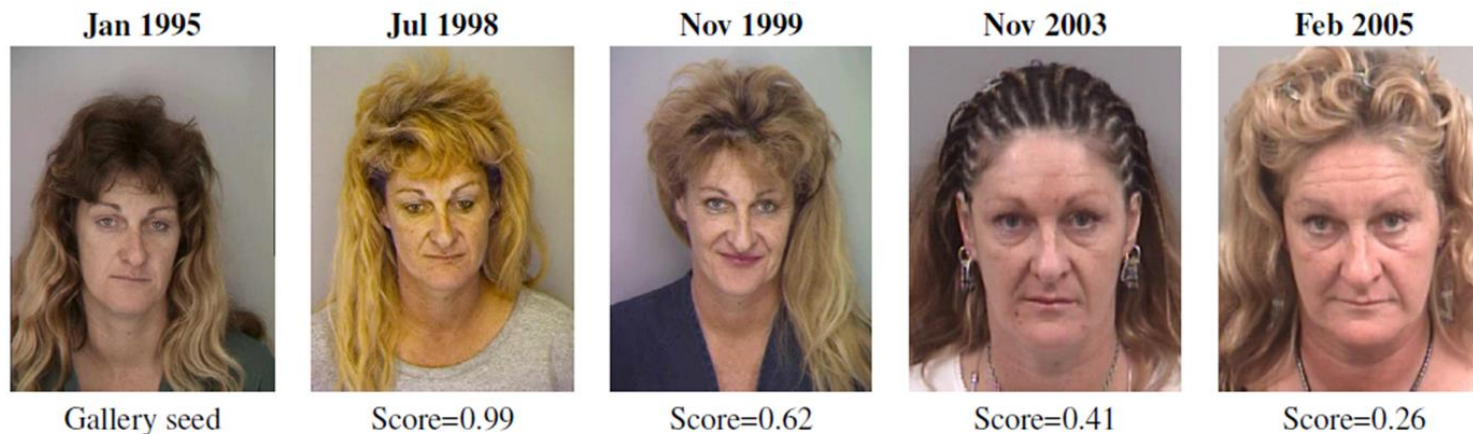


Fundamental Premise of Biometrics

- **Individuality:** Different individuals have different biometric feature values (templates/embeddings)

Large intra-person similarity & small inter-person similarity

- **Permanence:** Biometric recognition accuracy does not change over time



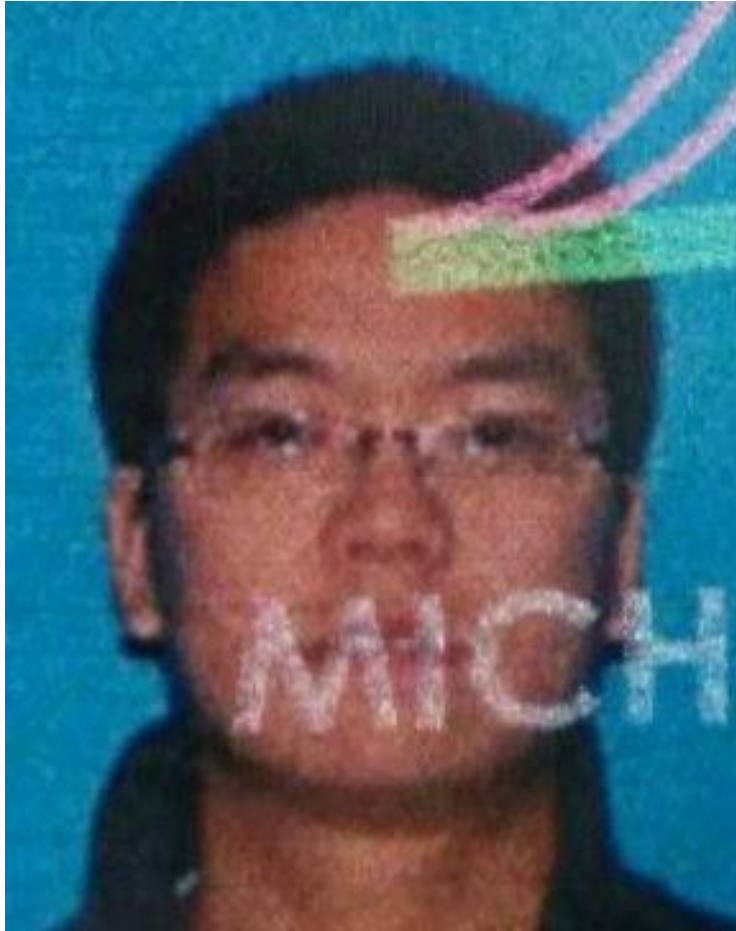
Intra-person similarity



<http://www.theguardian.com/theguardian/2010/dec/05/barack-obama-doppelganger-ilham-anas>

Inter-person similarity

Representation & Similarity



Probe

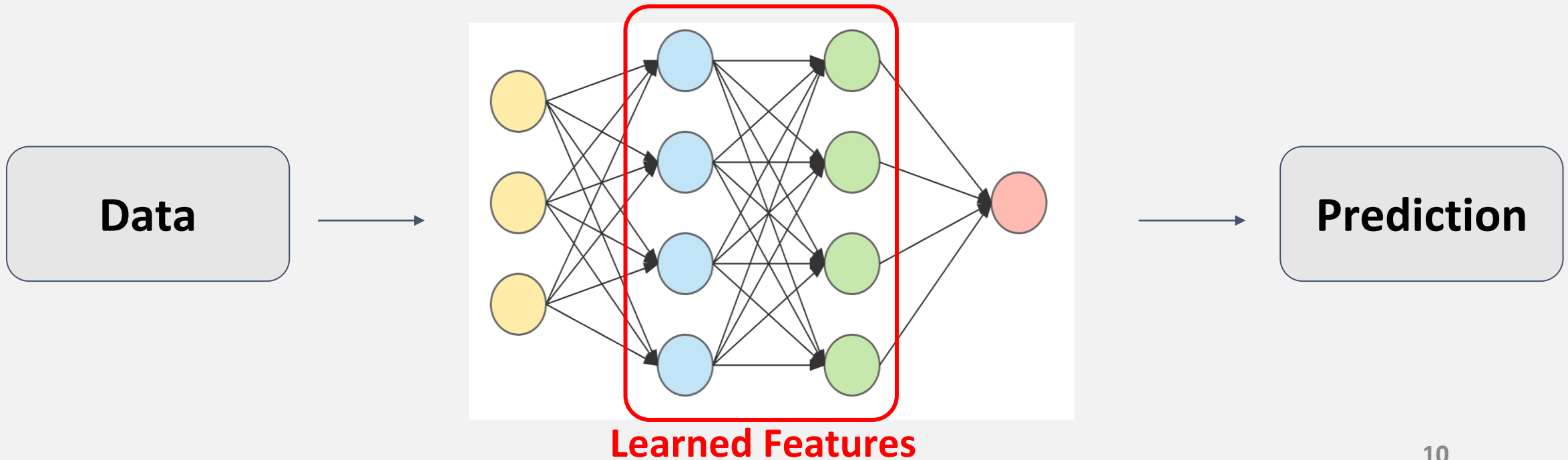
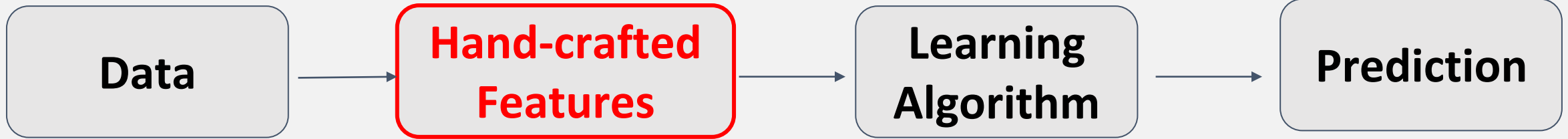
0.69 (ArcFace)



Gallery

Do these two face images belong to the same person?

Hand-crafted vs. Learned Representation

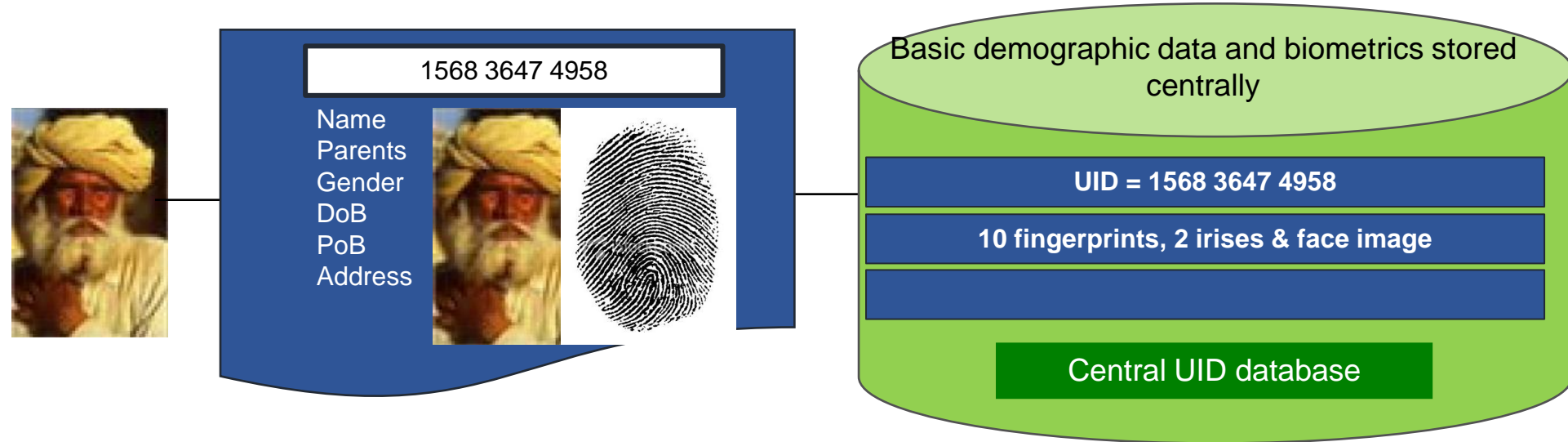


Application Requirements

- Accuracy
- Throughput (speed)
- Robustness
- Security
- Match on server vs. match on card
- Trust
- Usability
- Ease of integration in the overall solution
- Return on investment (RoI)

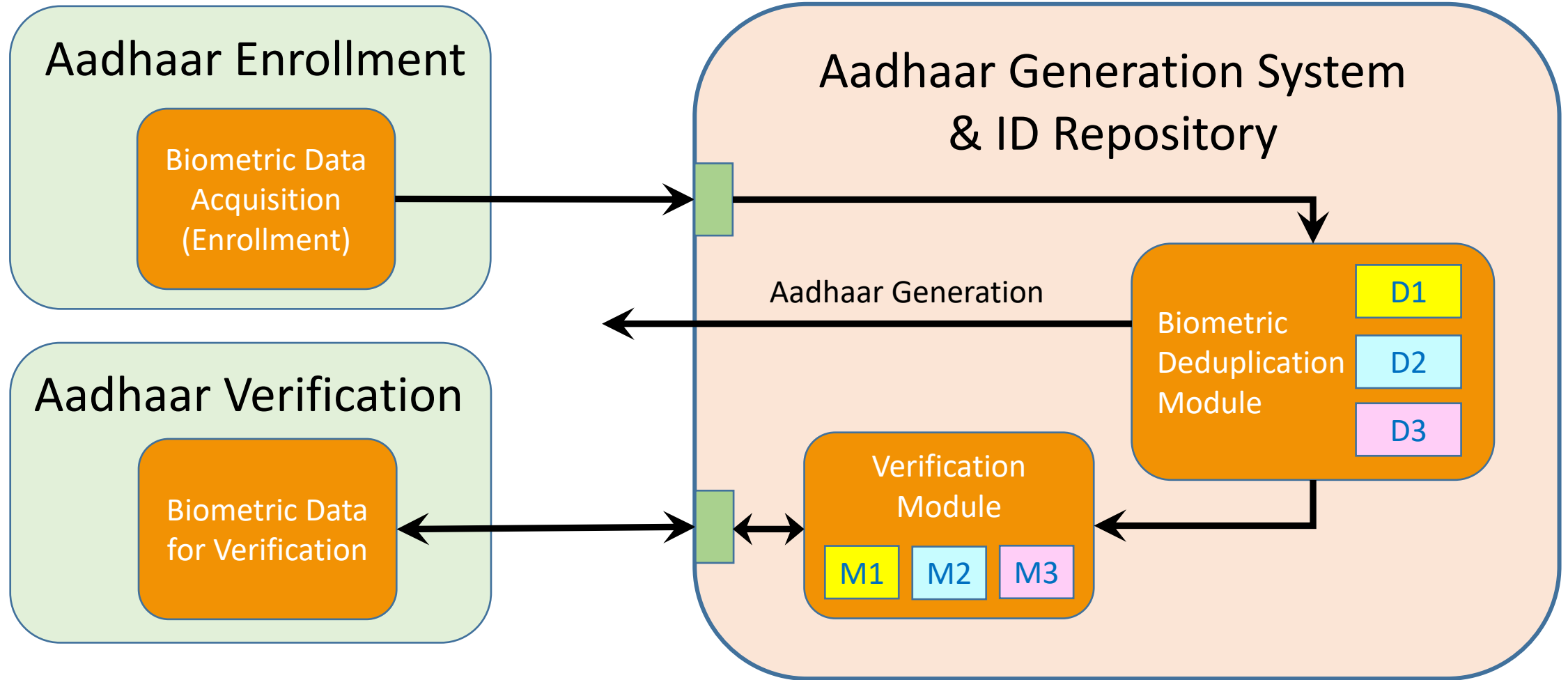
Fingerprint module in a mobile phone costs about \$1

Aadhaar: World's Largest Biometric System



- “To empower residents of India with a unique identity and a digital platform to authenticate anytime, anywhere.”
- The only output to an authentication query is “YES” or “NO”
- Over 1.3 “distinct” billion people have been enrolled since 2009

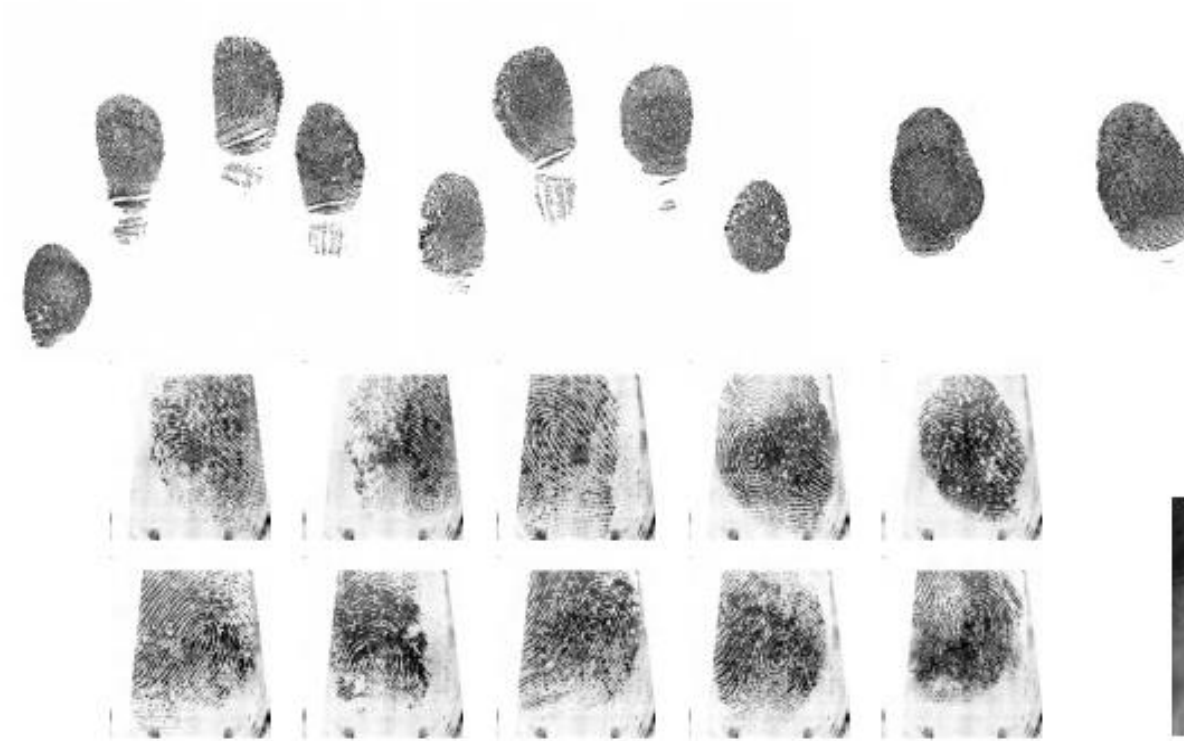
Aadhaar Biometric Modules



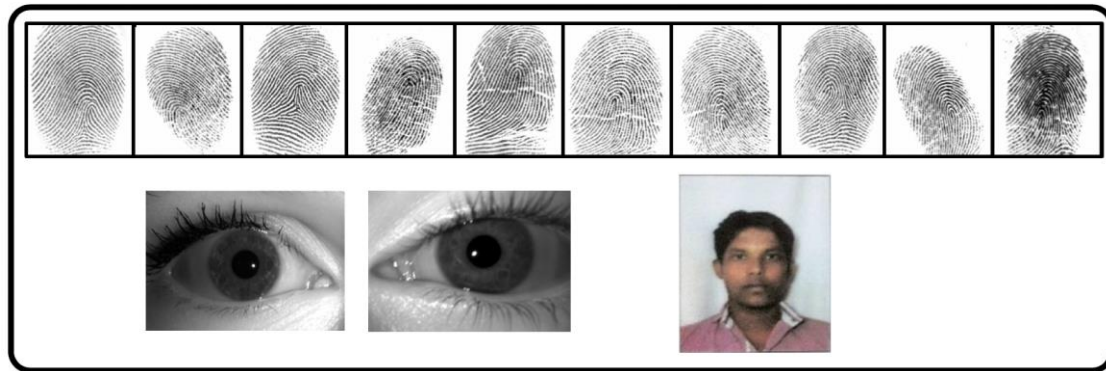
Enrollment



**Minimal documentation
(metadata) for enrollent**



De-duplication (Search for duplicates)



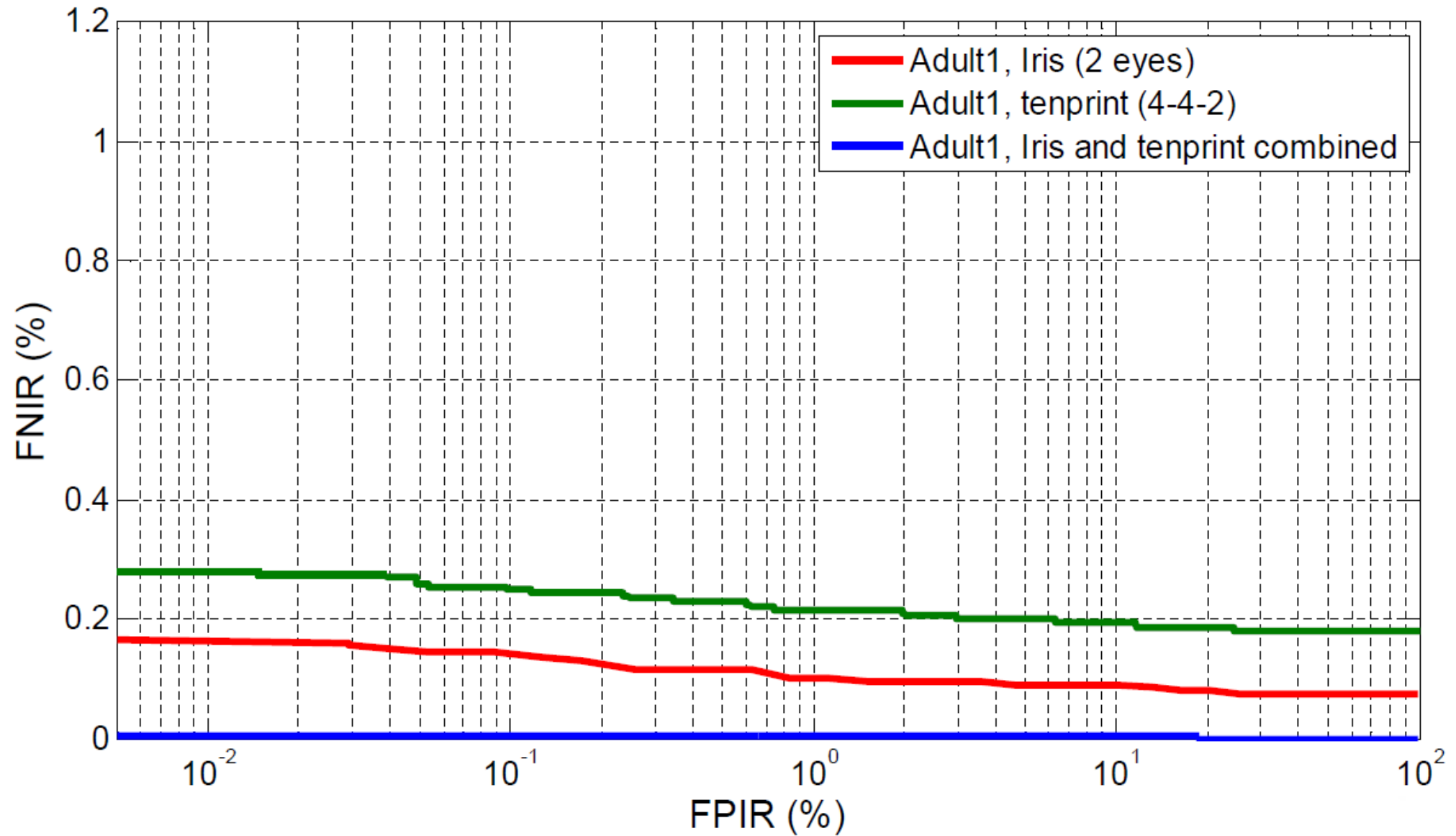
New Applicant

Fusion of face, fingerprint and iris to improve de-duplication



Already Exists in the Database?

Biometric Fusion for De-duplication



Authentication



Authentications in Nov 2021 alone = 1.5 billion (~50 million/day)

System Errors

- Failure to acquire (FTA)
- Failure to Enroll (FTE)
- Authentication
 - False Match Rate (FMR)
 - False Nonmatch Rate (FNMR)
 - Equal Error Rate (EER)
 - Receiver Operating Characteristics (ROC) curve
- Search
 - Open set: FPIR, FNIR
 - Closed set: Cumulative Match Characteristic (CMC) curve

Sources of error: user-reader interaction, trait quality, occlusion, environmental condition

Face Image Quality vs. Recog. Performance



LFW (2009)



YTF (2012)

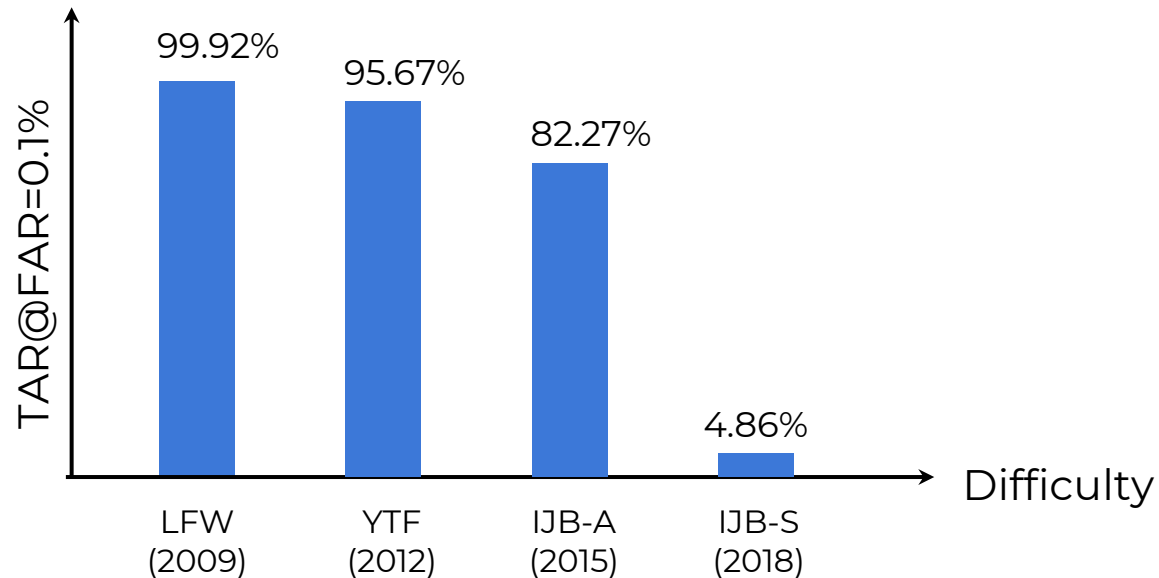


NIST IJB-A (2015)



NIST IJB-S (2018)

Frame-to-Frame Verification



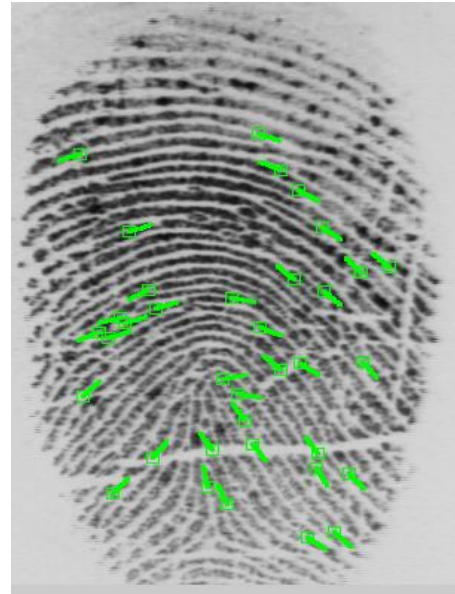
Template Identification

	Gallery Size	Rank1	Rank5
IJB-A	112	97.5	98.4
IJB-S (S2B)	202	62.0	67.1

Fingerprint Image Quality



No. of false minutiae = 0



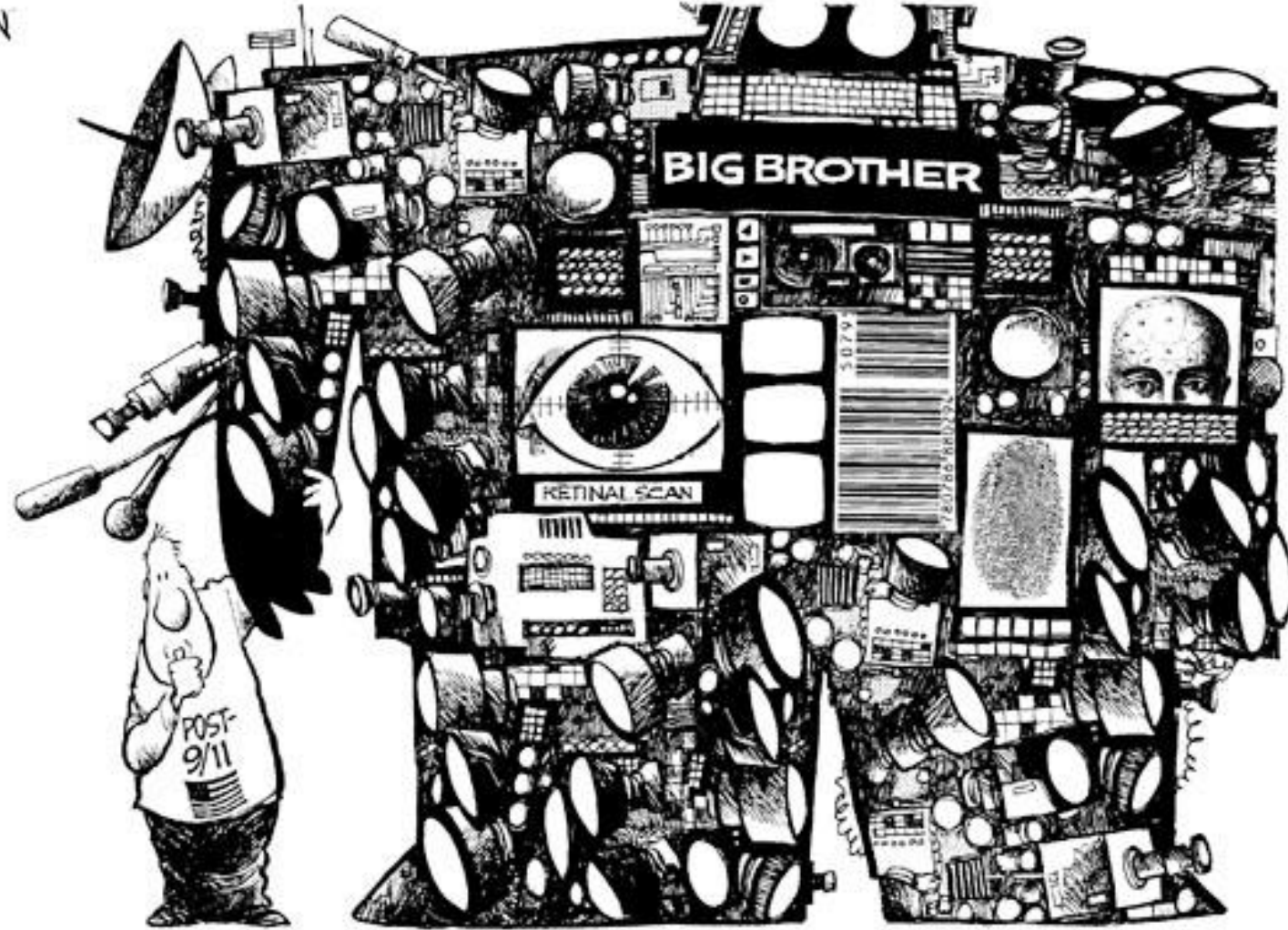
No. of false minutiae = 7



No. of false minutiae = 27

Trust

JIM BERGMAN
CONGRAT
ENGINEER
19/04



Data privacy & security, retention policy, recognition bias, recourse in case of FP/FN

Wrongfully Accused by an Algorithm





(a) Robert Williams

(a)

MICHIGAN STATE POLICE
INVESTIGATIVE LEAD REPORT
LAW ENFORCEMENT SENSITIVE

THIS DOCUMENT IS NOT A POSITIVE IDENTIFICATION. IT IS AN **INVESTIGATIVE LEAD ONLY** AND IS **NOT** PROBABLE CAUSE TO ARREST. FURTHER INVESTIGATION IS NEEDED TO DEVELOP PROBABLE CAUSE TO ARREST.

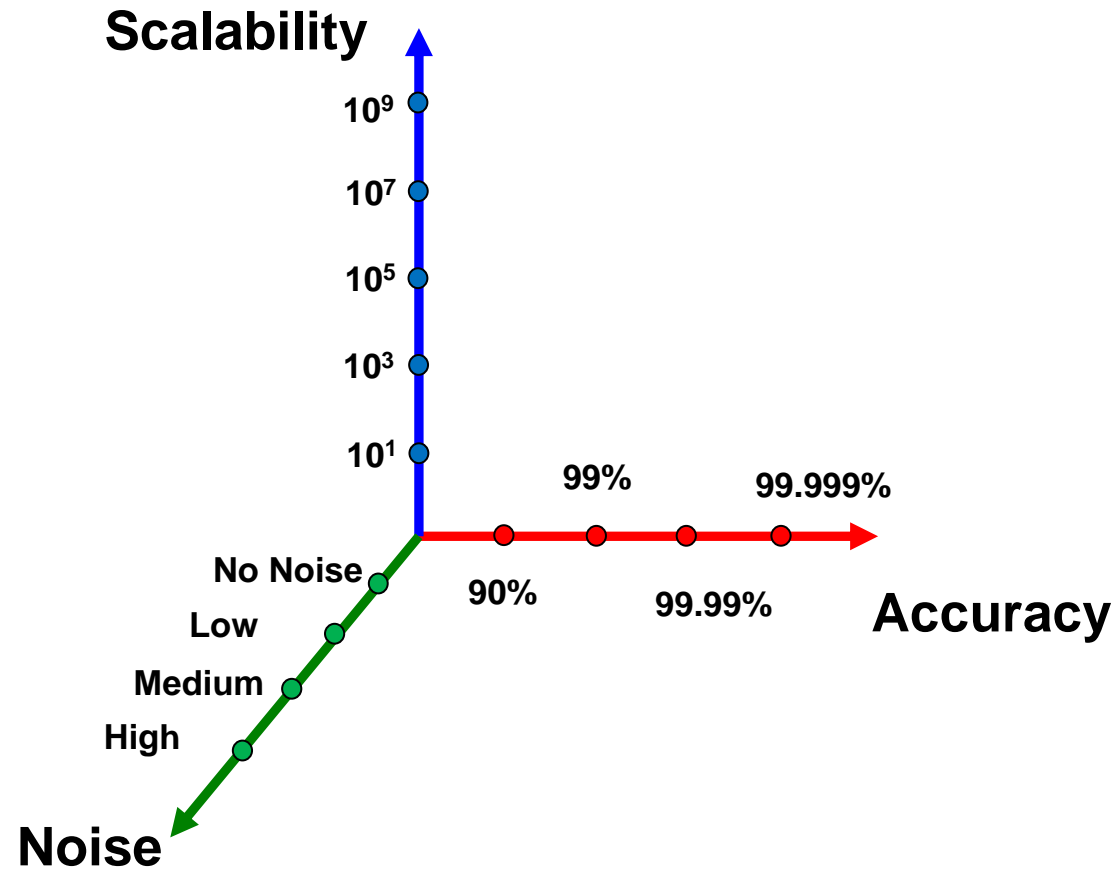
BID DIA Identifier: BID-39641-19	Requester: CA Yager, Rathe
Date Searched: 03/11/2019	Requesting Agency: Detroit Police Department
Digital Image Examiner: Jennifer Coulson	Case Number: 1810050167
	File Class/Crime Type: 3000

Probe Image	Investigative Lead
	

(b) Investigative Lead Report

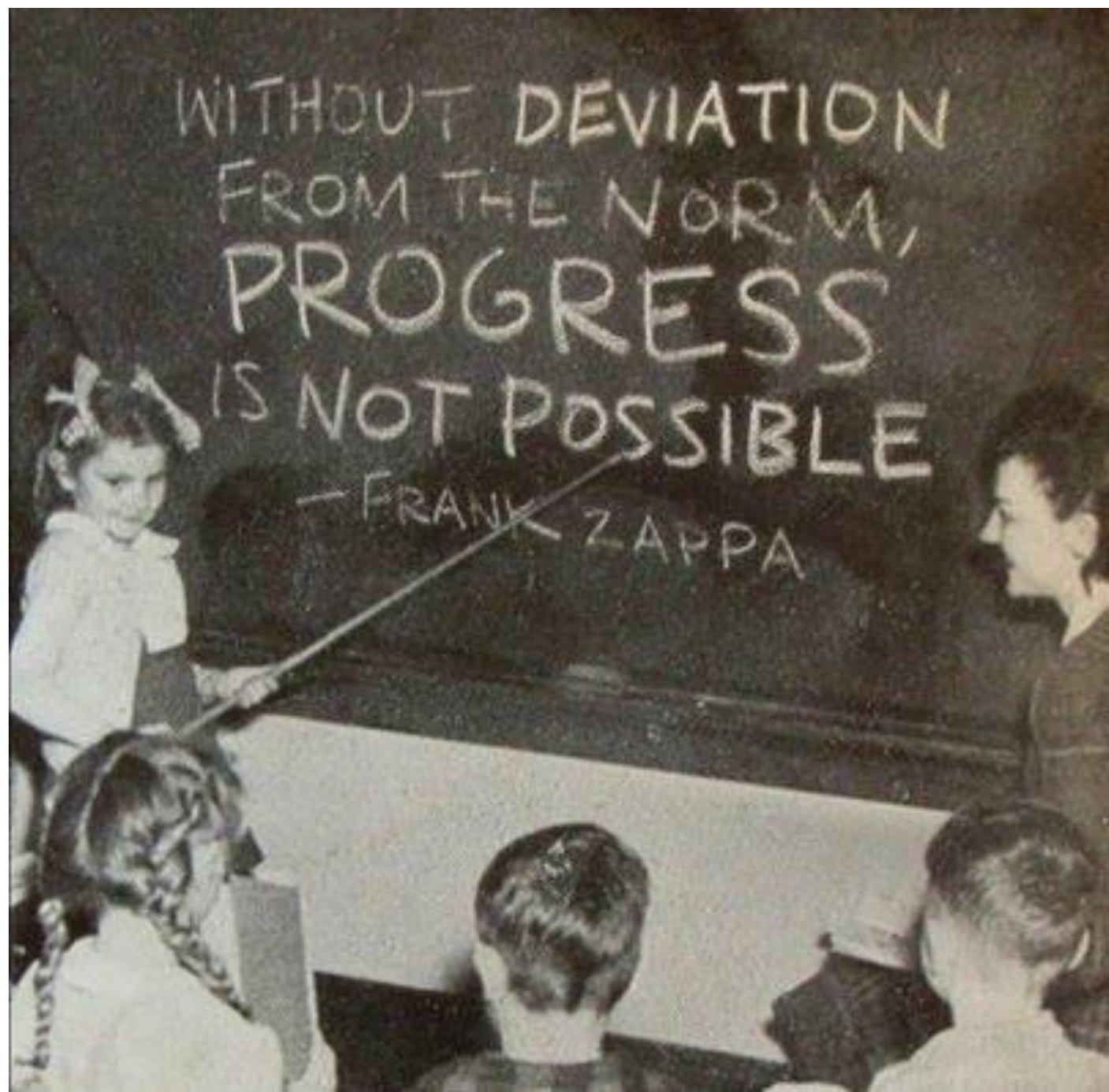
FR system wrongfully identified (a) Robert William when the CCTV frame in (b) was searched against a 49M gallery; forensic experts did not conduct a manual examination of the candidate list

Biometrics Challenge



- Need systems operating at the **edge** of this 3-D space
- Other factors: Usability, user acceptance, cost, robustness,....

WITHOUT DEVIATION
FROM THE NORM,
PROGRESS
IS NOT POSSIBLE
—FRANK ZAPPA



Reading Material

- A. K. Jain, D. Deb, and J. J. Engelsma, "Biometrics: Trust, but Verify", to appear in IEEE Trans. Biometrics, Behavior and Identity Science, 2021. DOI: 10.1109/TBIOM.2021.3115465 <https://arxiv.org/pdf/2105.06625.pdf>
- A. K. Jain, K. Nandakumar, A. Ross, "50 years of Biometric Research: Accomplishments, Challenges, and Opportunities", Pattern Recognition Letters, Volume 79, August 2016.
http://biometrics.cse.msu.edu/Publications/GeneralBiometrics/JainNandakumarRoss_50Years_PRL2016.pdf
- A. K. Jain, A. Ross and K. Nandakumar, Introduction to Biometrics, Springer, 2011 (ISBN 978-0-387-77325-4).
- A. K. Jain, "Biometric recognition: Q&A", Nature, Vol. 449, pp. 38-40, Sept. 6, 2007.
<http://biometrics.cse.msu.edu/Publications/GeneralBiometrics/JainNatureQNA2007.pdf>

Questions?