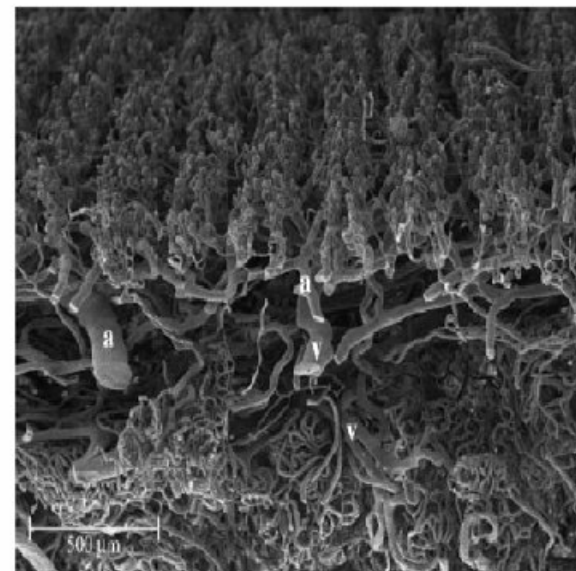
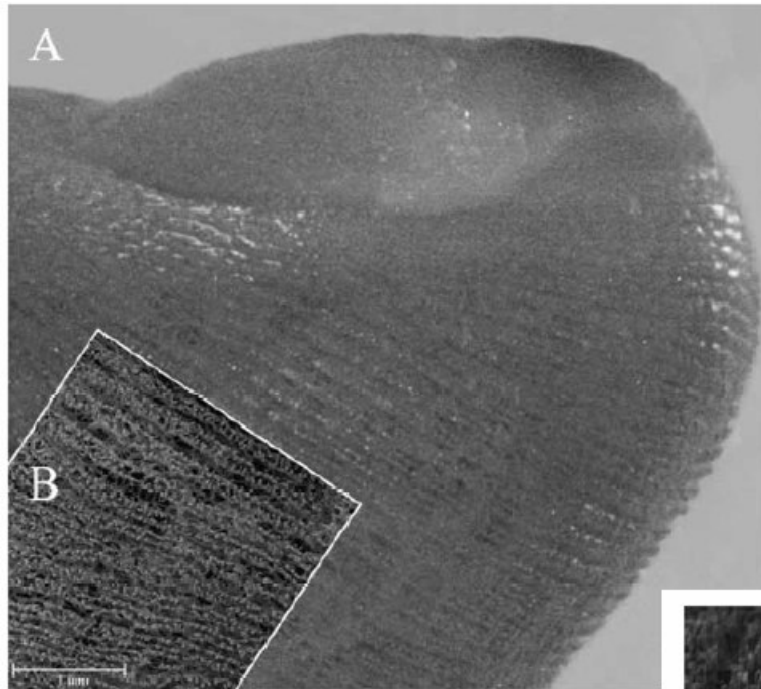


# Biometrics: Machines recognizing people

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Systems and Computer Engineering, Carleton

# Finger anatomy



*From S. Sangiorgi et al.,  
"Microvascularization of the human digit  
as studied by corrosion casting," J. Anat.  
204, 123 – 131 (2004)*

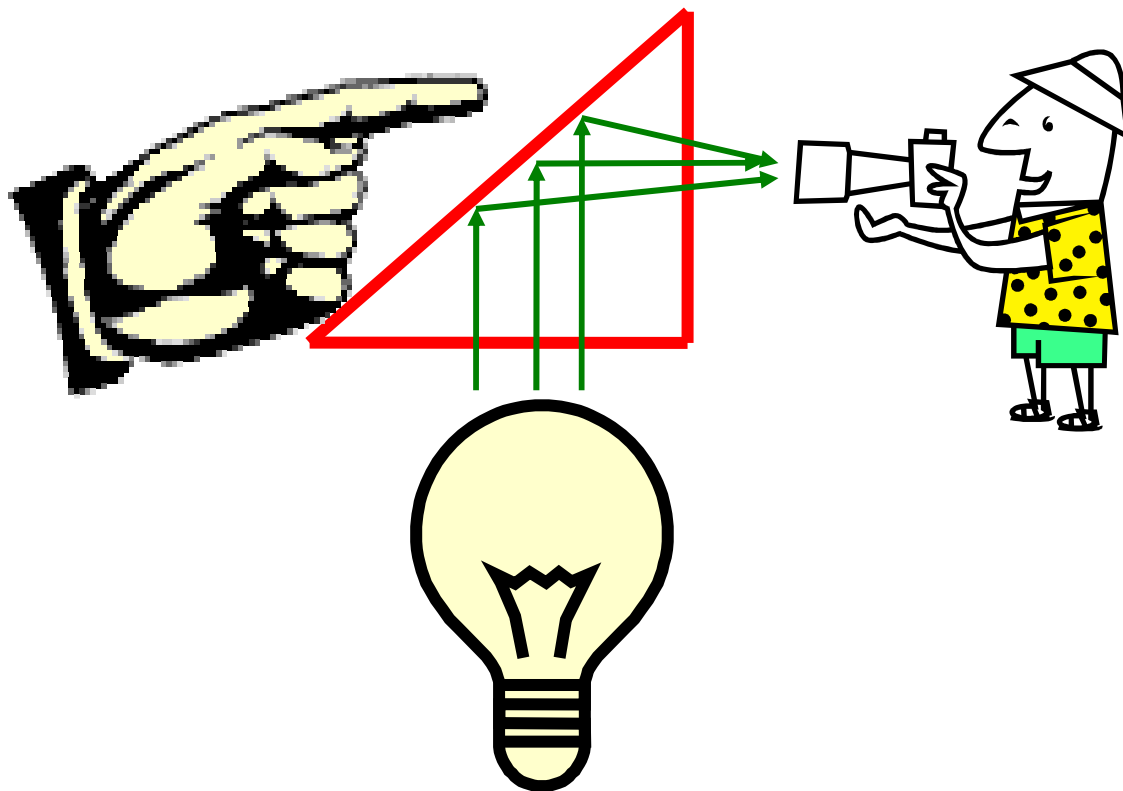
# Fingerprint: *Rolled ink*



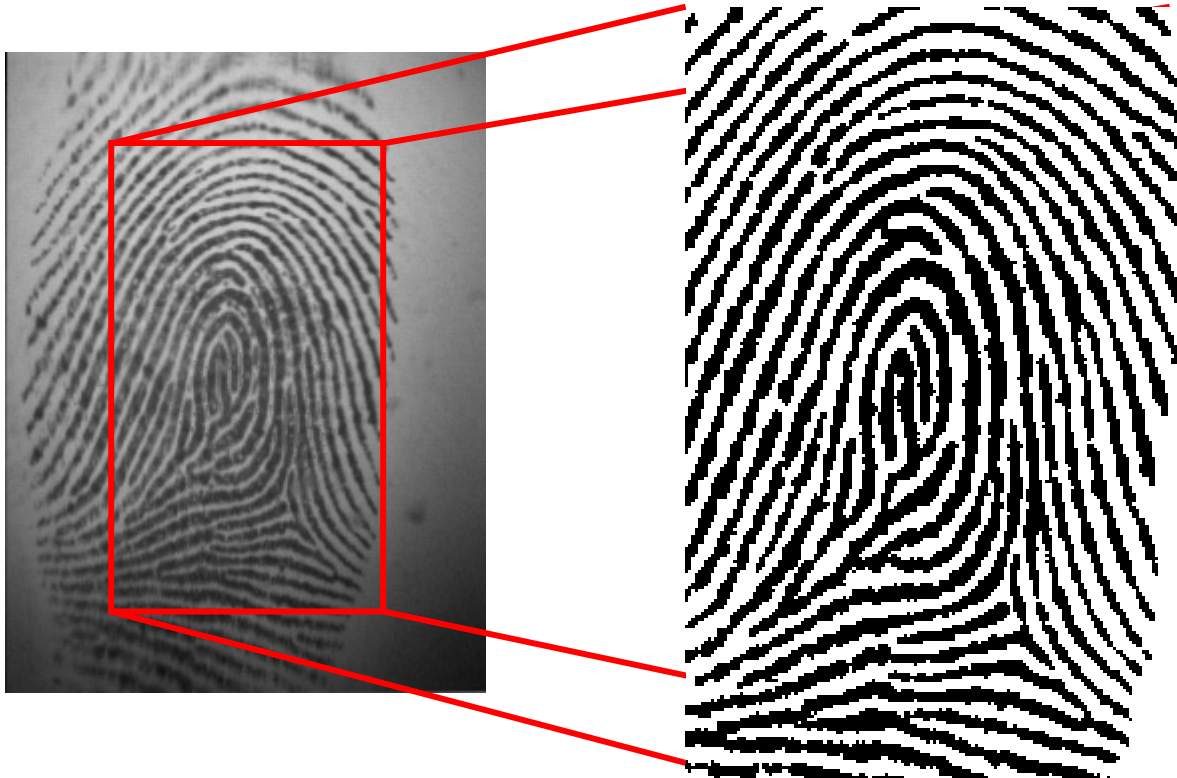
**Ink Roller**



# Fingerprints: *Optical Scanner*



# Cleaned fingerprint



# Get features: *minutiae*



# Fingerprint: *Compare*



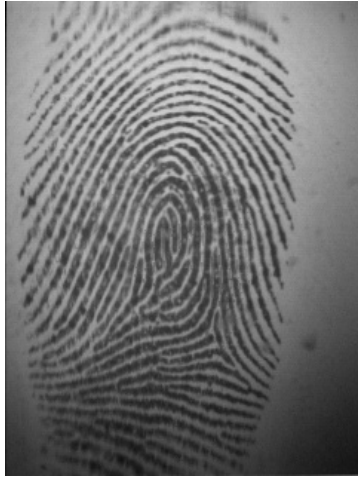
**Optical  
Scanner  
1998**



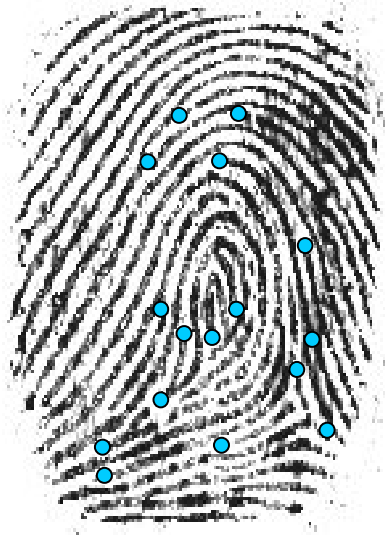
**Capacitive  
Scanner  
2004**

# Get features: *minutiae*

1998



2004



Compare  
and  
Decide



# Fingerprint examples

*Thumbs from my family*



Age 4

Age 6

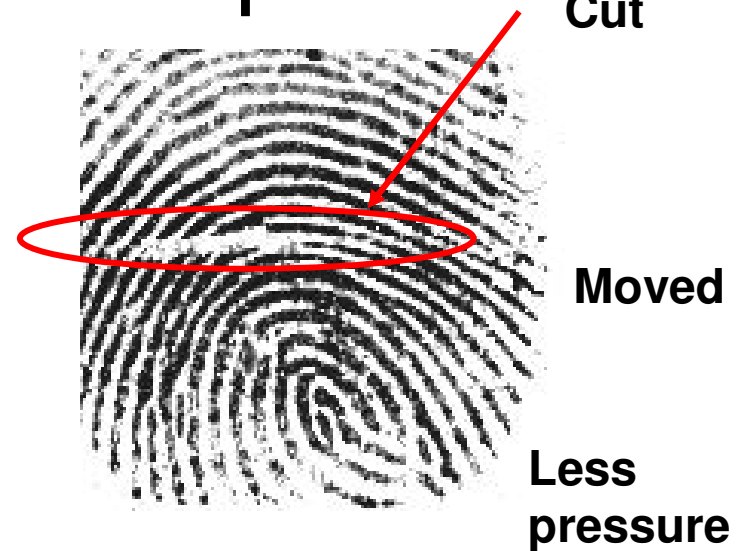
Age 34

Age 35

Age 65

# Are fingerprints unique?

What do you mean by unique?



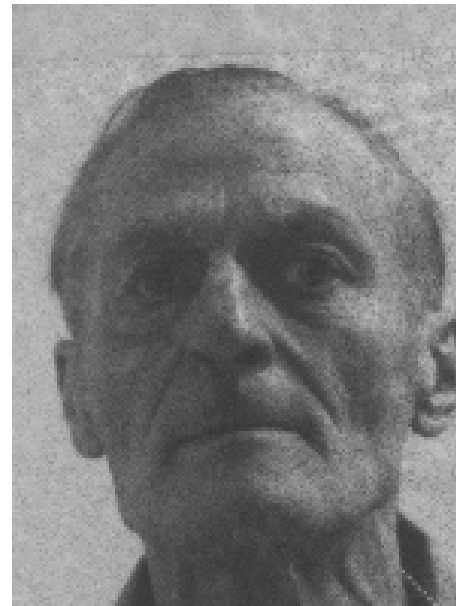
Real Question:

*Are fingerprints distinguishable?*

# What does Unique mean?

- No differences at all
  - But then fingers change every day
- Detectably different
  - But our detection algorithm keep getting better
- How informative is a fingerprint
  - “the decrease in uncertainty about the identity from a biometric measurement”

# Face Recognition:



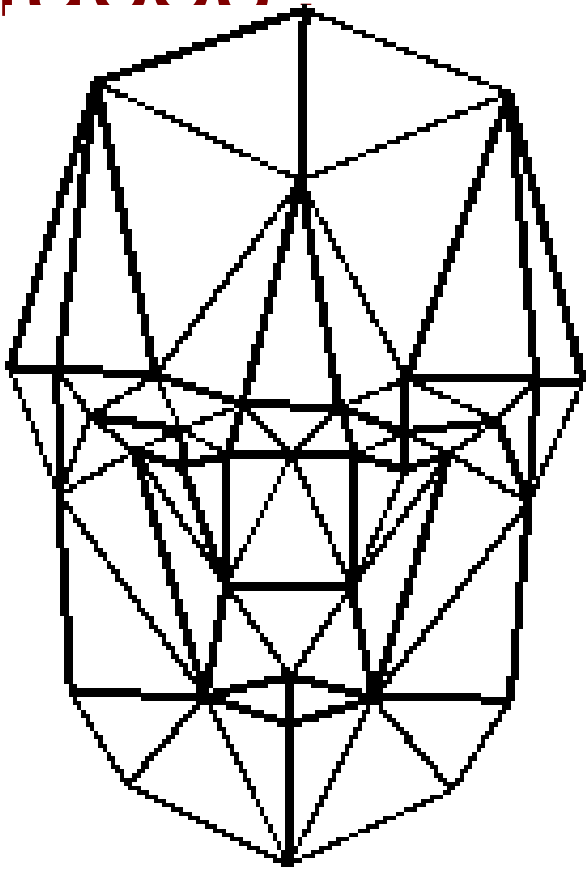
same person?

Same  
person?

**Yes**

- I have just demonstrated a massively parallel face recognition computer
- Question:  
Are computers better or worse than people at faces?

# How do computers recognize faces?

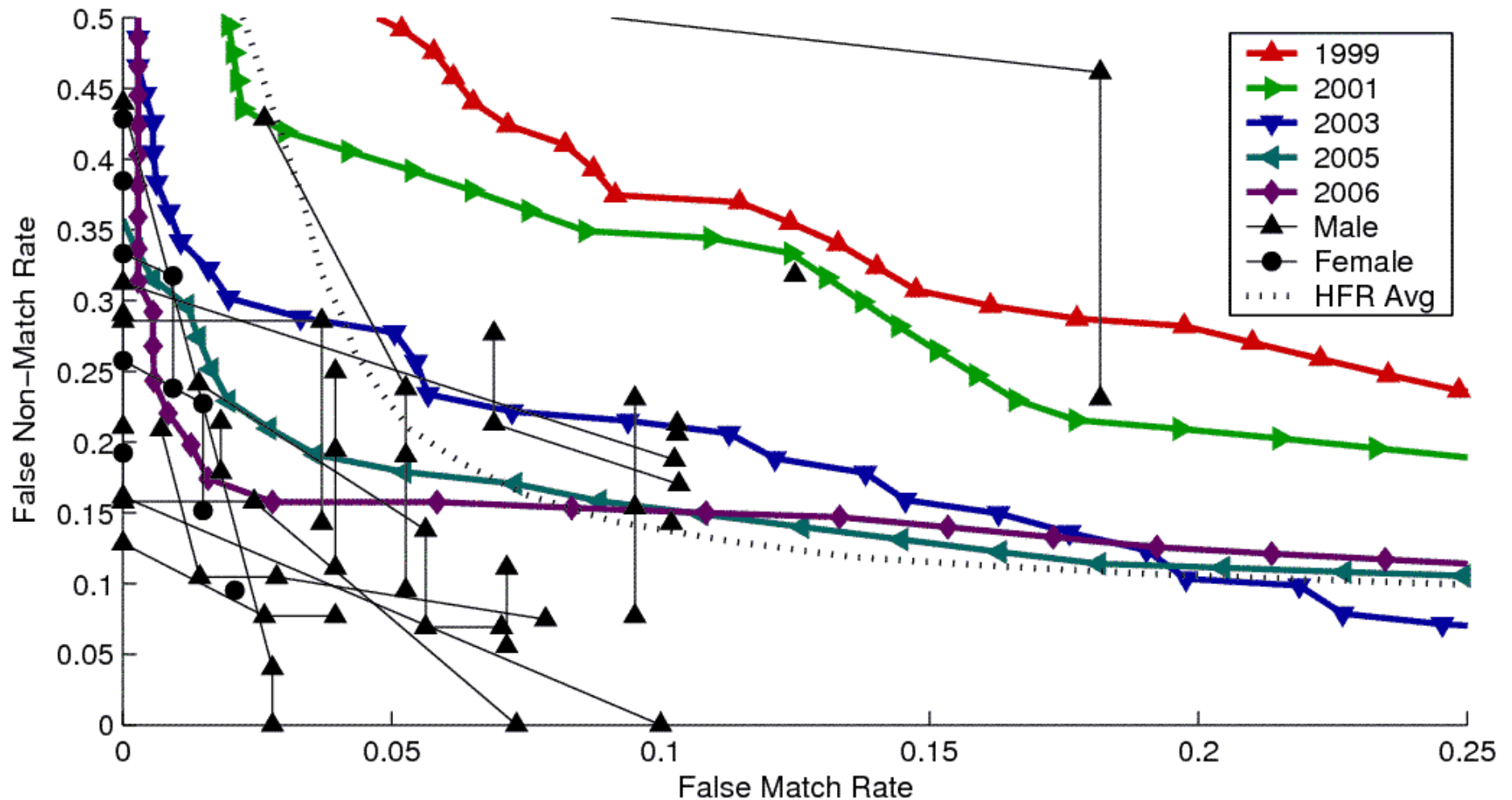


**Landmarks**

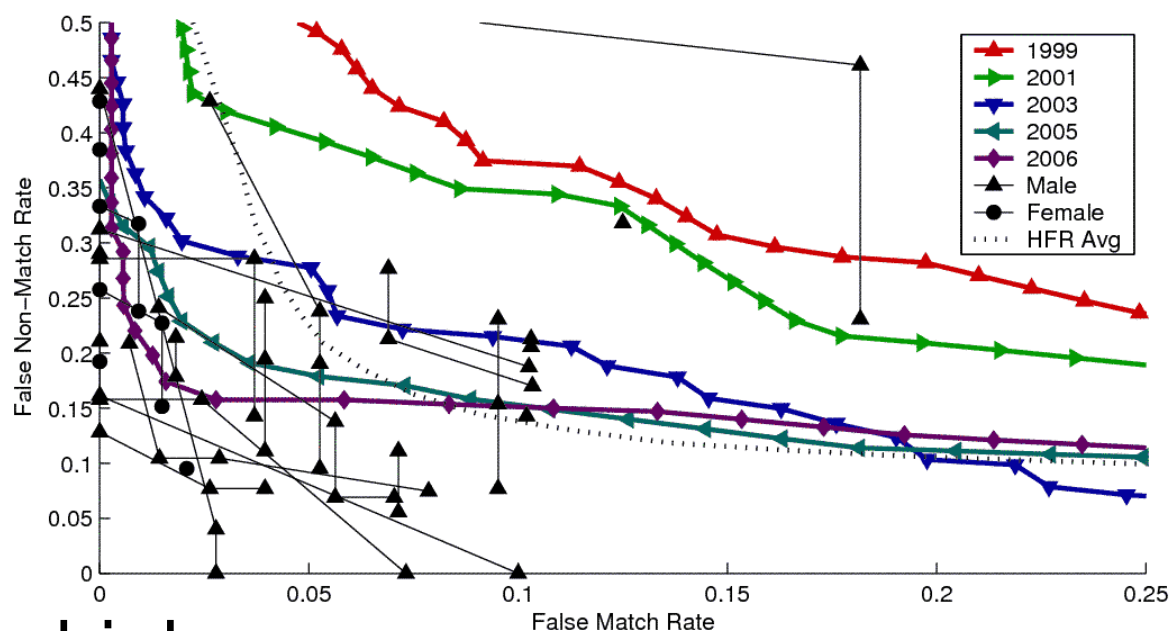


**Eigenfaces**

# Today's FR algs are better than half of people



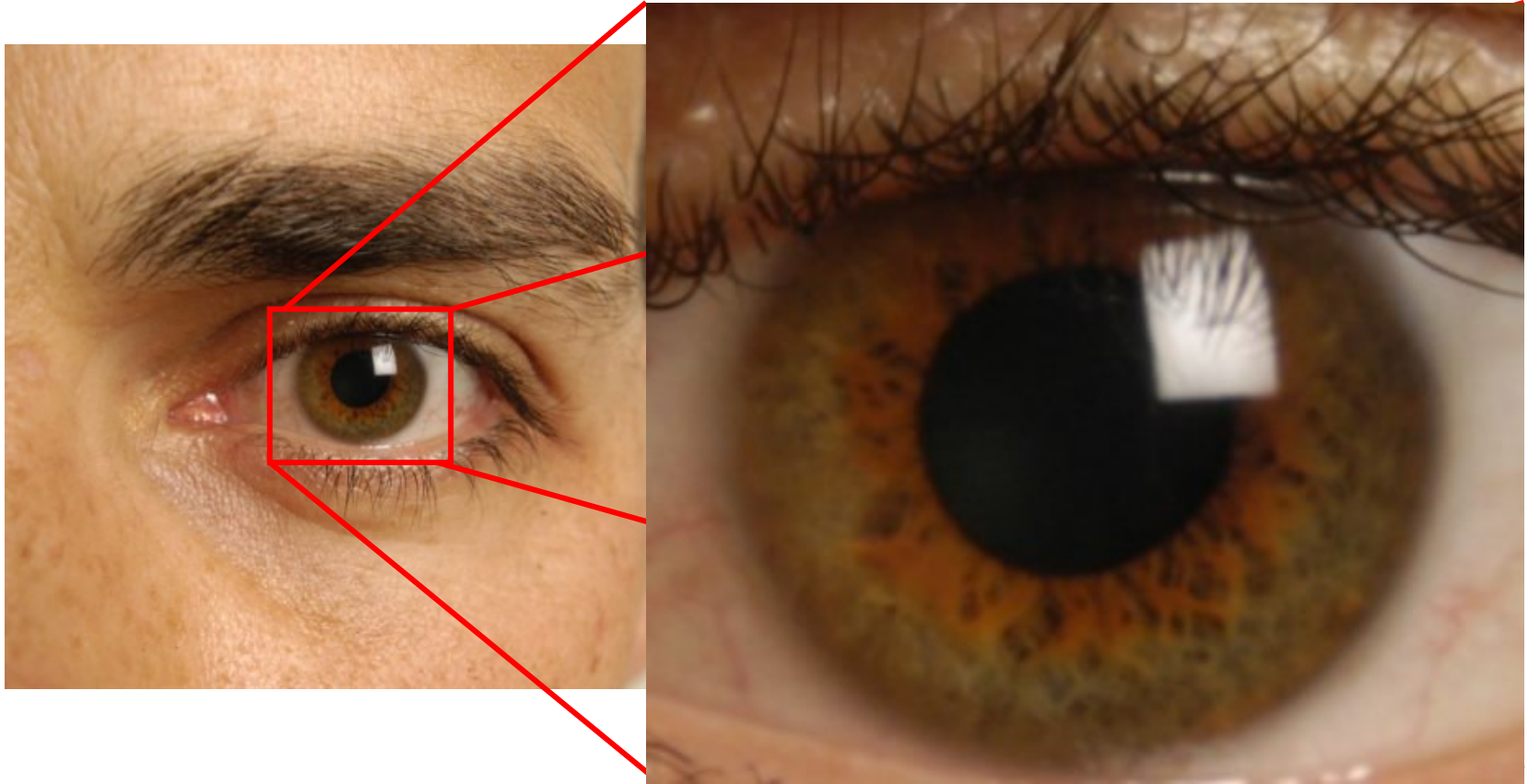
# Results



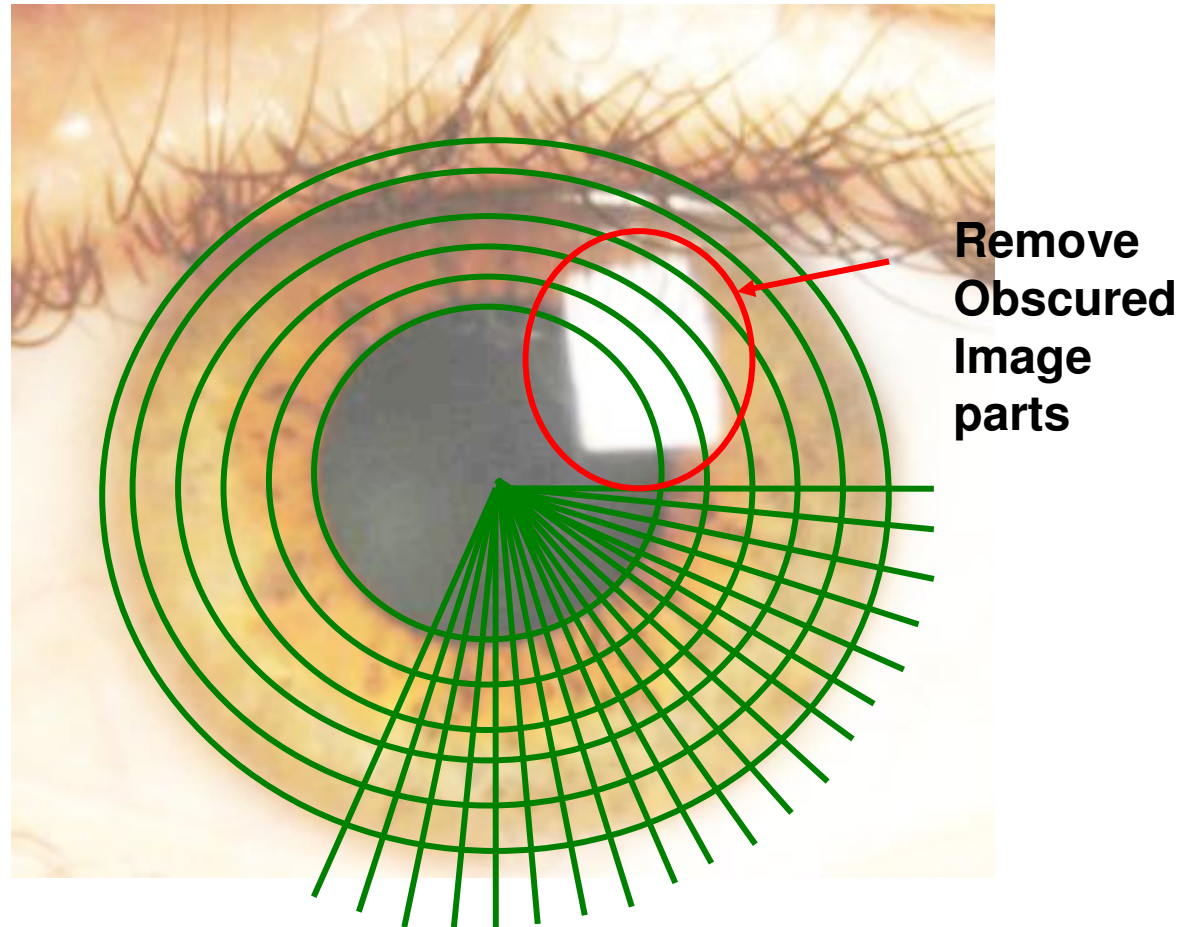
- Error rates are high
- Significant improvement in SW 1999-2006
- Most recent algs outperform about half of people
- No significant difference male/female



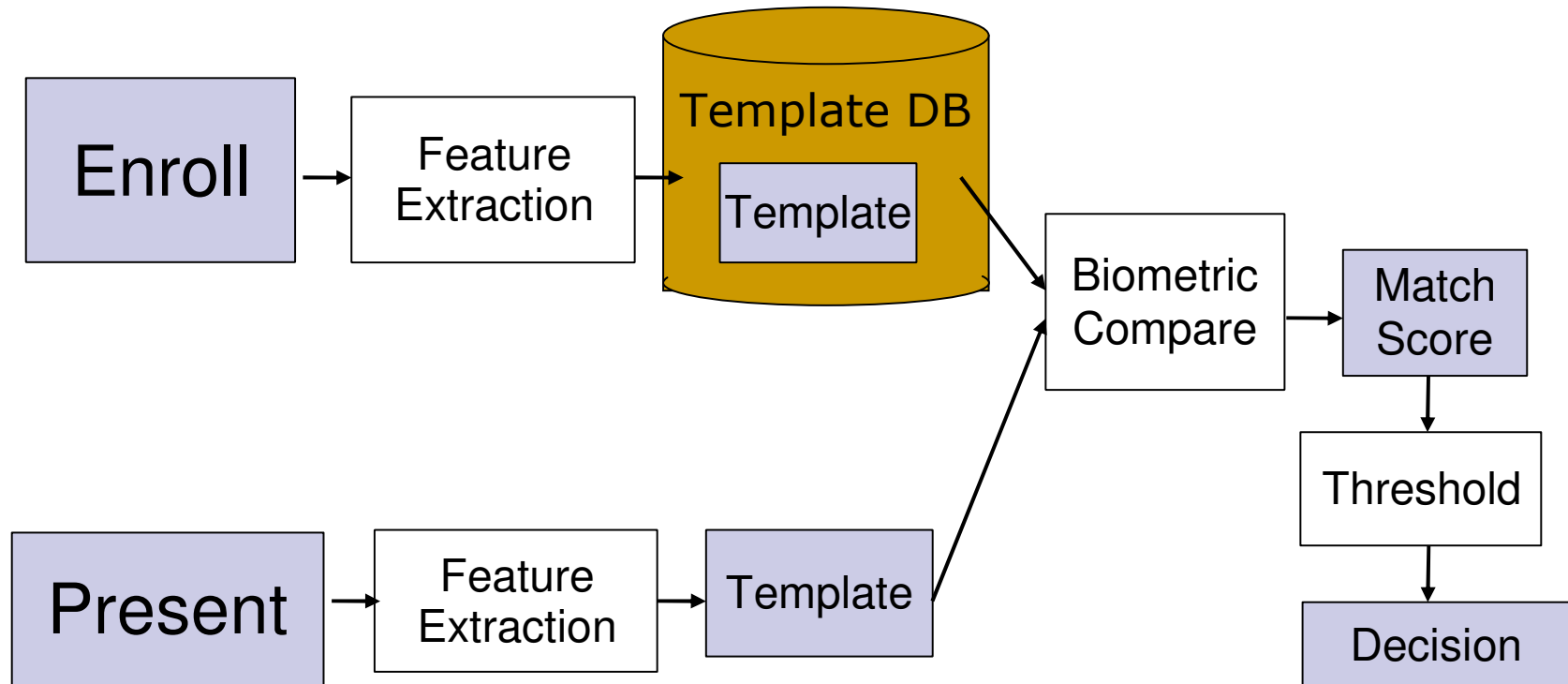
# Iris



# Iris: *Processing*



# How is this used?



# What can go wrong?

Very approximate values! Depends on all sorts of things

	Face	Finger	Iris
Failure to enroll	0%	3%	7%
Failure to acquire	3%	10%	10%
False Match	1%	10ppm	10ppm
False non-match	5%	1-5%	1-5%

# Biometrics Vulnerabilities

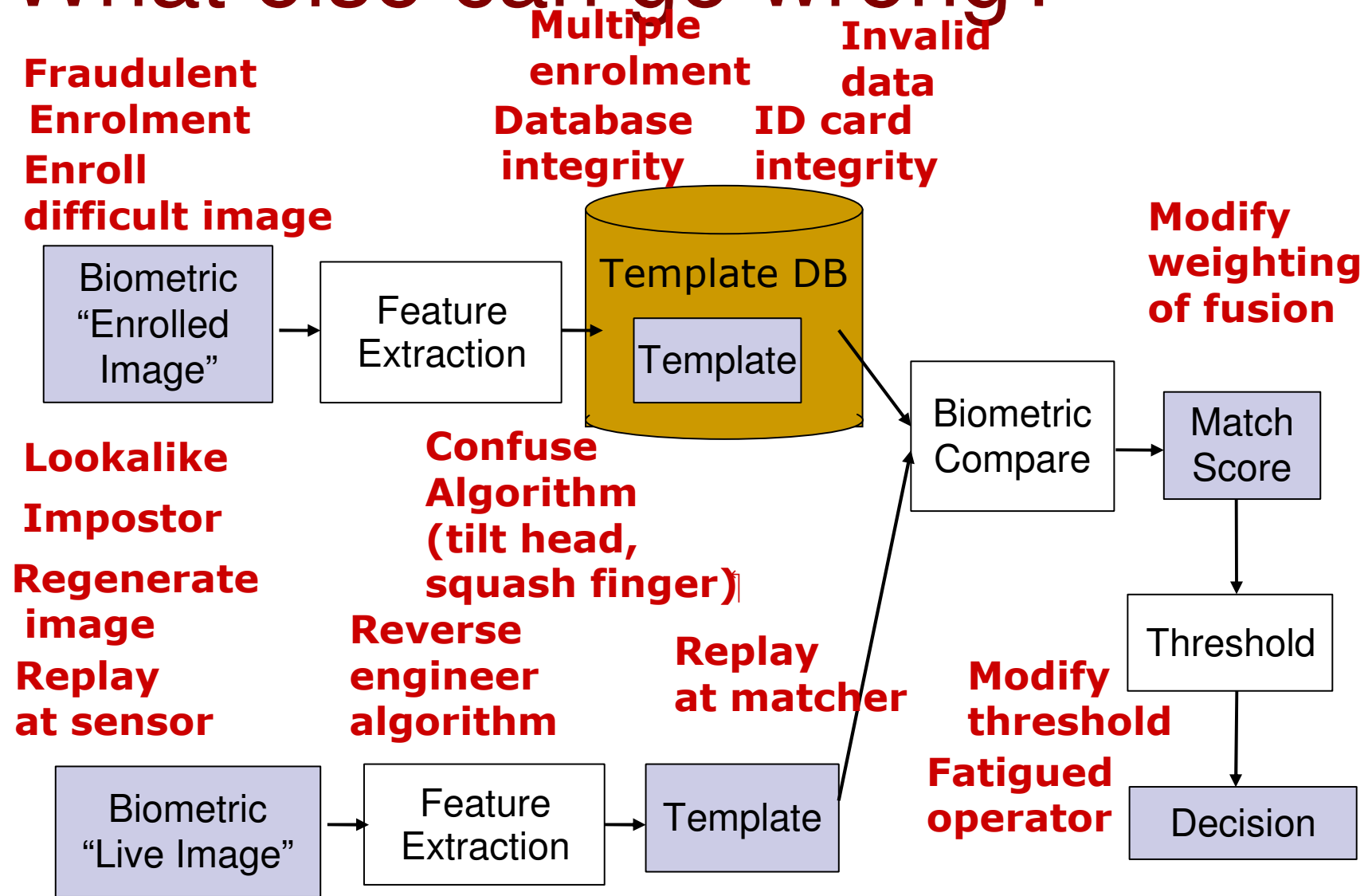
Taxonomy (from Maltoni et al, 2003):

- ❑ Circumvention
- ❑ Covert acquisition
- ❑ Collusion / Coercion
- ❑ Denial of Service

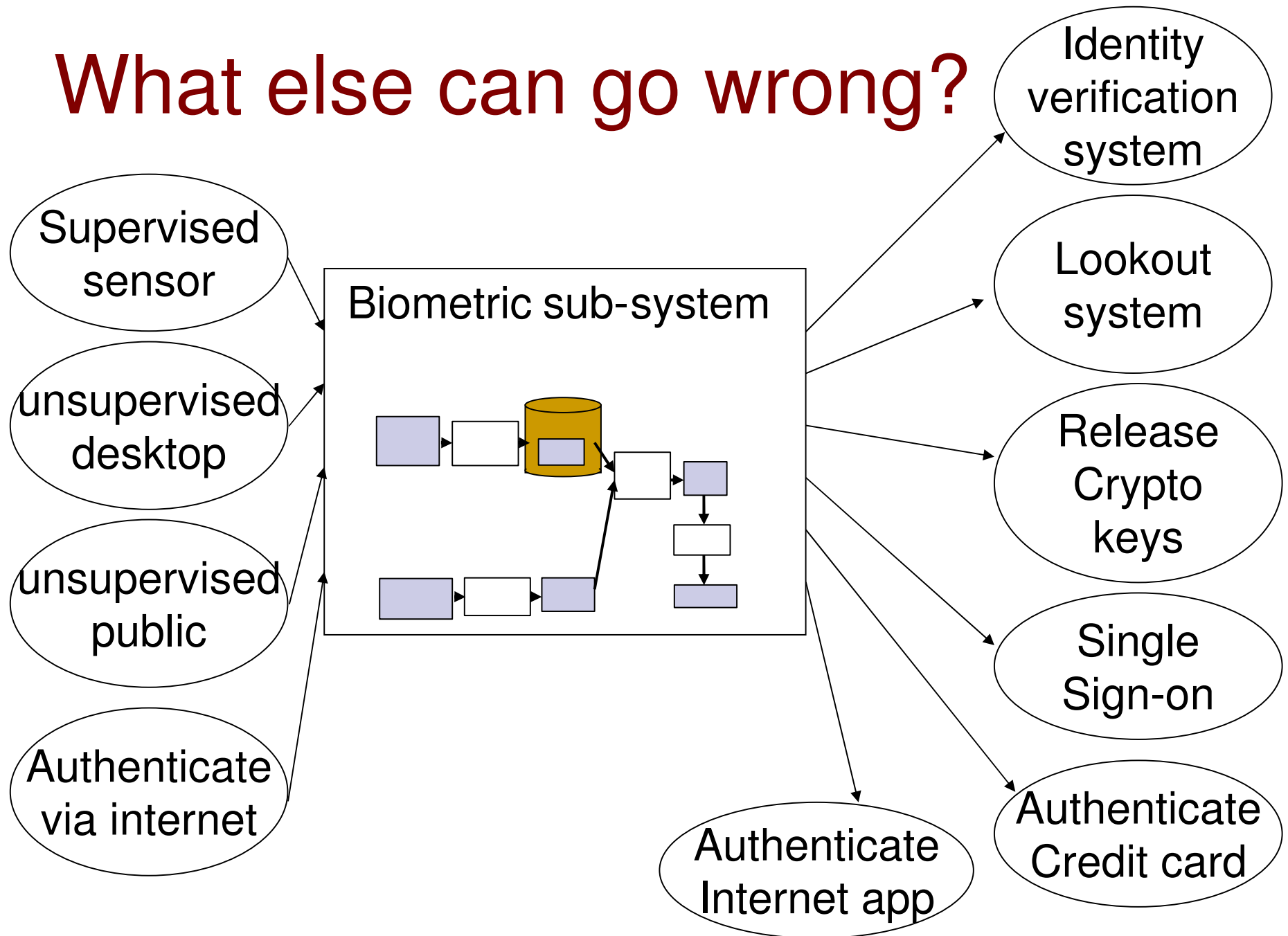
# Biometrics Security Issues

- Biometrics are not secrets
- Biometrics cannot be revoked
- Biometrics have secondary uses

# What else can go wrong?



# What else can go wrong?





# Spoofting



# Who manages registration?

<i>Who</i>	<i>What</i>	<i>Example</i>
Government	Passport	Iris for fast passenger processing
Industry	Credit card	Voiceprint. Callback to validate sales
Individual	Cell Phone	User locks phone with fingerprint

	<i>Vulnerable</i> ✖		Pass- port	Credit Card	Cell phone
	<i>Secure</i> ✔				
Theft			✔	✔	✔
Duplication			✔	✔	✔
Theft and modification			½	½	✖
Registration fraud			½	✖	✖
Spoofing			½	½	✖
Phishing			✔	✖	✖
“Dumpster Diving”			✔	✖	✔
Secondary use of data			½	✖	✔
Privacy worries			✖	✖	✔

# Biometrics in Canada (Gov't)

- Passports
- Immigration
- Customs
- Defence
- Natural Resources
- Public Safety

# Epilogue: Our future?

Operator: "Thank you for calling Pizza Hut."

**Customer: "One All-Meat Special..."**

Operator: "Thank you, Sir. Your voice print verifies with your National ID Number: 6102049998"

**Customer: (Sighs) "I'd like to order an All-Meat Special pizza..."**

Operator: "I don't think that's a good idea, sir."

**Customer: "Whaddya mean?"**

Operator: "Sir, your medical records indicate that you've got very high blood pressure and cholesterol. Your Health Care provider won't allow such an unhealthy choice."

**Customer: "Darn. What do you recommend, then?"**

# Epilogue:

Operator: "You might try our low-fat Soybean Yogurt Pizza. I'm sure you'll like it"

**Customer: "What makes you think I'd like something like that?"**

Operator: "Well, you checked out 'Gourmet Soybean Recipes' from your local library last week, sir."

**Customer: "OK, lemme give you my credit card number."**

Operator: "I'm sorry sir, but I'm afraid you'll have to pay in cash. Your credit card balance is over its limit."

**Customer: "@#%/\$@&?#!"**

Operator: "I'd advise watching your language, sir. You've already got a July 2012 conviction for cussing ... "