CSE 40537 / 60537: Biometrics

Biometrics Basics 3
Definitions
Deconstructing “Biometrics”

“the use of physical or behavioral properties of human beings for automatic identity recognition”

• Something characteristic only to me
  - (e.g., my face, my handwriting, my voice)

• Not something I know
  - (e.g., a password or PIN)

• Not something I have
  - (e.g., a key or authentication token)
Deconstructing “Biometrics”

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• We need a living subject
Pop Quiz

Which fingerprint is the real one?

Latex  Wood Glue  Gelatine
Deconstructing “Biometrics”

“the use of physical or behavioral properties of human beings for automatic identity recognition”

Why do we want computers to do this?

- High throughput
- Repeatability
- Predictability

Image Credit: Frank Couch/Birmingham News
How reliable are humans?

Fix the Flaws in Forensic Science

By ERIC S. LANDER   APRIL 21, 2015

THE F.B.I. stunned the legal community on Monday with its acknowledgment that testimony by its forensic scientists about hair identification was scientifically indefensible in nearly every one of more than 250 cases reviewed. But the conclusion should come as no surprise to scientists. It is the culmination of a collision between law and science . . .
Mayfield Case

Latent print suspected to belong to Madrid bomber

Print belonging to Brandon Mayfield


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**Statement on Brandon Mayfield Case**

**Washington, D.C.**

May 24, 2004

Upon review it was determined that the FBI identification was based on an image of substandard quality, which was particularly problematic because of the remarkable number of points of similarity between Mr. Mayfield’s prints and the print details in the images submitted to the FBI.

The FBI apologizes to Mr. Mayfield and his family for the hardships that this matter has caused.

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**FBI National Press Office**

(202) 324-3691
Biometric Recognition Types

Positive Recognition
A sample represents a subject known to the system (i.e., already registered)

Negative Recognition
A sample represents a subject unknown to the system (i.e., not yet registered)

Biometric Modality

• **single** physical or behavioral property we use for biometric recognition
Probe and Gallery

Probe: A sample presented to a biometric system

“Who is this?”

Gallery: A collection of enrolled templates

“Halle Barry”
Authentication Types: Pair Matching

Do these two images match?

Answer: Yes or No
Authentication Types: Verification

Does this sample of Kevin Bowyer match the one in our system?

New Sample

Stored Image

Answer: Verified or Not Verified
Authentication Types: Identification

Does this person exist in our system?

Answer: Identified or Not Identified
Authentication Types: Negative Authentication

• Negative Verification: I’m not the subject X
• Negative Identification: I’m not a member of group X
Authentication Types: Deduplication

Known Records

New User

We know you!

Kumar et al., PubFig
Search

“Find all instances of this person”

Top 10 Hits
Recognition Pipeline

Enrollment: New user comes in
Acquisition ⇒ Feature Extraction ⇒ Template Generation

Recognition: We need to make a decision
Acquisition ⇒ Feature Extraction ⇒ Matching ⇒ Labeling
Recognition Pipeline: Acquisition

A biometric sample is the raw or preprocessed data collected from a subject by a sensor

Let $I \in \mathbb{R}^\nu$ be an image
\[ \nu = \text{number of pixels} \]
pixel space

“Tangled”

Example courtesy of D. D. Cox
V1 space

“Untangled”

IT space
Visualize Best Projections
Recognition Pipeline: Features

\[ x = F(I, \varphi_F), x \in \mathbb{R}^D \]

feature extractor \hspace{1cm} assumptions

\[ y = \text{label} \ (\text{if we know it}) \]