

Biometrics: How Do I Know Who You Are?

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Indonesia AI Summit 2020

Indonesia Electronic ID Card: e-KTP

- E-KTP stores demographic data, photo, right & left index fingerprints in embedded chip



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**Compulsory ID for Indonesians & foreign residents; issued at the age of 17;
2 population is ~270 million with ~175 million adults**

Outline

- **Person recognition**
- **Biometric recognition**
- **Milestones**
- **Enrollment/de-duplication/verification**
- **State-of-the-art recognition errors**
- **Challenges**

Person Recognition

We now live in a society, where people cannot be **trusted** based on **passports, PW and PIN**



How do we know who is entering card & PIN?

Lost & stolen Passports



Interpol's stolen/lost Travel Documents database contains 84M records; searched 3 bn times in 2018, resulting in more than 289,000 positive 'hits'.

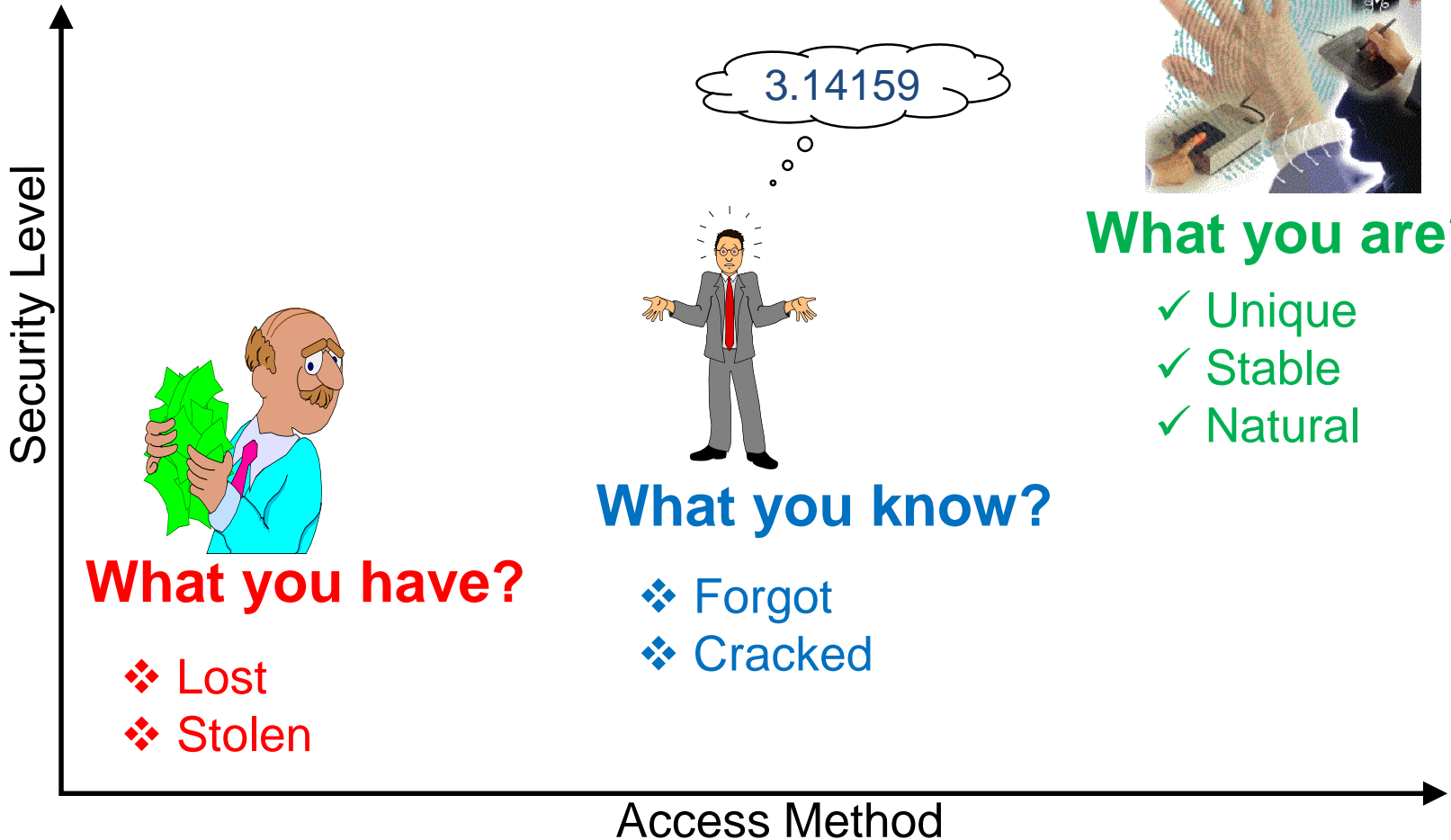
Too Many Passwords!

Copyright 1996 Randy Glasbergen. www.glasbergen.com



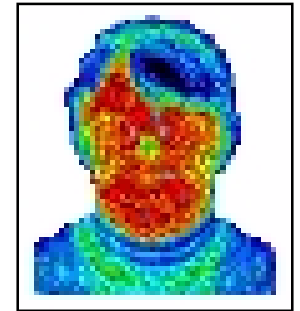
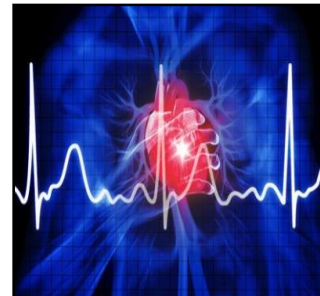
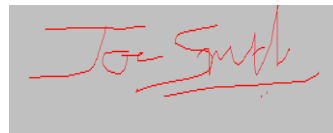
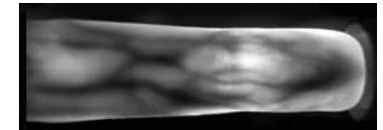
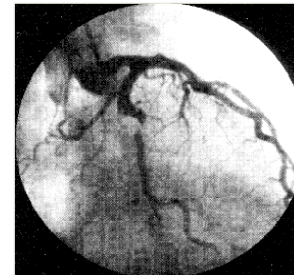
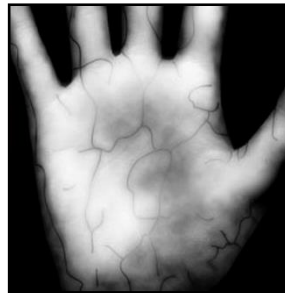
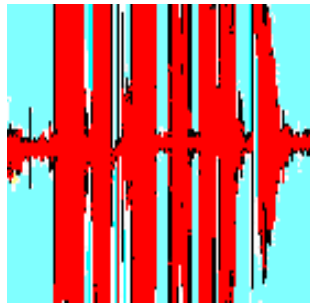
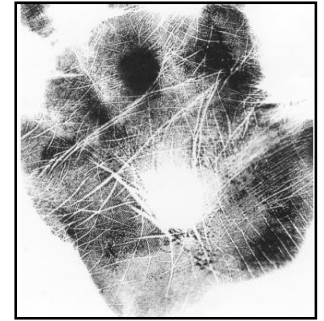
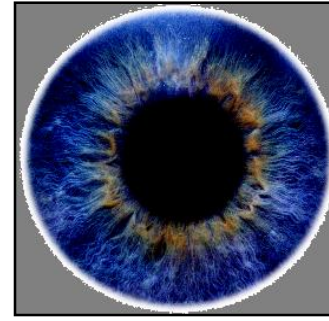
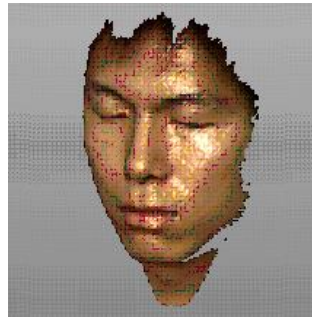
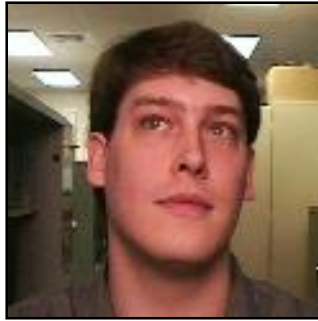
“Sorry about the odor. I have all my passwords tattooed between my toes.”

Biometrics



Biometrics: *Bios* (body) + *Metron* (measurement)

Biometric Traits



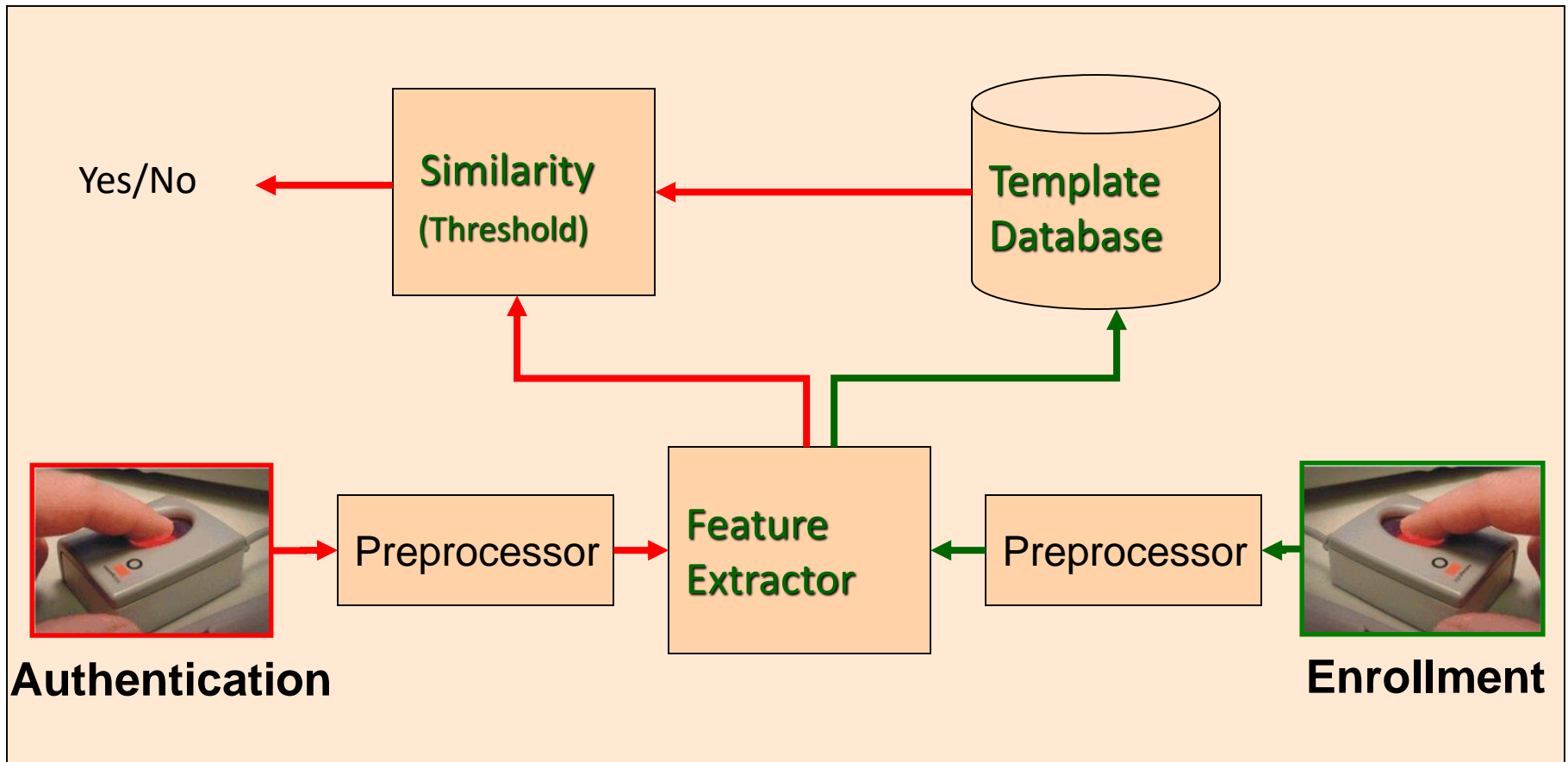
Which biometric trait? Uniqueness, persistence, accuracy, ease of embedding, cost, usability and resilient to noise, spoof and mimicry

Biometric-Enabled ATM



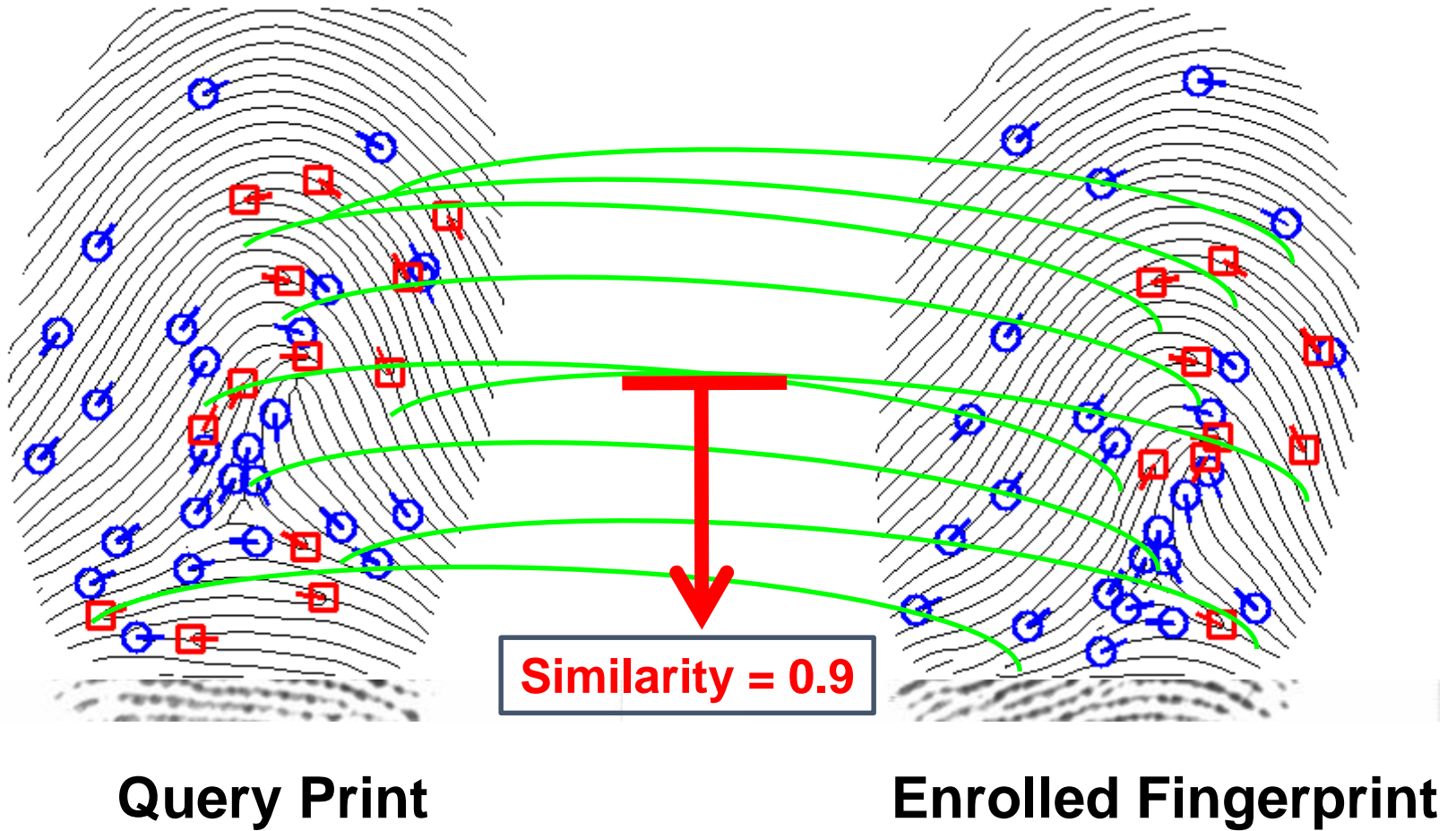
Three-factor Authentication: Palm vein + Card + PIN

Biometric Recognition System



- **False accept rate (FAR):** Proportion of imposters accepted
- **False reject rate (FRR):** Proportion of genuine users rejected
- **Threshold value determines trade-off between FAR and FRR**

Similarity Computation



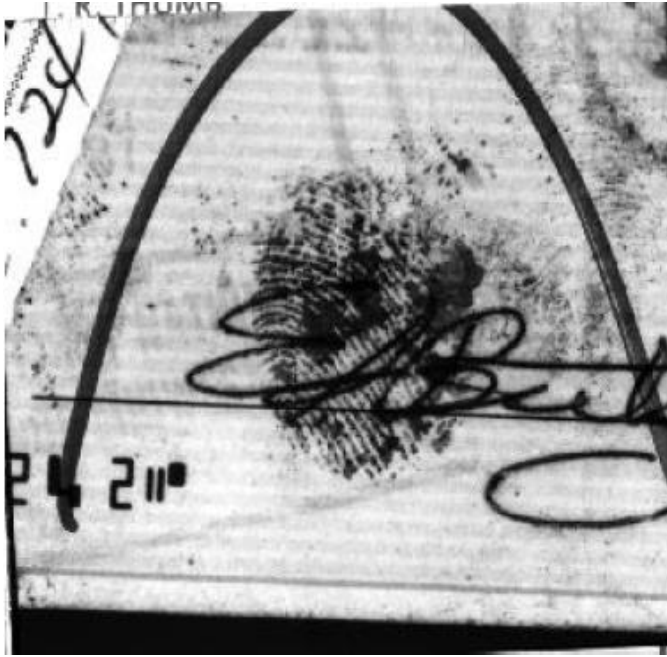
Biometric Milestones

Law Enforcement: Scotland Yard



1905: First use of fingerprints in British criminal case

Law Enforcement: FBI



APPLICANT <i>Leave Blank</i>		TYPE OR PRINT ALL INFORMATION IN BLACK LAST NAME Teacher, Theresa C.			FBI <i>Leave Blank</i>	
SIGNATURE OF PERSON FINGERPRINTED <i>Leave Blank</i>		AKA Formerly: Theresa Smith	O NY921940Z	DATE OF BIRTH 12/31/70		
RESIDENCE OF PERSON FINGERPRINTED 318 School Street Hometown, NY 12111		STATE US	NYSTED Dept-FPU ALBANY, NY	DOB		
DATE 5/02/02	SIGNATURE OF OFFICIAL TAKING FINGERPRINTS <i>Leave Blank</i>	CITIZENSHIP US	SEX F	HAIR W	HT 5'7"	
EMPLOYER AND ADDRESS <i>(if applicable)</i> Smart Falls Central School Dist Smart Falls, NY 12111		WEIGHT 155	POB Gr	RELIGION Bro	PLACE OF BIRTH Ohio	
REASON FINGERPRINTED <i>Leave Blank</i>		CLASS <i>Leave Blank</i>	REF <i>Leave Blank</i>			
IDENTIX TP600 1259		AIS004228 LEX004229				
LEFT FOUR FINGERS TAKEN SMALL FINGER ONLY		L THUMB	R THUMB	RIGHT FOUR FINGERS TAKEN SMALL FINGER ONLY		



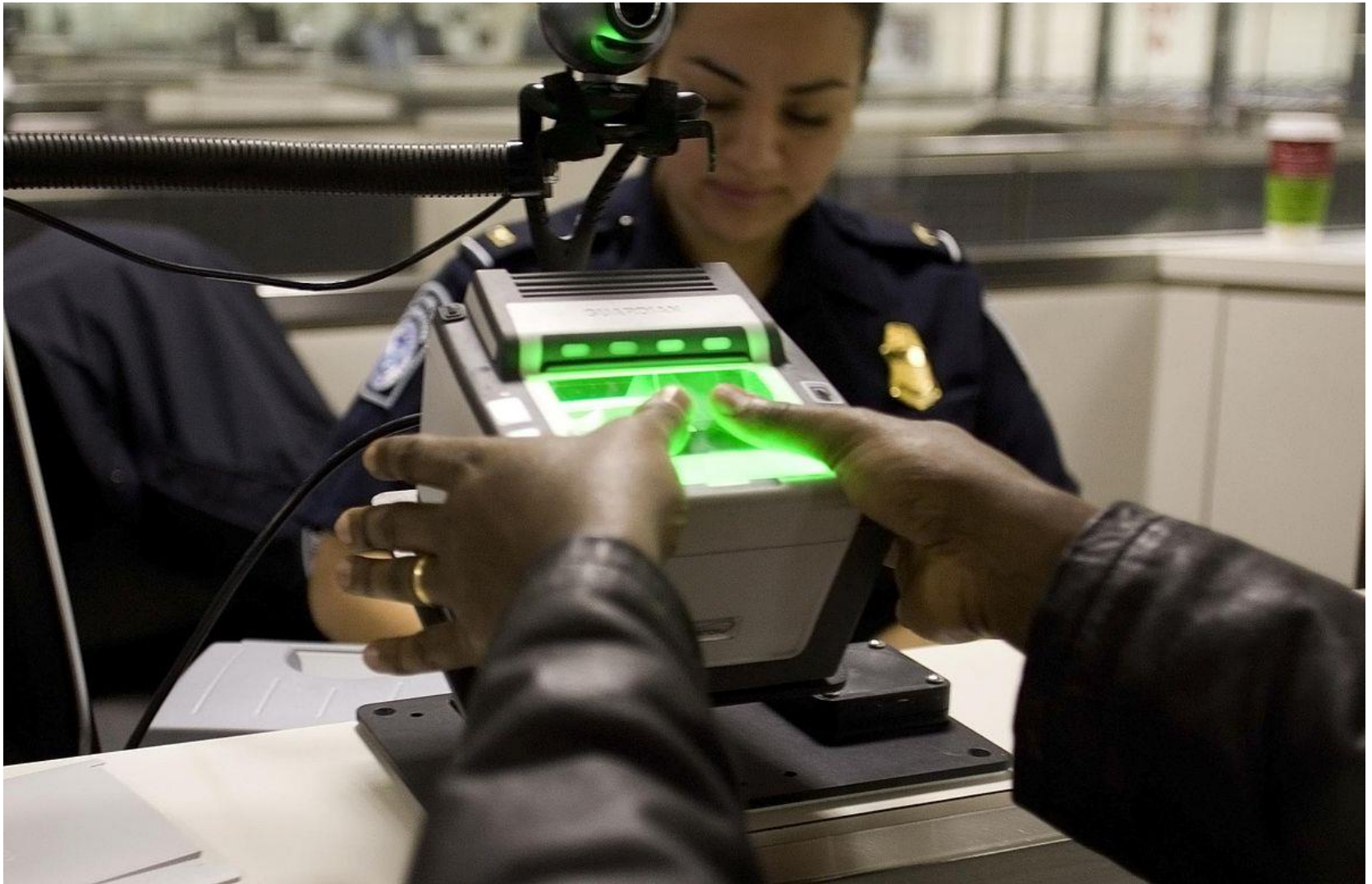
1924: US Congress authorizes DOJ to collect fingerprints and arrest information

Homeland Security: DHS



2001: 9/11 attacks lead Congress to mandate use biometrics for entry to U.S.

Border Crossing



2003: US-VISIT (now OBIM, uses all 10 fingers)

Theme Park



2005: Disney World (~21 M visitors to Orlando in 2019)

World's Largest Biometric System

The advertisement features a large orange background with a fingerprint pattern. On the left, a vertical white letter is shown being cut by a pair of scissors into a smaller, portable card. The letter contains the following text: 'भारतीय विशिष्ट पहचान प्राधिकरण', 'भारत सरकार', 'Unique Identification Authority of India', 'Government of India', 'Enrollment No.: 12345678901234', 'To: सपना सिंग, Sapna Singh, D/O Pawan Singh, A/B-34, Budhnagar, Indrapuri, New Delhi - 110012', 'AA123456789022', 'आपका आधार क्रमांक / Your Aadhaar No.: 4444 5555 6666', and 'आधार - आम आदमी का अधिकार'. The card being cut contains: 'भारत सरकार', 'GOVERNMENT OF INDIA', a photo of Sapna Singh, 'सपना सिंग, Sapna Singh', 'जन्म वर्ष / Year of Birth: 1990', 'महिला / Female', '4444 5555 6666', and 'आधार - आम आदमी का अधिकार'. At the top right, the logo of the Unique Identification Authority of India is shown with the text 'Unique Identification Authority of India, Planning Commission, Government of India'. In the center, the text reads 'ALWAYS CARRY YOUR AADHAAR WITH YOU and avail benefits of various services'. Below the card, it says 'Cut this portion of Aadhaar letter and carry it with you. (You may get it laminated too)'. At the bottom, a row of icons illustrates services: 'opening a Bank account', 'getting a Mobile connection', 'getting a LPG connection', 'AADHAAR helps in proving ID during Train travel', and '...and many more services'. The Aadhaar logo and 'www.uidai.gov.in' are at the bottom right.

भारतीय विशिष्ट पहचान प्राधिकरण
भारत सरकार
Unique Identification Authority of India
Government of India
Enrollment No.: 12345678901234

To: सपना सिंग
Sapna Singh
D/O Pawan Singh
A/B-34, Budhnagar
Indrapuri
New Delhi - 110012

AA123456789022

आपका आधार क्रमांक / Your Aadhaar No.:
4444 5555 6666
आधार - आम आदमी का अधिकार

भारत सरकार
GOVERNMENT OF INDIA

सपना सिंग
Sapna Singh
जन्म वर्ष / Year of Birth: 1990
महिला / Female

4444 5555 6666

आधार - आम आदमी का अधिकार

Unique Identification Authority of India
Planning Commission, Government of India

ALWAYS CARRY YOUR AADHAAR WITH YOU
and avail benefits of various services

Cut this portion of Aadhaar letter
and carry it with you.
(You may get it laminated too)

Aadhaar : your proof of identity and proof of address for

opening a Bank account
getting a Mobile connection
getting a LPG connection
AADHAAR helps in proving ID during Train travel
...and many more services

AADHAAR
Aam Aadmi Ka Adhikaar
www.uidai.gov.in

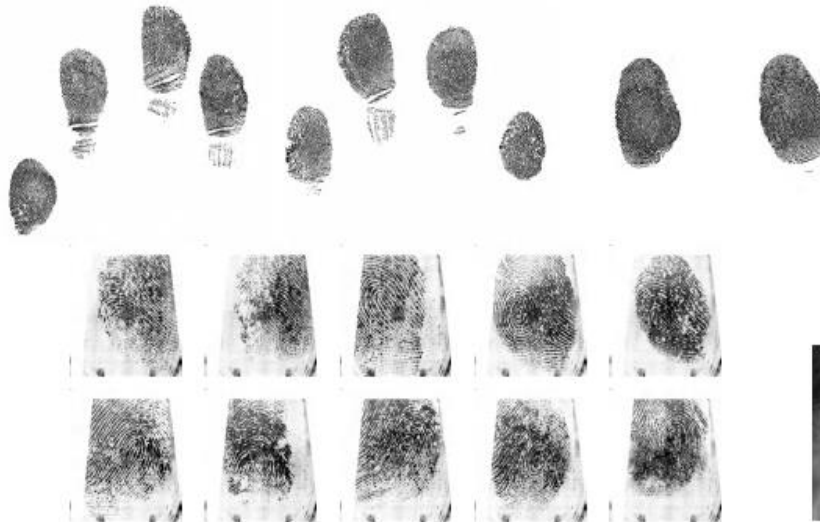
“To empower residents of India with a unique identity and a digital platform to authenticate anytime, anywhere.”

2008: Aadhaar

Enrollment

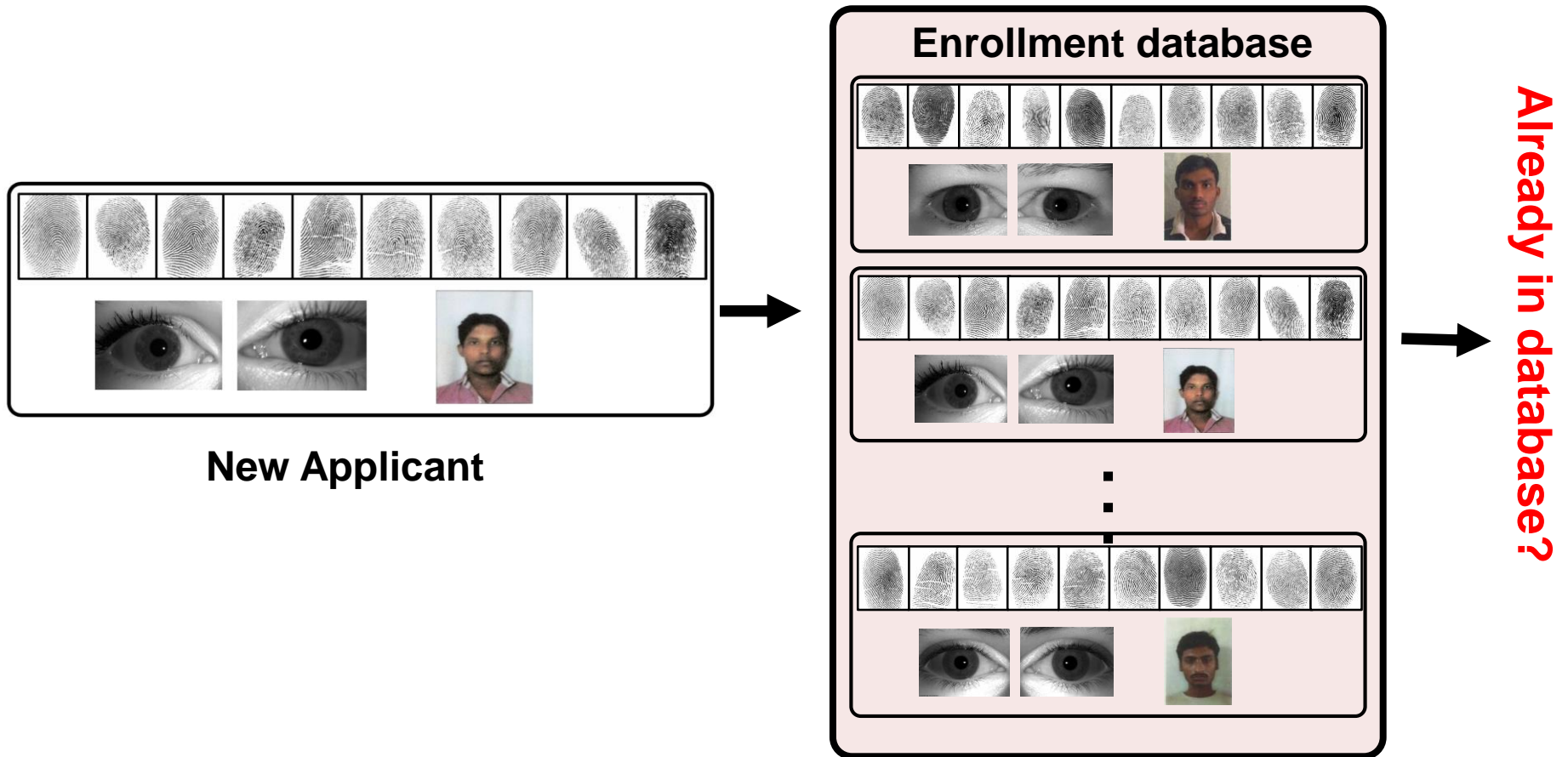


Minimal documentation needed



~1.3 billion Indian residents enrolled (age > 5 yrs.)

De-duplication (Search)



Authentication



https://uidai.gov.in/aadhaar_dashboard/auth_trend.php

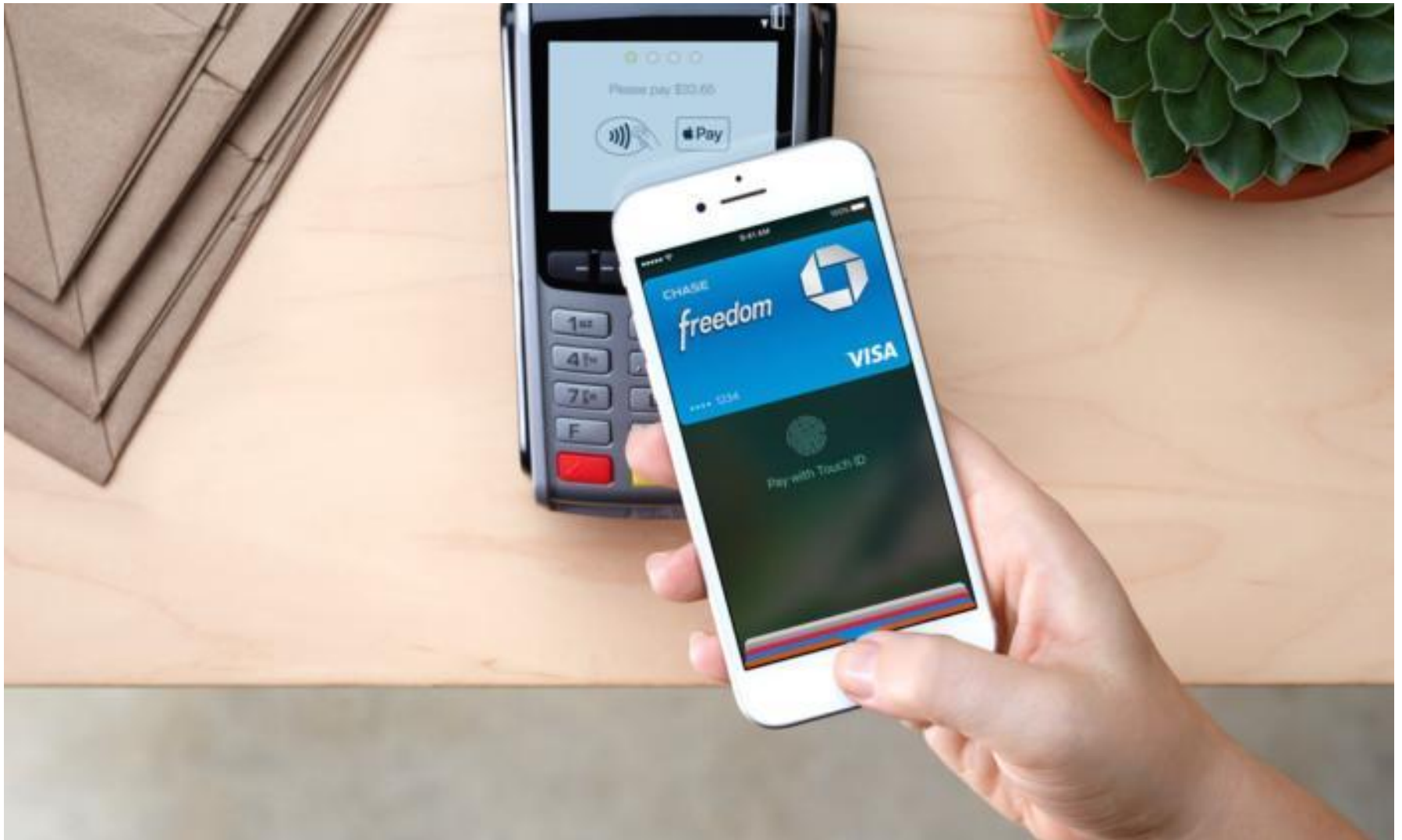
Two-factor authentication; 40 M authentications/day

Mobile Unlock



2013: Apple TouchID (new levels of usability and accuracy)

Mobile Payment



2014: ApplePay (Match on phone)

Mobile Unlock



2017: Apple FaceID (remove the bezel to increase screen size)

Mobile Unlock



2018: First In-display Fingerprint Sensor in smartphones

Match on Card



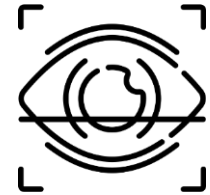
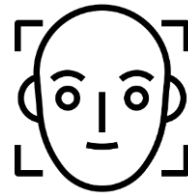
2019: Biometric Payment Cards

Just Walkout Shopping!



2019: Amazon Go (face + sensors on shelf and ceiling)

Three Most Popular Traits



Incheon, South Korea: Smart Entry



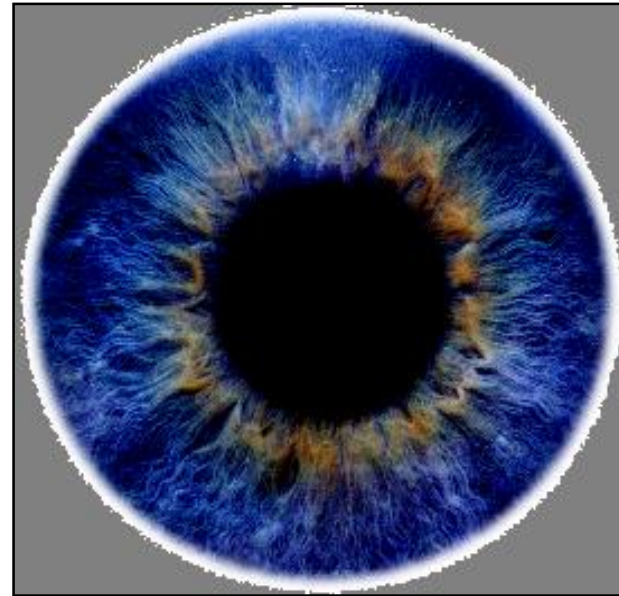
Australia: SmartGate



Schiphol Privium border passage

Uniqueness, persistence, legacy data, accuracy, fast search,...

State of the Art: Authentication



Fingerprint: TAR = 99.96% @ FAR = 0.01% (FVC-ongoing)

Iris: TAR = 99.82% @ FAR = 0.01% (NIST IREX II)

Face: TAR = 99.7% @ FAR = 0.1% (NIST FRVT 2010)

Challenges & Opportunities

Image Quality V. Accuracy



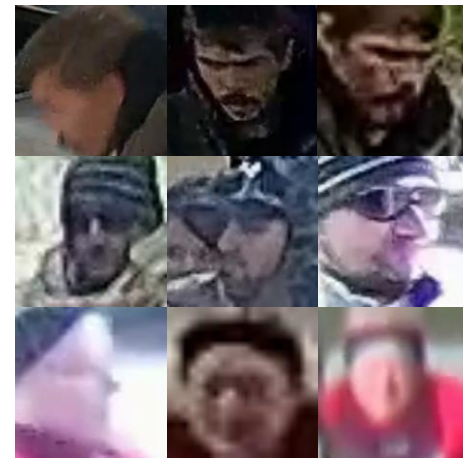
LFW (2009)



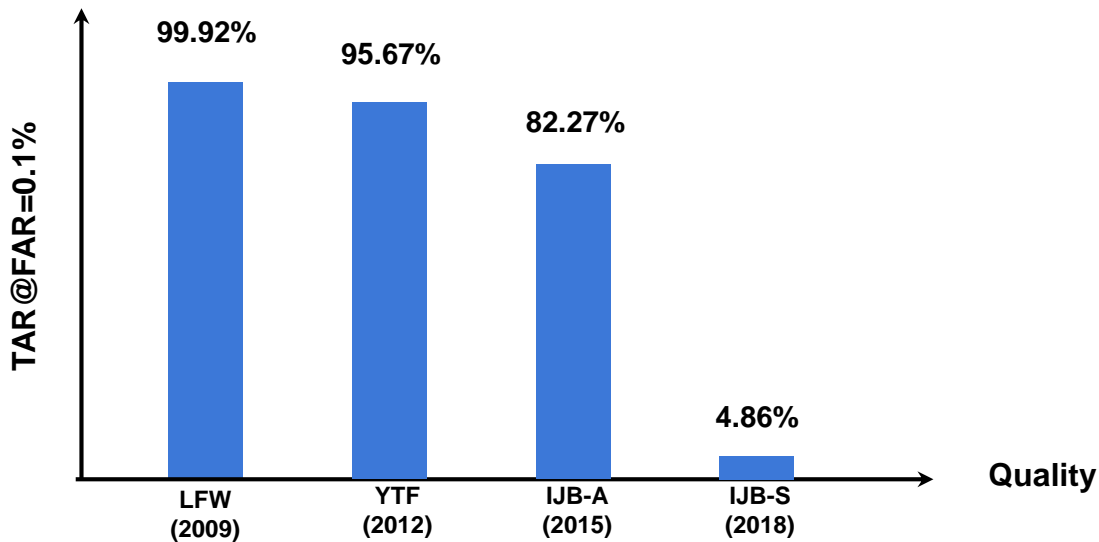
YTF (2012)



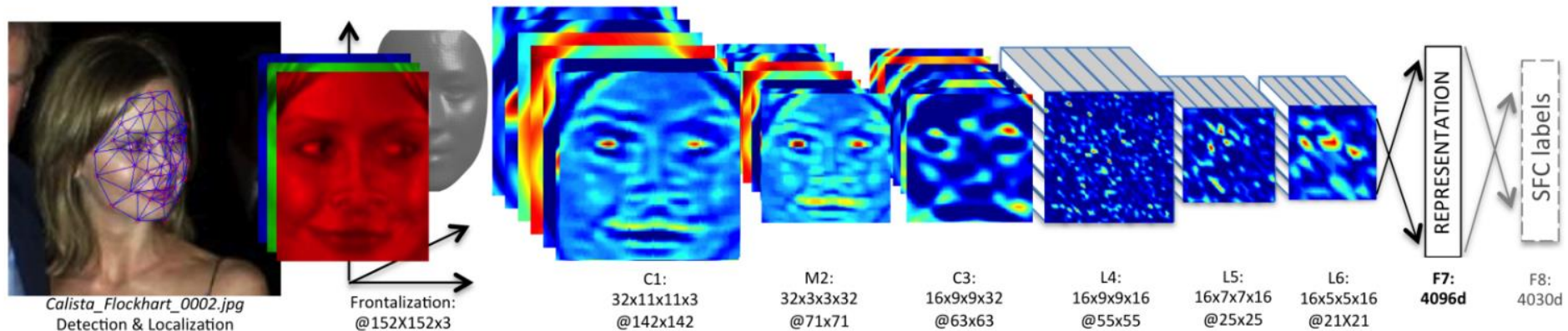
NIST IJB-A (2015)



NIST IJB-S (2018)



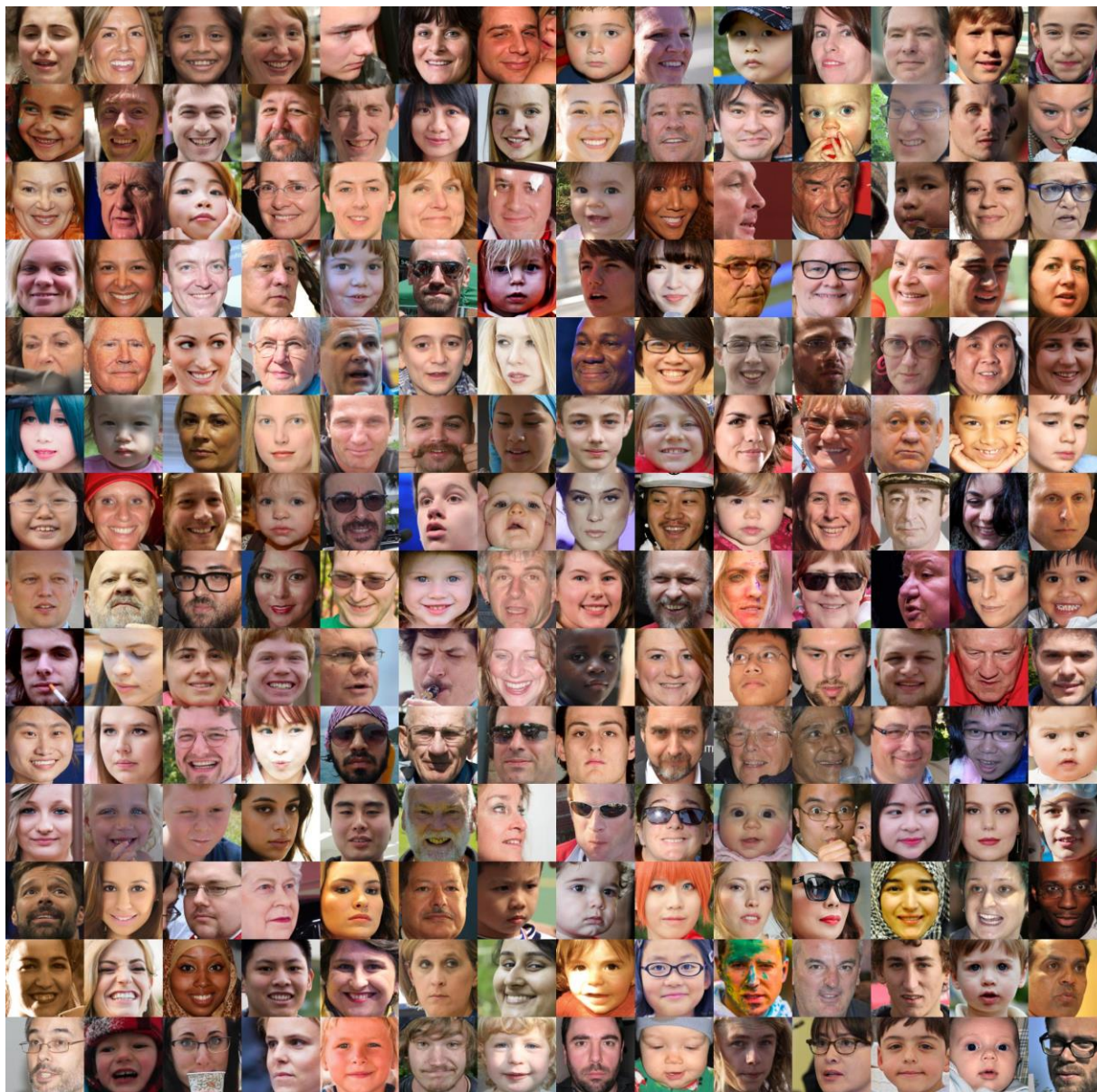
Deep Networks



- **Joint learning of features and recognition**
- **Multiple layers of neurons connected to a small area in preceding layer**
- **Has dramatically improved face recog. accuracy**

Taigman, Yang, Ranzato, Wolf. "Deepface: Closing the gap to human-level performance in face verification." CVPR, 2014.

Large-scale Annotated Datasets



MS-Celeb: 8M images from 100K subjects collected from the web

Progress in Face Recognition

Study	Year	Gallery Size	Search (Rank-1)	Verification (TAR @ 0.1% FAR)
FERET	1993-94	316	78.00	21.00
FERET	1996-97	831	95.00	46.00
FRVT	2002	37,437	73.00	80.00
FRGC	2005	16,028	N/A	99.00
FRVT	2006	N/A	N/A	99.00
MBE	2010	1.6M	92.00	99.00
FRVT	2014	1.6M	96.00	N/A
FRVT	Ongoing	12M	99.98	99.99

Mugshot database: constrained image capture and cooperative subjects

Fairness: Demographic Bias

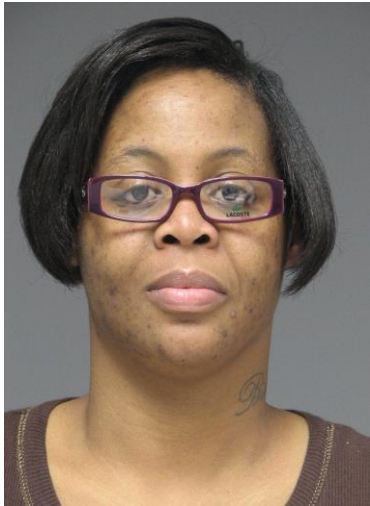
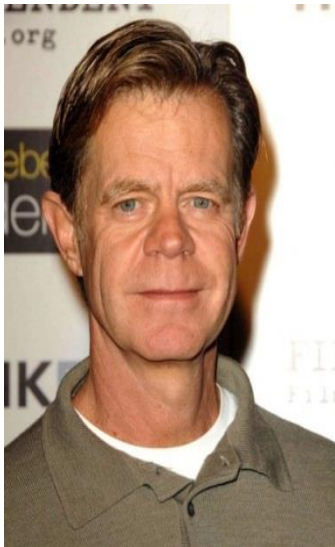
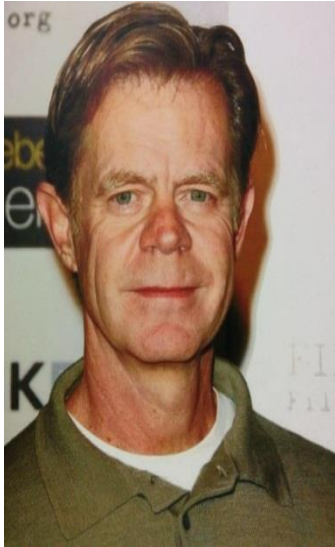
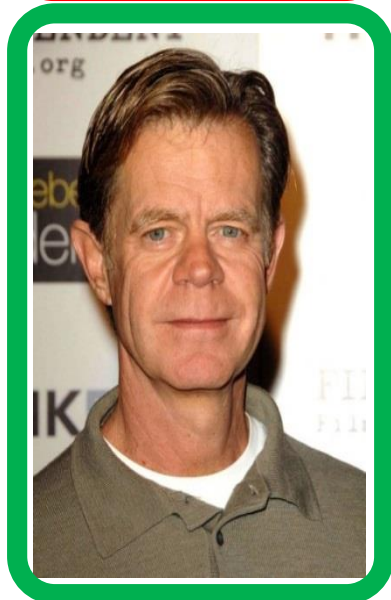
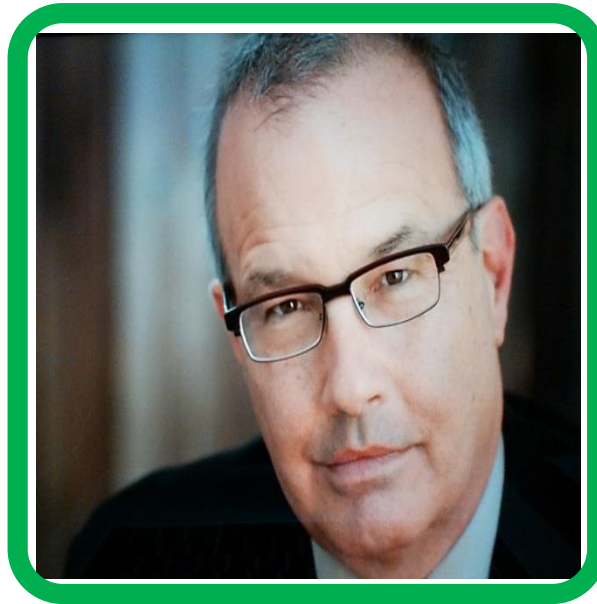
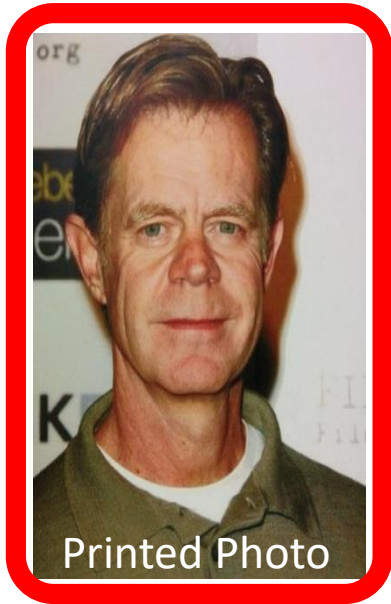


Figure 64: “For the mugshot images, error tradeoff characteristics for **white females, black females, black males and white males.**”, NIST.gov Face Recognition Vendor Test (FRVT) 1:1 Ongoing, Nov. 11, 2019

Which Faces Are Real?



Which Faces Are Real?



Biometrics at Airports

International traveler's entry/exit photo compared with DHS database (e.g., photos from passports, visas, flight manifest)



Accuracy, ergonomics, throughput, 24/7 operation, user acceptance,...

Targeted Advertisement

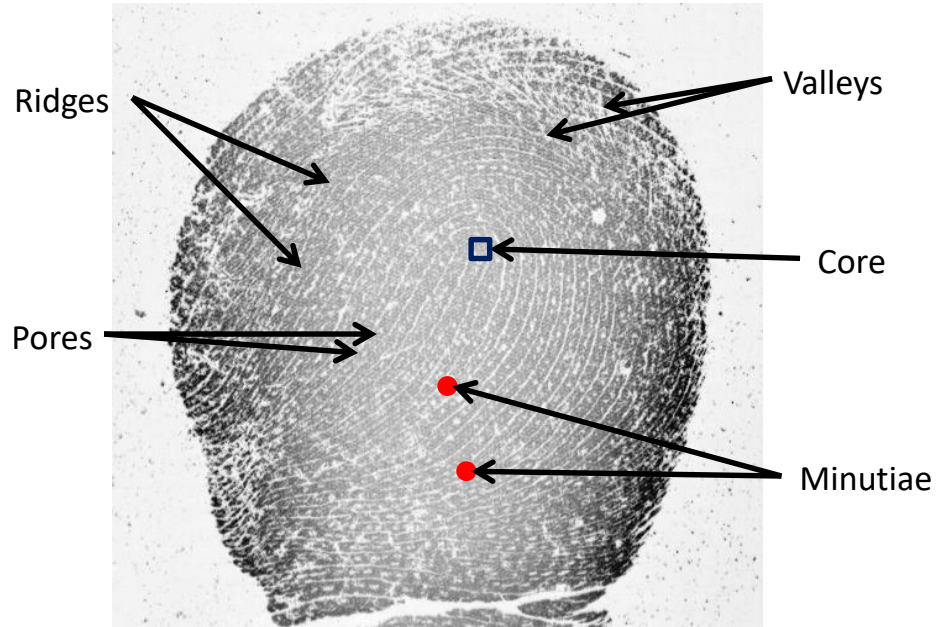


Minority Report (2002)

Who is This Infant?

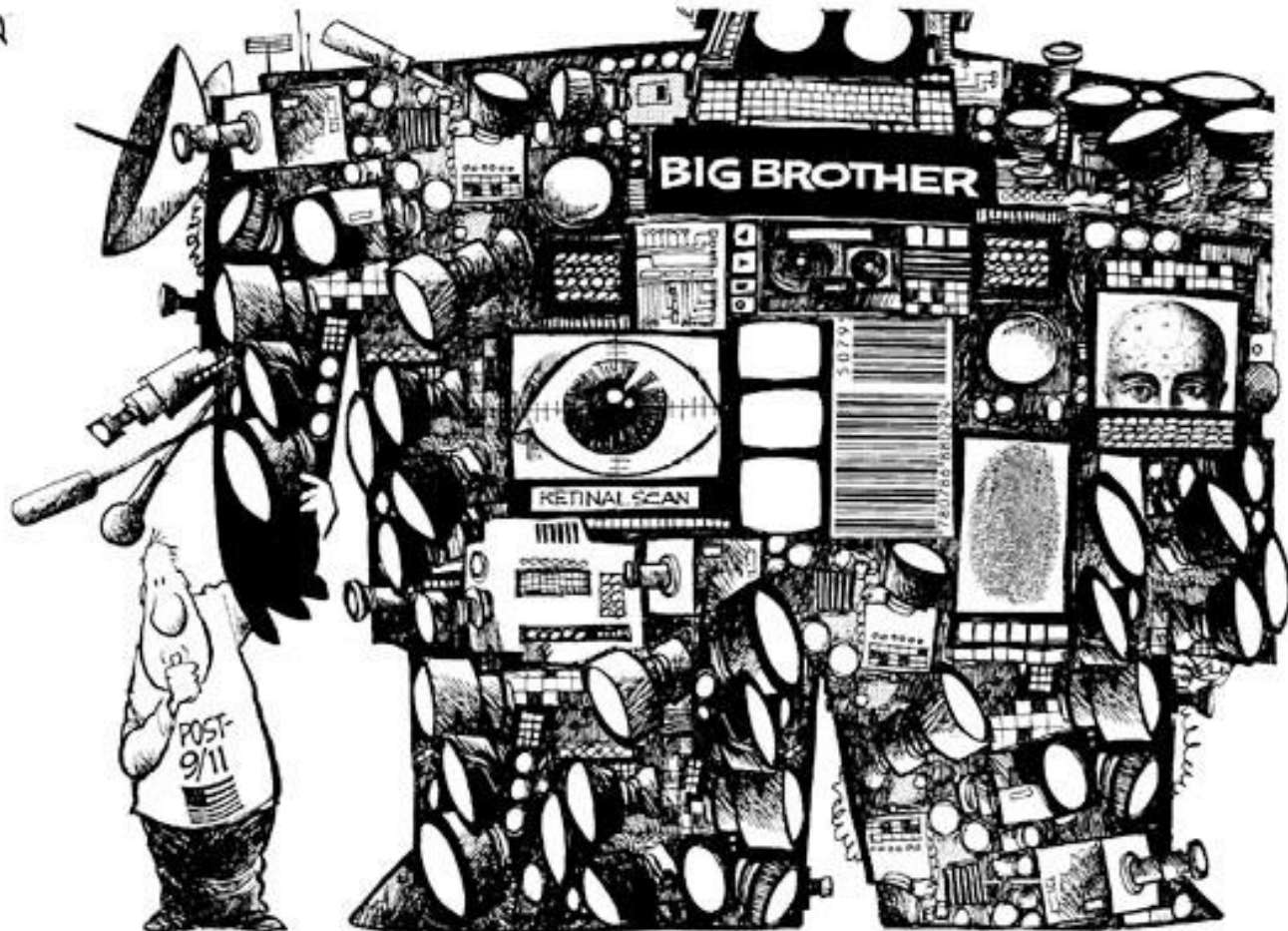


6-hour old baby



Privacy Concerns

JIM BERGMAN
CONCEPT
ARTIST
19/04



- 770 million surveillance cameras, half of them in China
- Concerns: data security, retention policy, function creep

Summary

- **Biometrics is the only way to answer:**
 - ***Are you who you claim to be?***
 - ***Who are you?***
- **Applications: Law enforcement, forensics, National ID, access control, surveillance, time and attendance, travel, banking...**
- **Challenges: Image quality, recognition accuracy for unconstrained image acquisitions, system security (spoofs and template protection), user privacy,...**