Information Security
Identification and authentication

Advanced User Authentication II

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LiU expanding reality

Agenda for lecture I within this part of the course

- Background
- Statistics in user authentication
- Biometric systems
- Tokens

Authentication✔
eID✔
ePassports✔
Biometrics in general✔
Statistics(✔)
Generic biometric system

Fumy, W. and Paeschke, M. Handbook of eID Security

A. Jain, A. Ross and K. Nandakumar, Chapters 1 in "Introduction to Biometrics"

Agenda for lecture II within this part of the course

Background

Statistics in user authentication

Biometric systems

Tokens

- Statistics
- Generic biometric system
- Design cycle
- Multibiometrics
- Security threats
- Attacks

A. Jain, A. Ross and K. Nandakumar, Chapters 1, 6 & 7 in "Introduction to Biometrics"

Biometrics, definition

"The automated use of physiological or behavioural characteristics to determine or verify identity”

Bio from Greek life

Metric from Greek measurement

In this case we measure

- Physical properties of the user’s body
- Behaviour properties of the user

User authentication/identification

Can in an IT system be achieved via

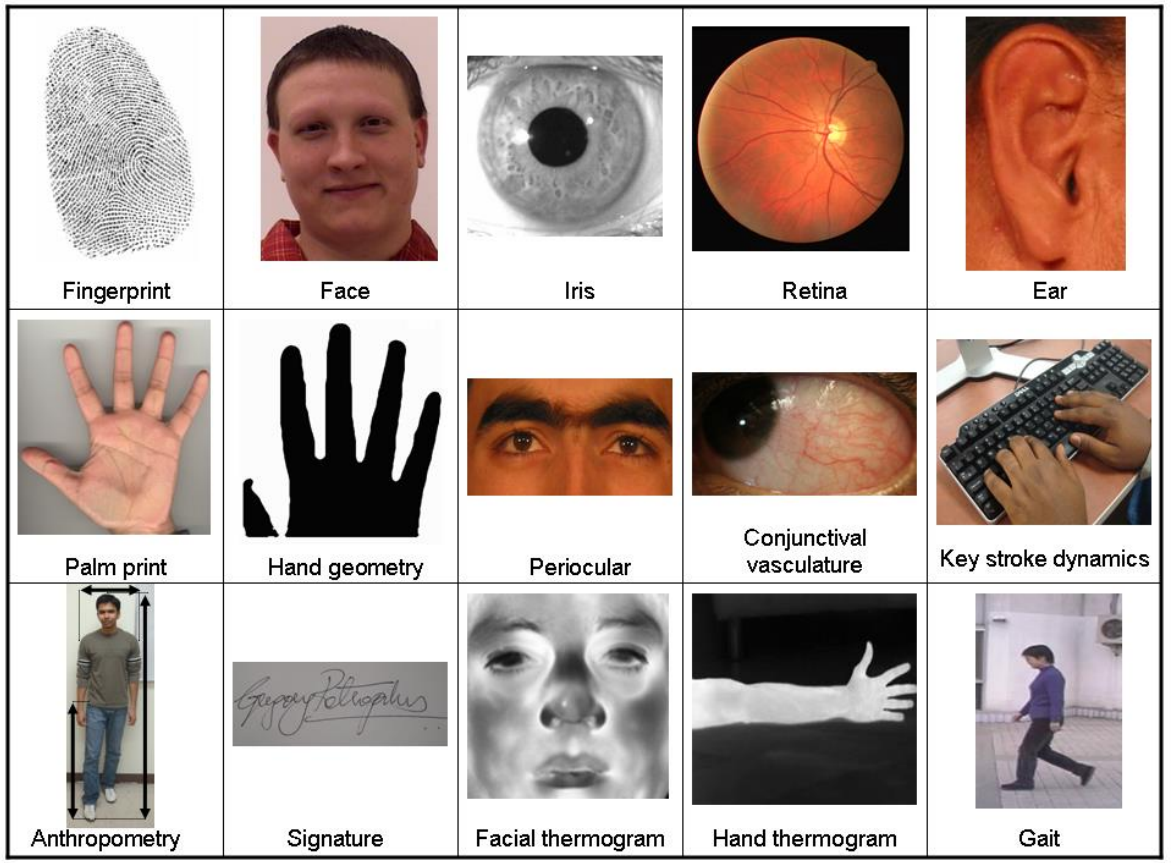
- What I know – passwords, PIN
- What I have – ID-cards, smart-card, token
- What I am/do – biometrics

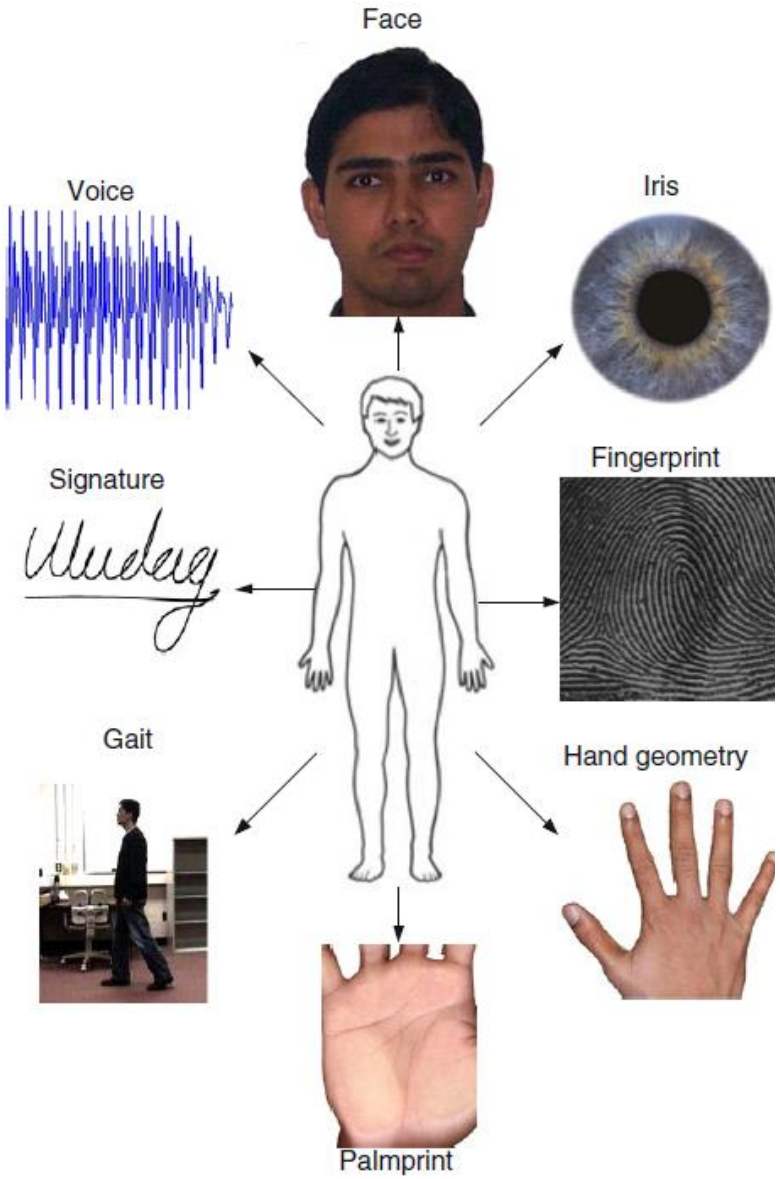
Identification

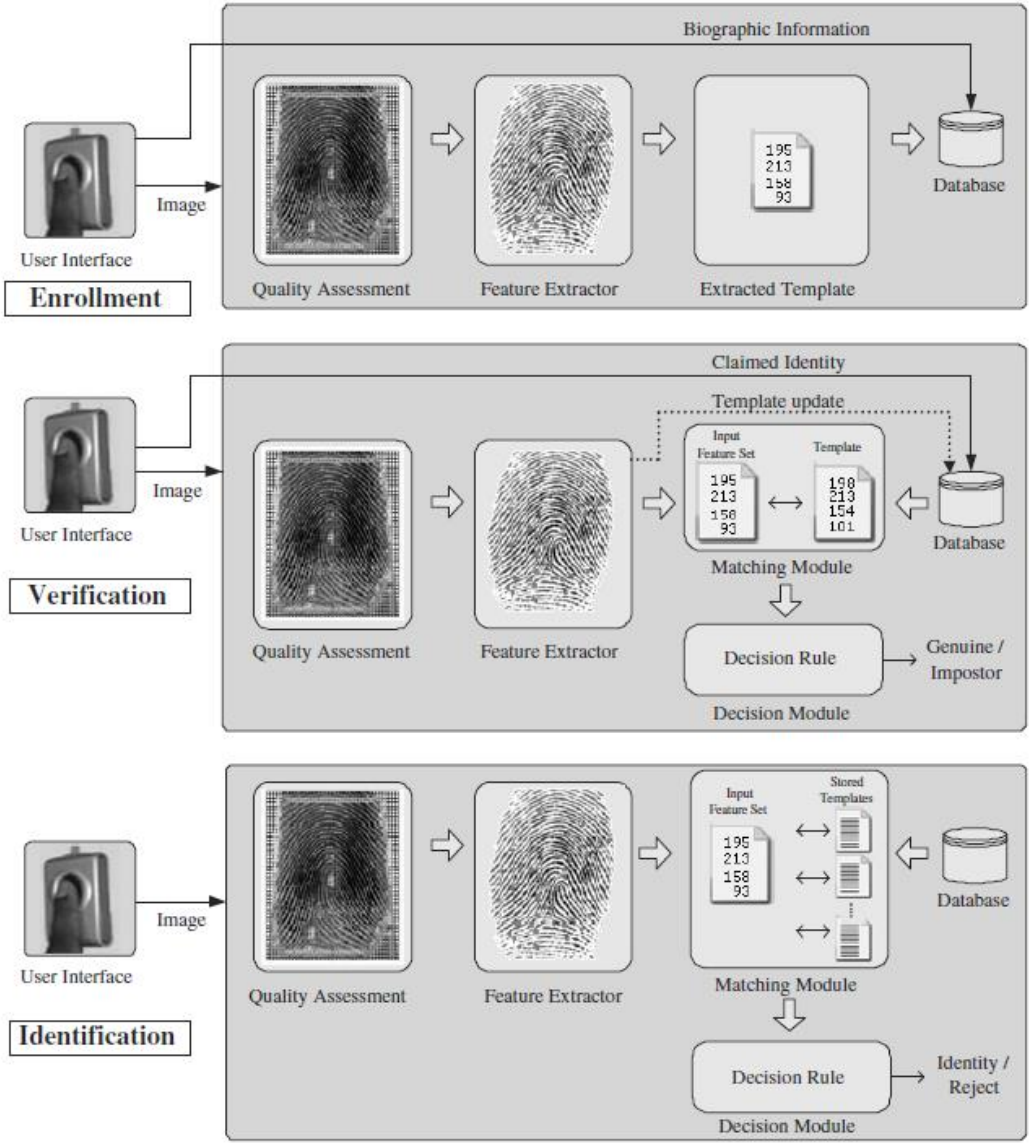
Authentication

Biometrics, examples

- Written signature
- Retinal scan
- DNA
- Vein pattern
- Thermal pattern of the face
- Keystroke dynamics
- Finger prints
- Face geometry
- Hand geometry
- Iris pattern
- Voice
- Ear shape
- Body motion patterns




Face
Voice
Iris
Signature
Fingerprint
Gait
Hand geometry
Palmprint

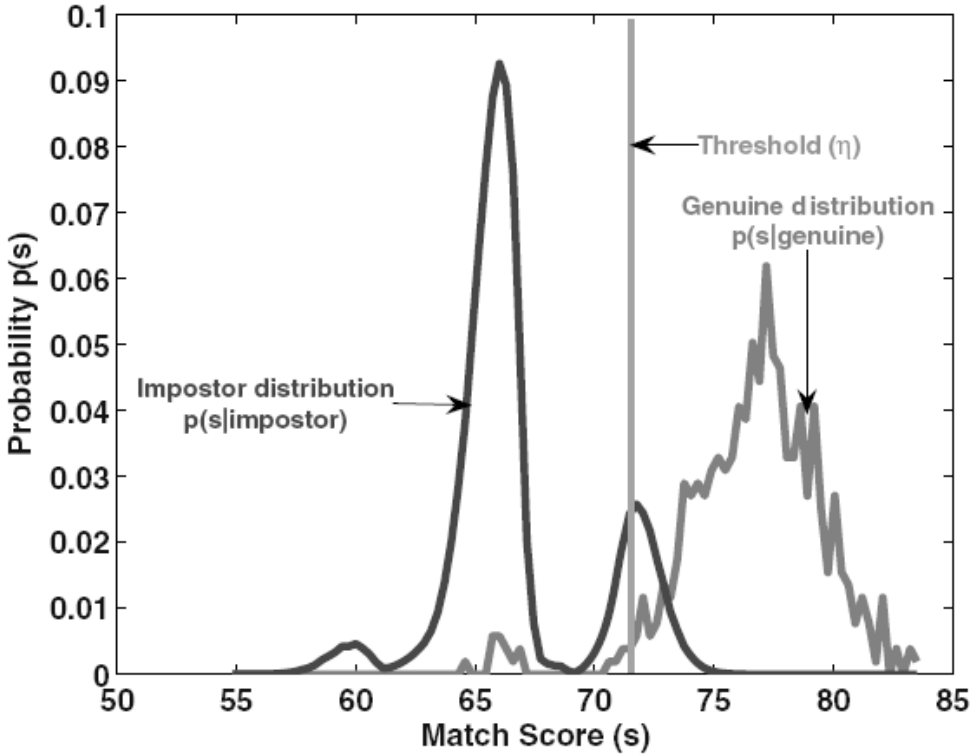

Biographic Information
Image
User Interface
Enrollment
Quality Assessment
Feature Extractor
Extracted Template
Database
Claimed Identity
Template update
Input Feature Set
Template
Matching Module
Decision Rule
Genuine / Impostor
Decision Module
Verification
Identification
Stored Templates
Identity / Reject

Statistics in user authentication

Problems and unexpected effects

Statistics in biometrics

- A typical system has a threshold parameter which determines the allowed variance
- Use statistical theory for hypothesis testing
- Balance user population statistics against intended use plus importance of each of the CIA criteria, and set thresholds accordingly



Identity testing problems

Suppose there are 10,000 persons on a “no fly” list

An airport uses identification devices with FAR=0,1% and FRR=5%. Reasonable values?

- A terrorist has a 5% chance of getting aboard. Send 20 and one will succeed
- A typical airport like Arlanda (≈ 50 000 passengers per day) will detain 50 innocent people each day

Traps in using FRR

False Rejection Rate is a mean value over a trial population

It does not (necessarily) give the general probability that a given user is rejected

Usually there is a subset of users who get most of the rejections

It is not valid for users deliberately trying not to be recognised

Conditional v mean values

If the correct user is often rejected due to anomalies, attempts at false acceptance as that user may fail often and vice versa. This distorts “true” values

If the attacker knows the statistics of single users, the most likely victim can be chosen

Example 1

A user population has two sets of users, X with excellent characteristics for the biometric system and Y with bad characteristics. 1% belong to Y

A user from X has FAR 0.5%

A user from Y has FAR 50%

Total FAR ≈ 1%

An attack deliberately at a Y person still has 50% probability of succeeding

Example 2

A user population has two sets of users, X with good characteristics for the biometric system and Y with bad characteristics. 1% belong to Y

A user from X has FRR 0.5%

A user from Y has FRR 50%

Total FRR ≈ 1% (looks good, you must re-authenticate only once for every 100 attempts on the average)

Users from Y must re-authenticate every other time when using the system. And they must make three attempts one out of four times etc.

General statistics

How large is the set of possible values?

Are some more likely than others?

How large is the user population?

How many guessing attempts can be made per time unit?

Are there restrictions on the possible number of attempts against the same user?

Are there general restrictions on the number of attempts?

Illustration example, card PIN

A card PIN has 10,000 possible values

The probability to guess a PIN in the usually allowed three consecutive attempts is thus only one in more than 3000

If 3500 cards are stolen each year, at least one misuse through correctly guessed PIN should be expected per year

With 5000 stolen cards, it is more likely that one of them gets its PIN guessed in the first attempt, than that none gets that effect

Remember

Balance risks against population characteristics, like size but not only size

Average risks can be much higher for subsets of users than for the total population

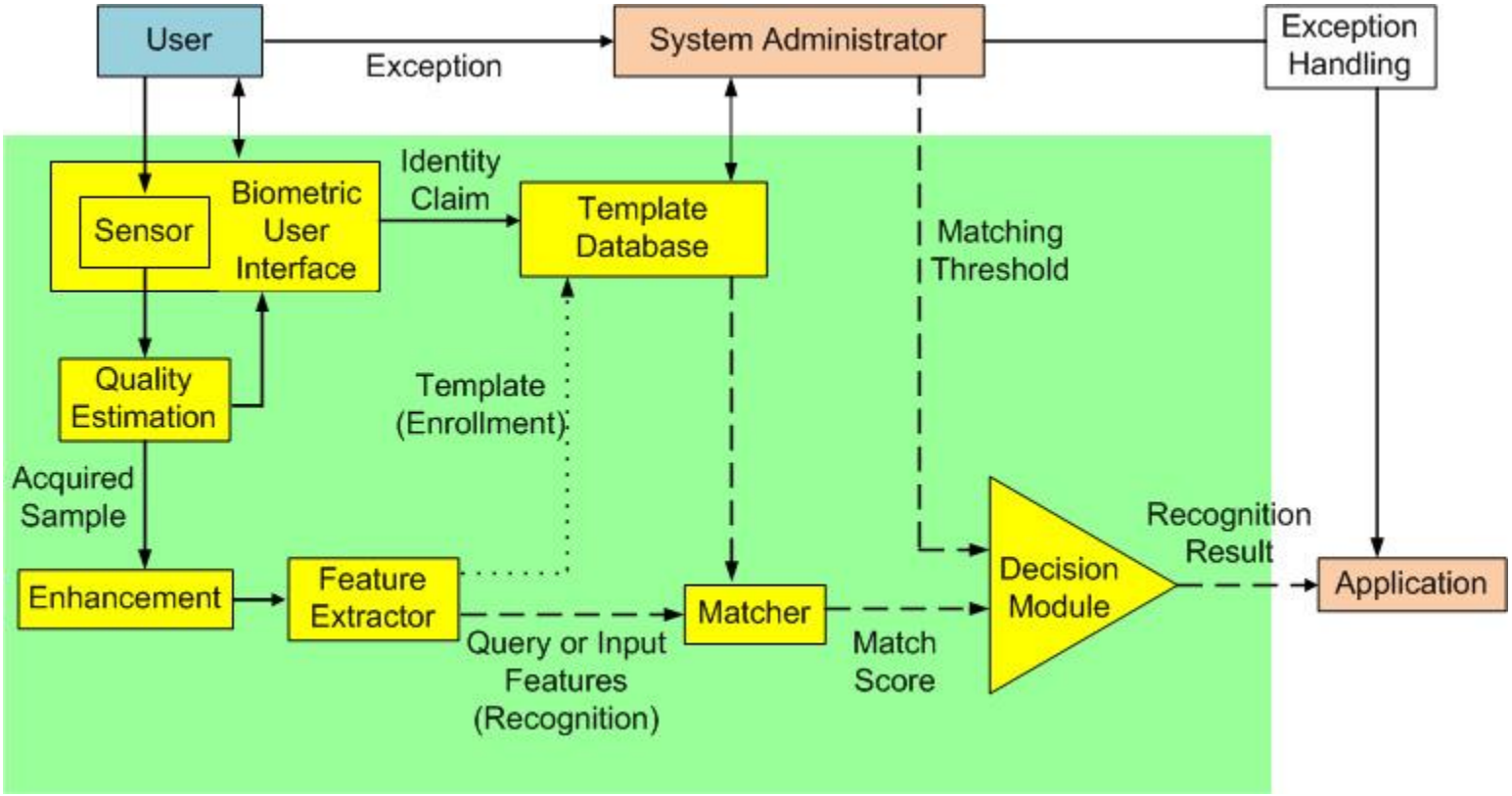
If one single customer is hit, it does not matter to that customer that the average risk per customer was very low

If some customers are at high risk, the organisation is bound to get hit eventually

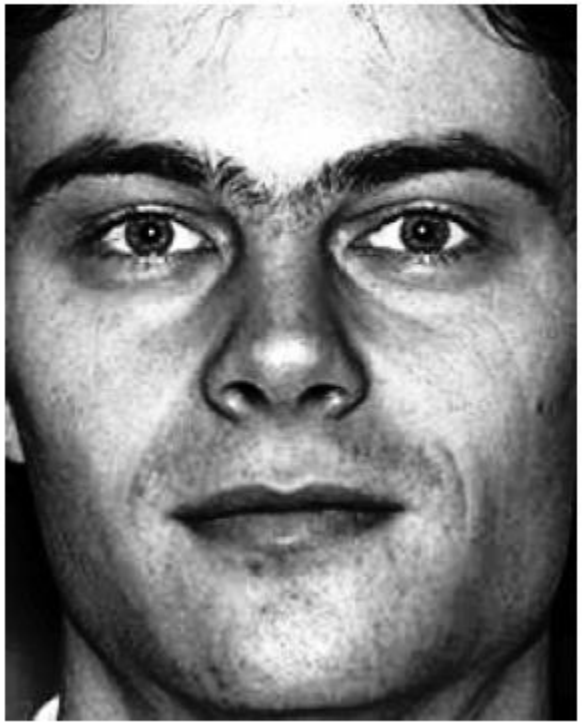
And the Gileadites took the passages of Jordan before the Ephraimites: and it was so, that when those Ephraimites which were escaped said, Let me go over; that the men of Gilead said unto him, Art thou an Ephraimite? If he said, Nay; **Then said they unto him, Say now Shibboleth: and he said Sibboleth**: for he could not frame to pronounce it right. Then they took him, and slew him at the passages of the Jordan: and there fell at that time of the Ephraimites forty and two thousand.

— Judges 12:5–6

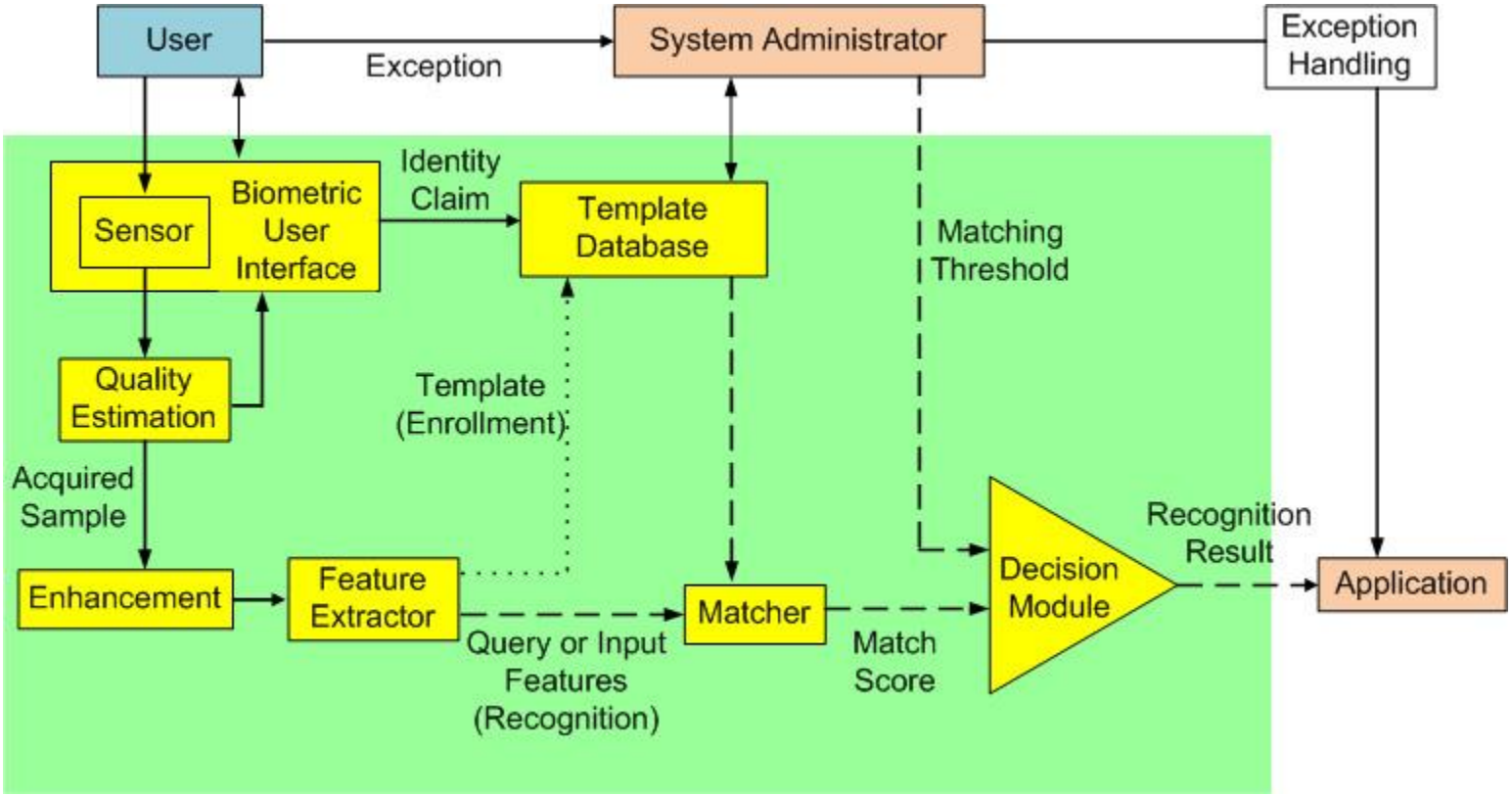
Generic biometric system: Building blocks



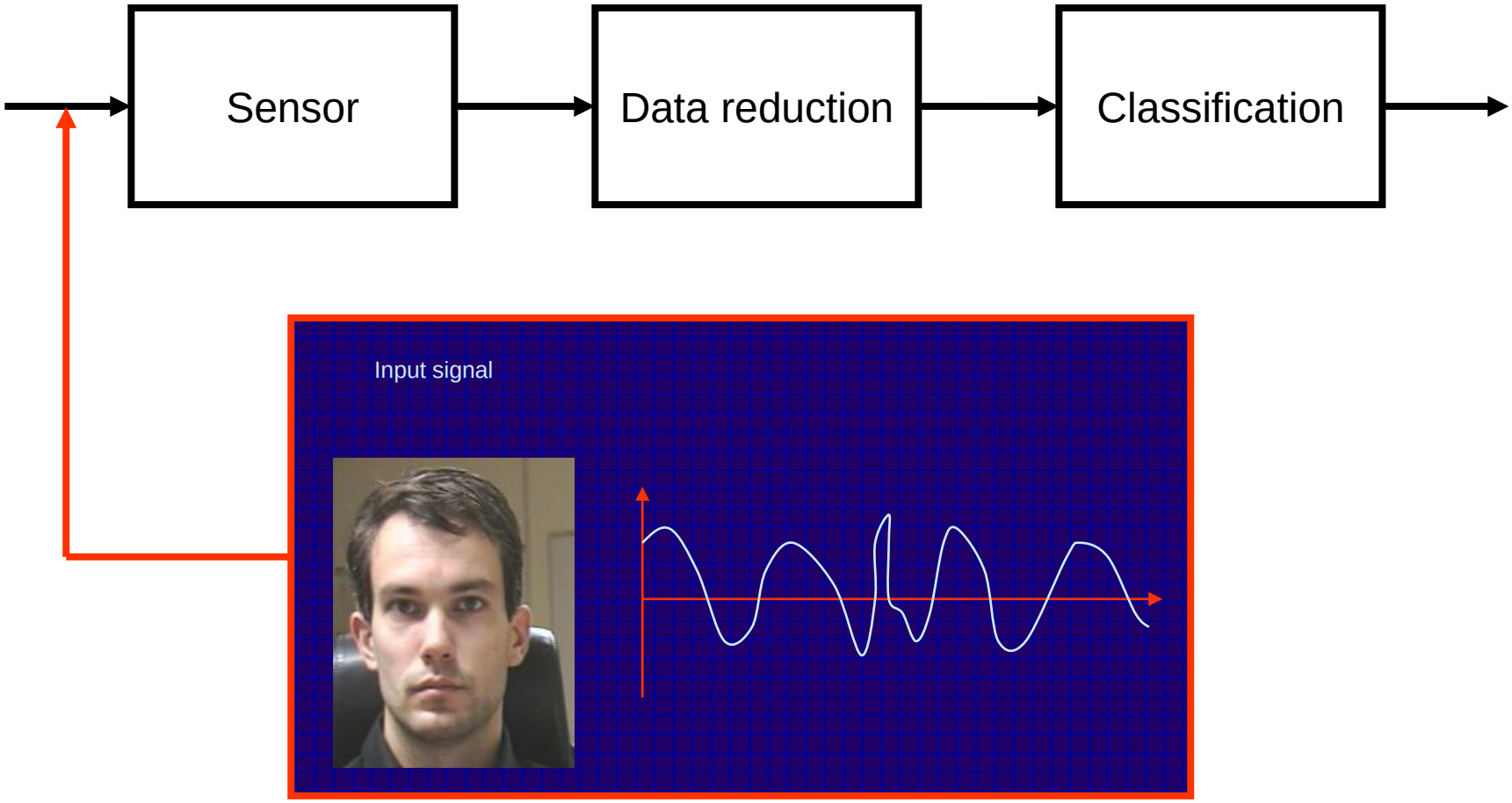
Feature extraction: Segmentation and enhancement



Generic biometric system: Building blocks



A generic biometric system



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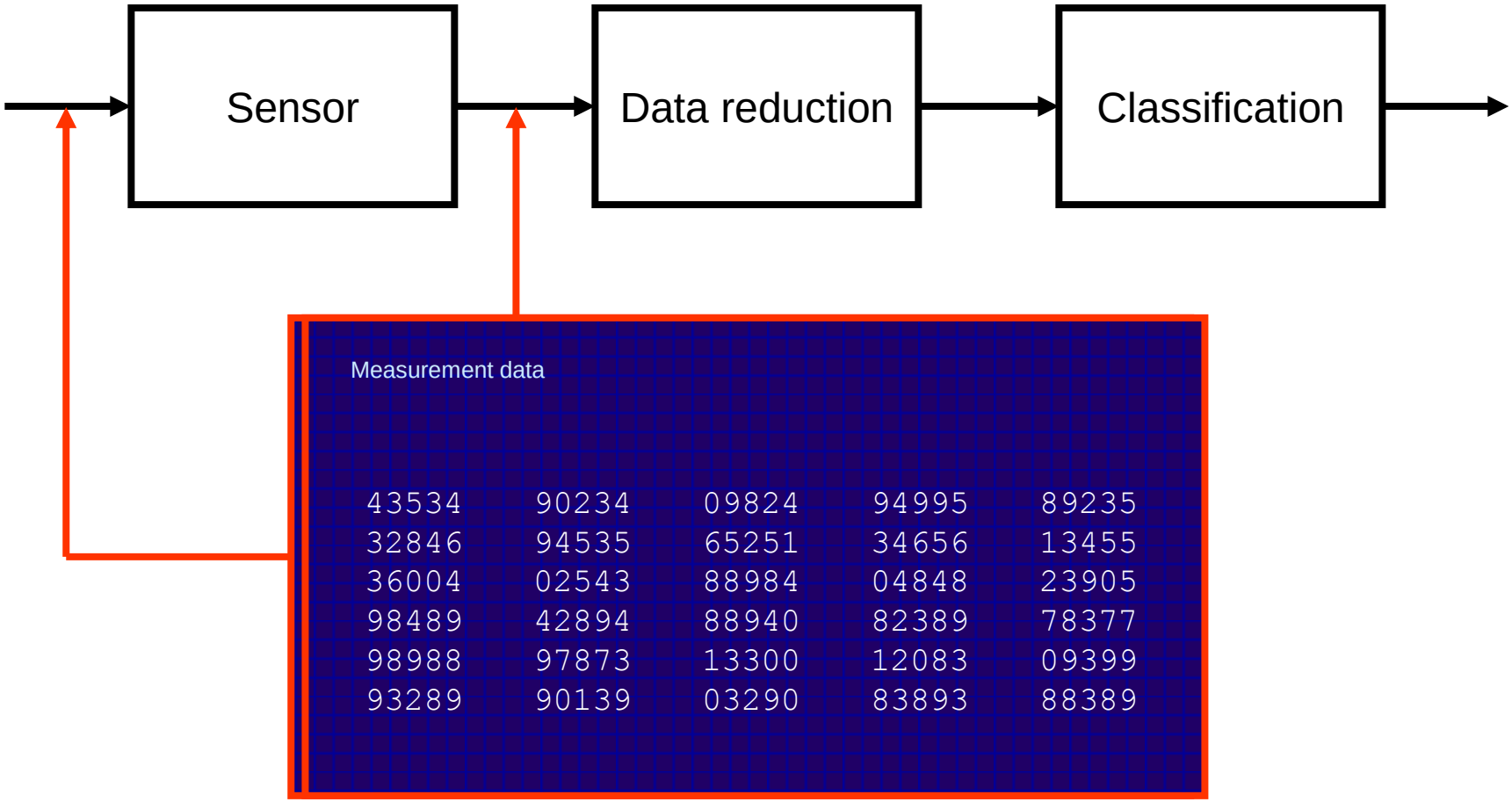
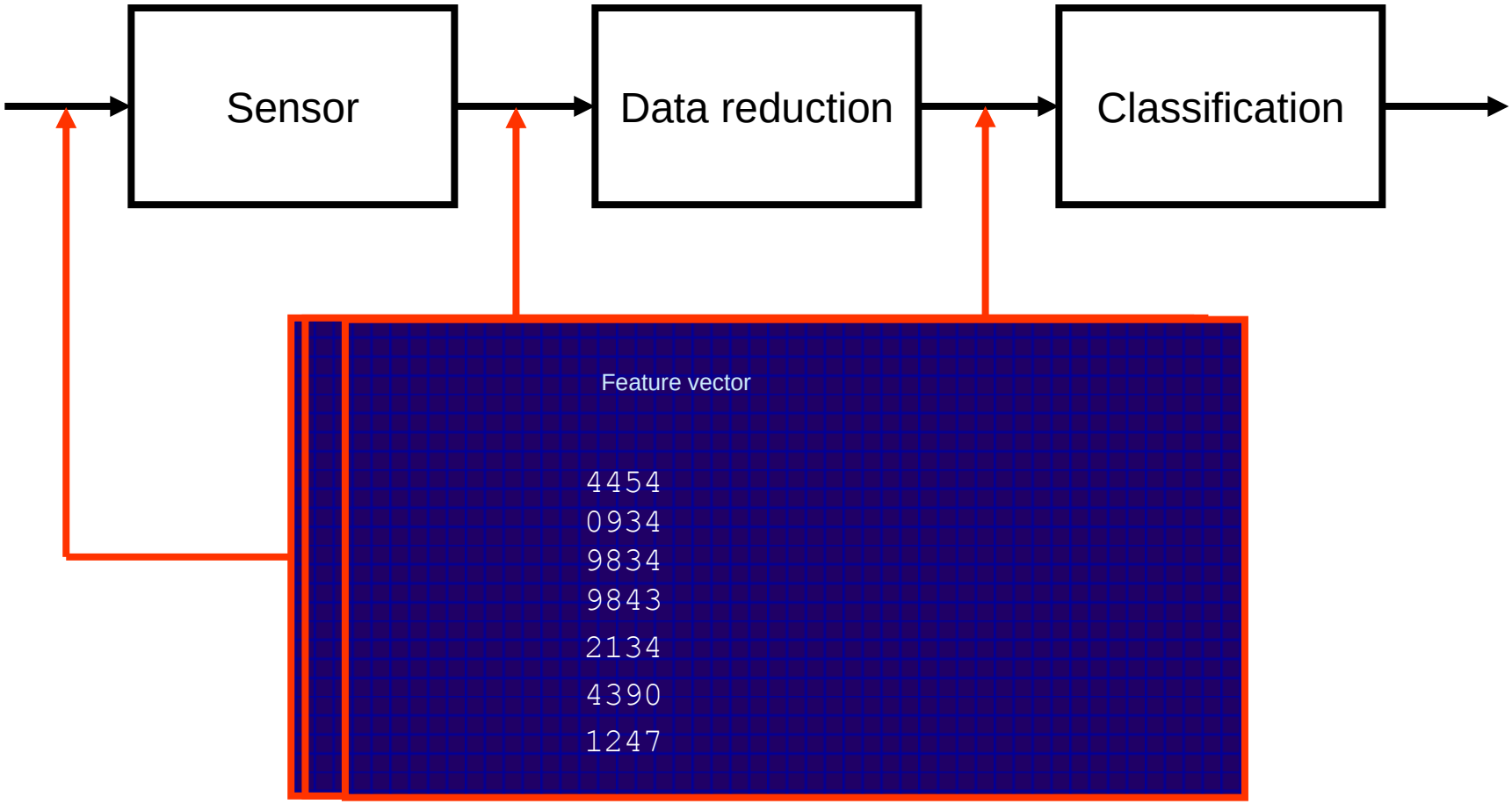
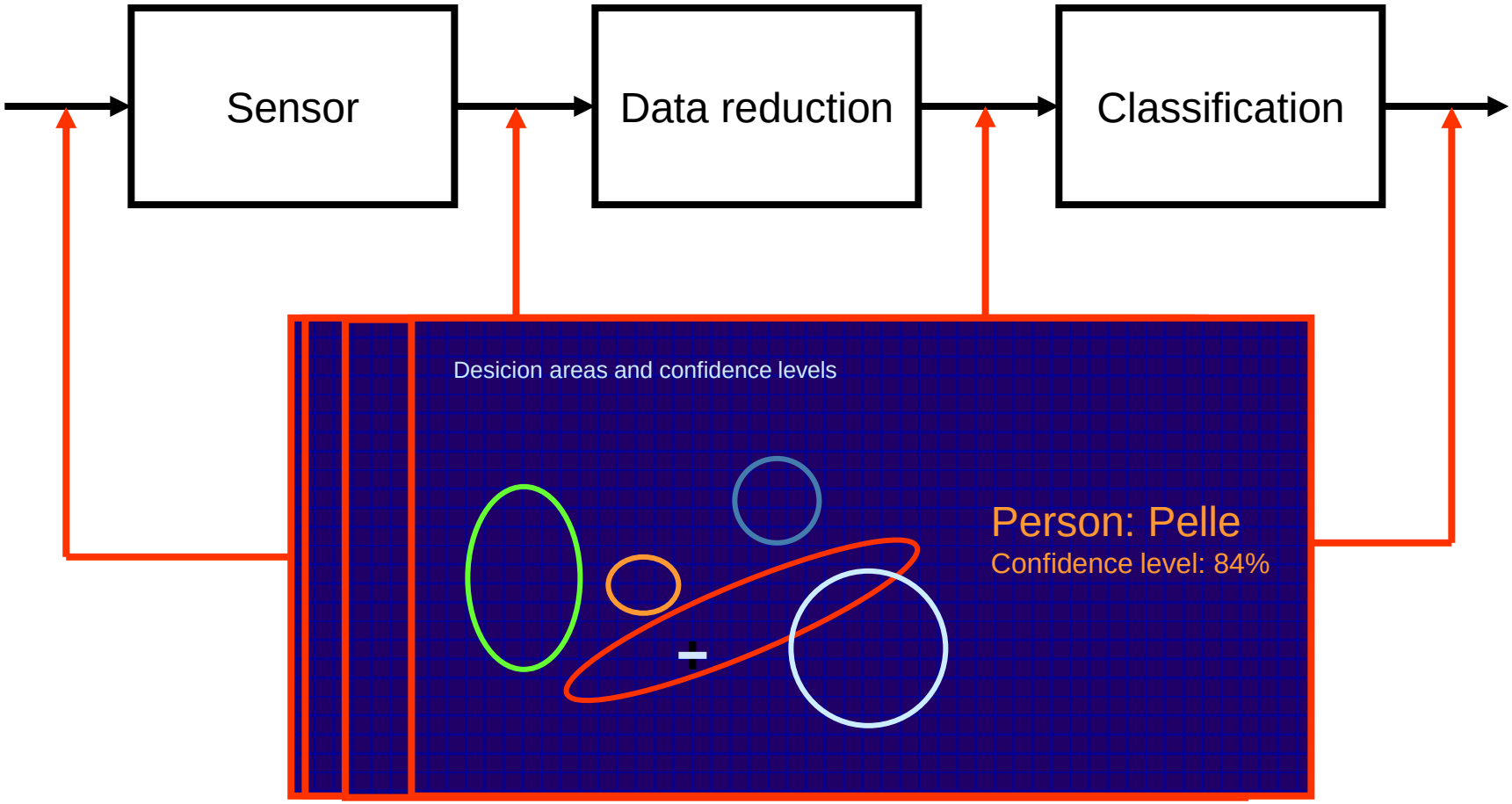


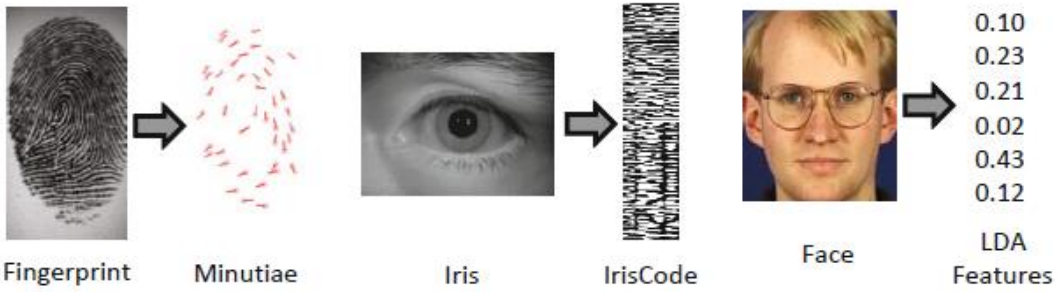
A generic biometric system

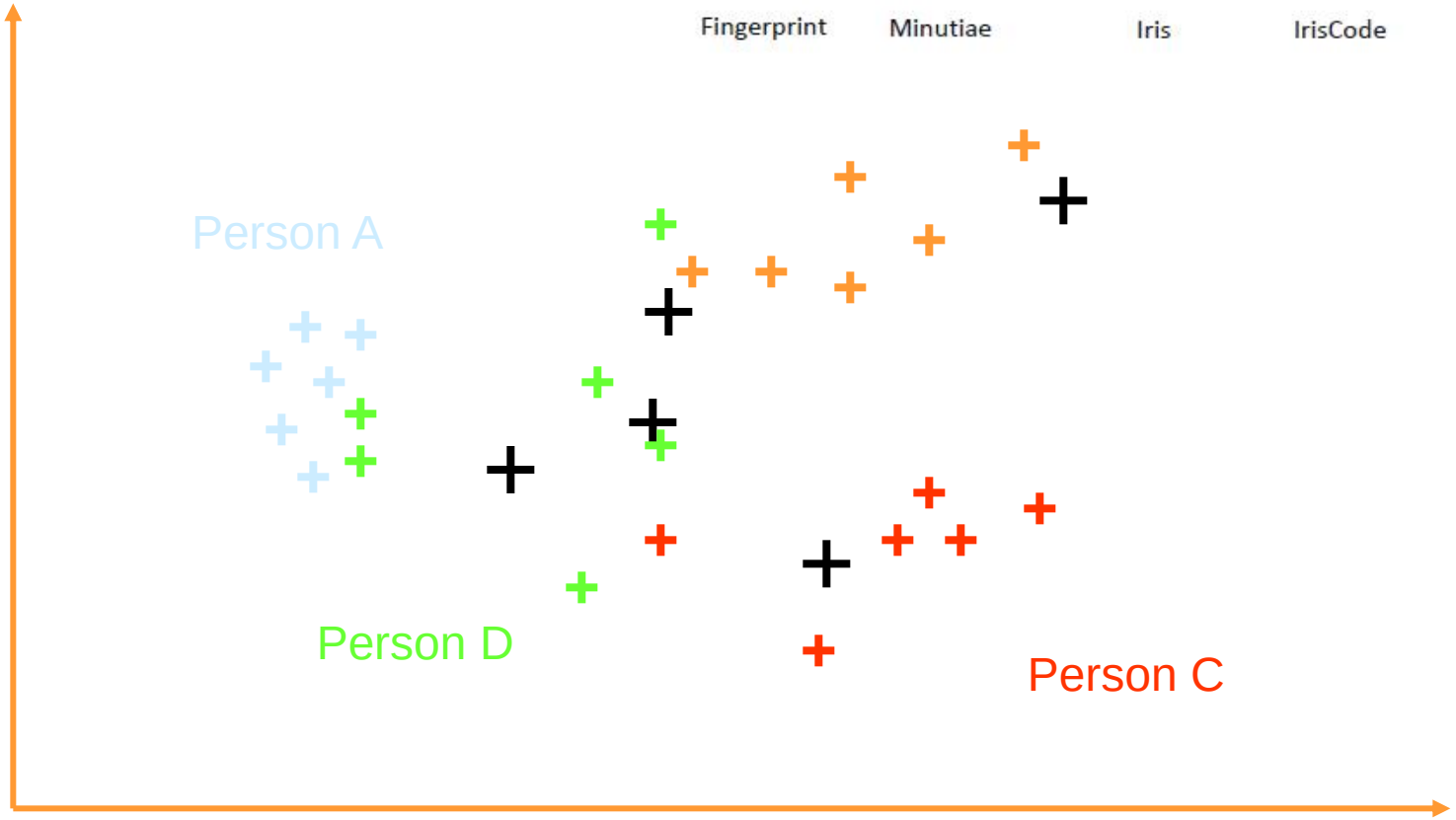


A generic biometric system

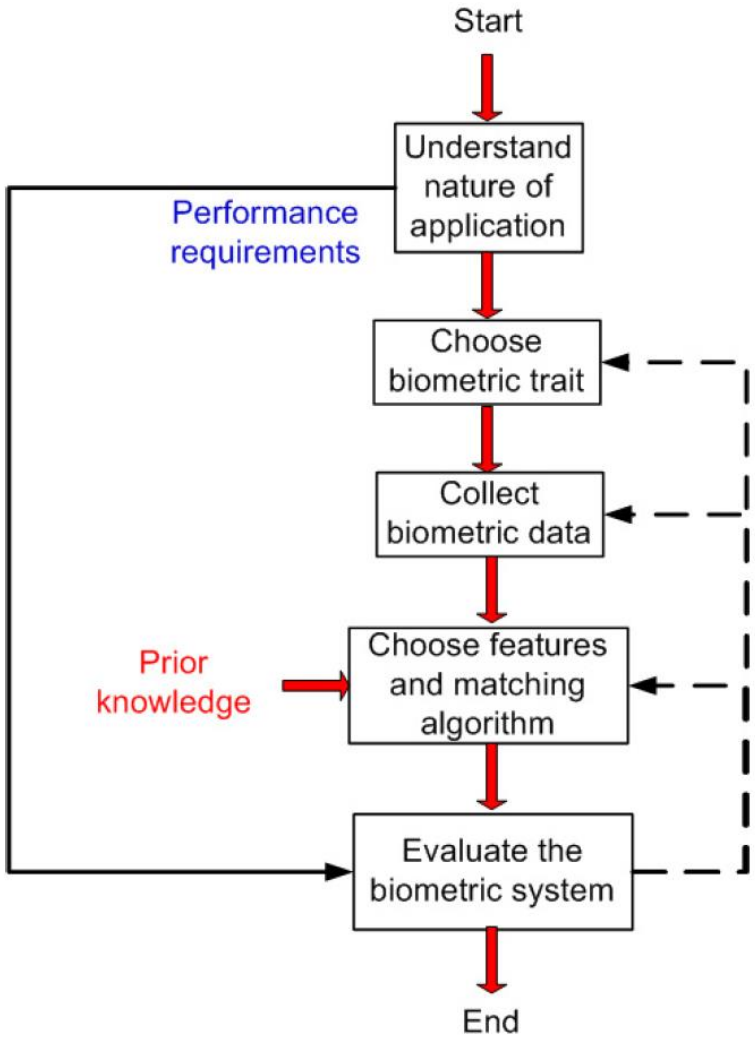


Classification

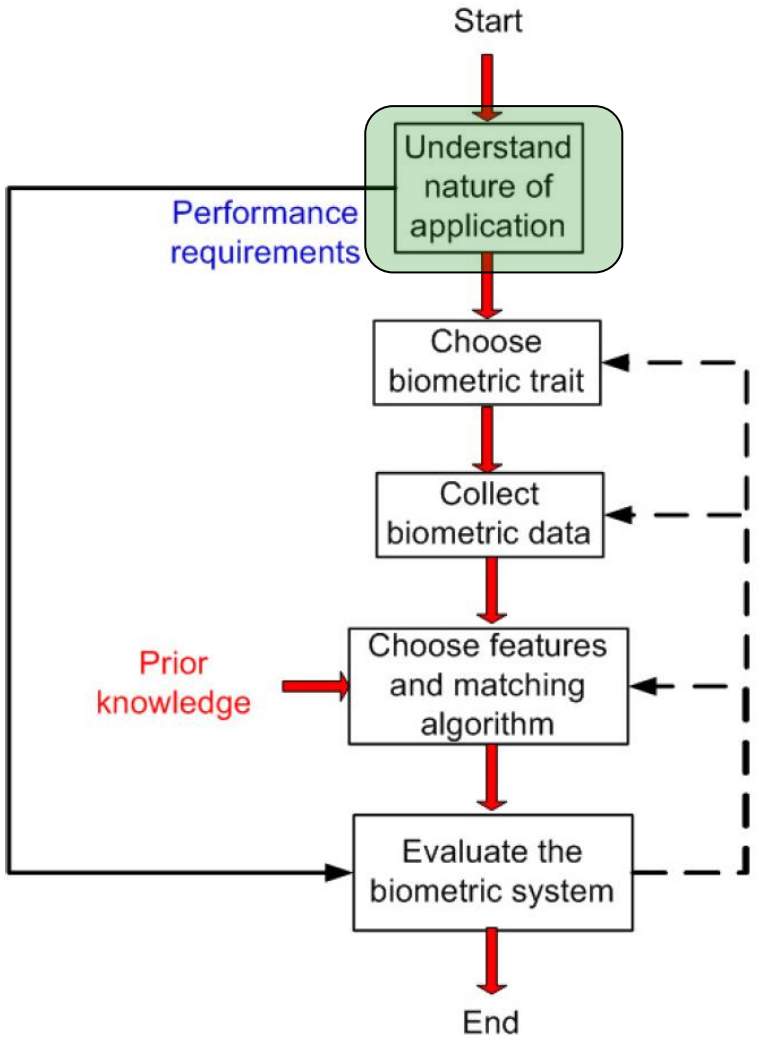




Design cycle of biometric systems



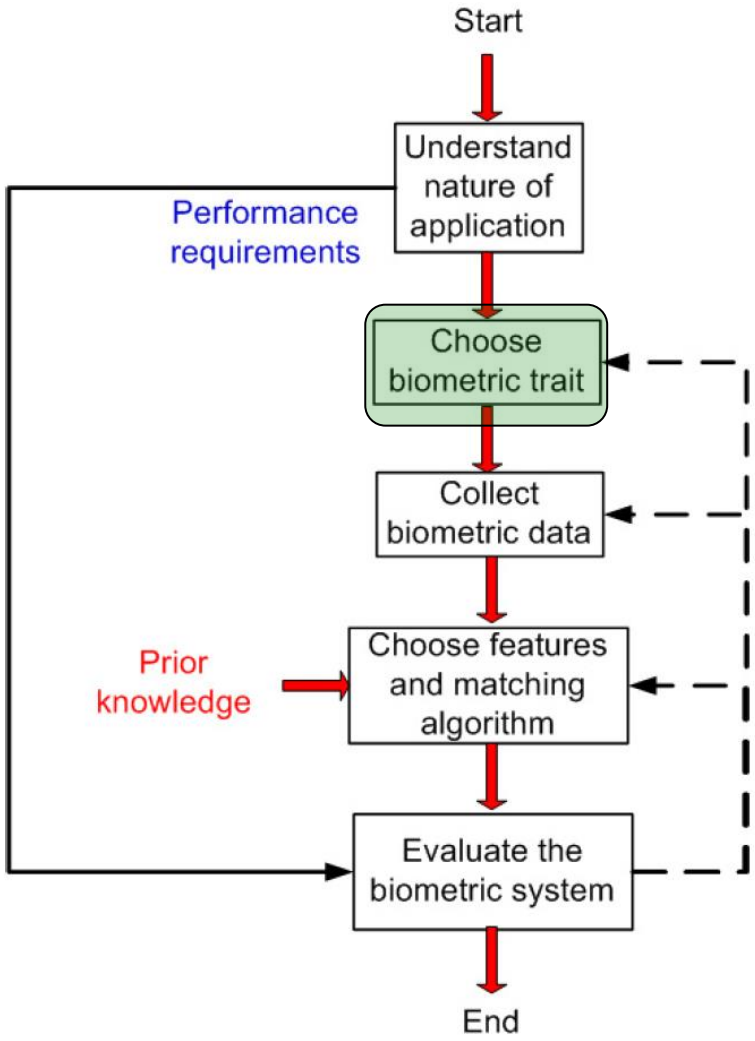
Design cycle of biometric systems



Nature of application

- Cooperative users
- Overt/covert deployment
- Habituated/Non-habituated users
- Attended/Unattended operation
- Controlled/Uncontrolled operation
- Open/Closed system

Design cycle of biometric systems



Choice of biometric trait

- Universality
- Uniqueness
- Permanence
- Measurability (Collectability)
- Performance
- Acceptability
- Circumvention

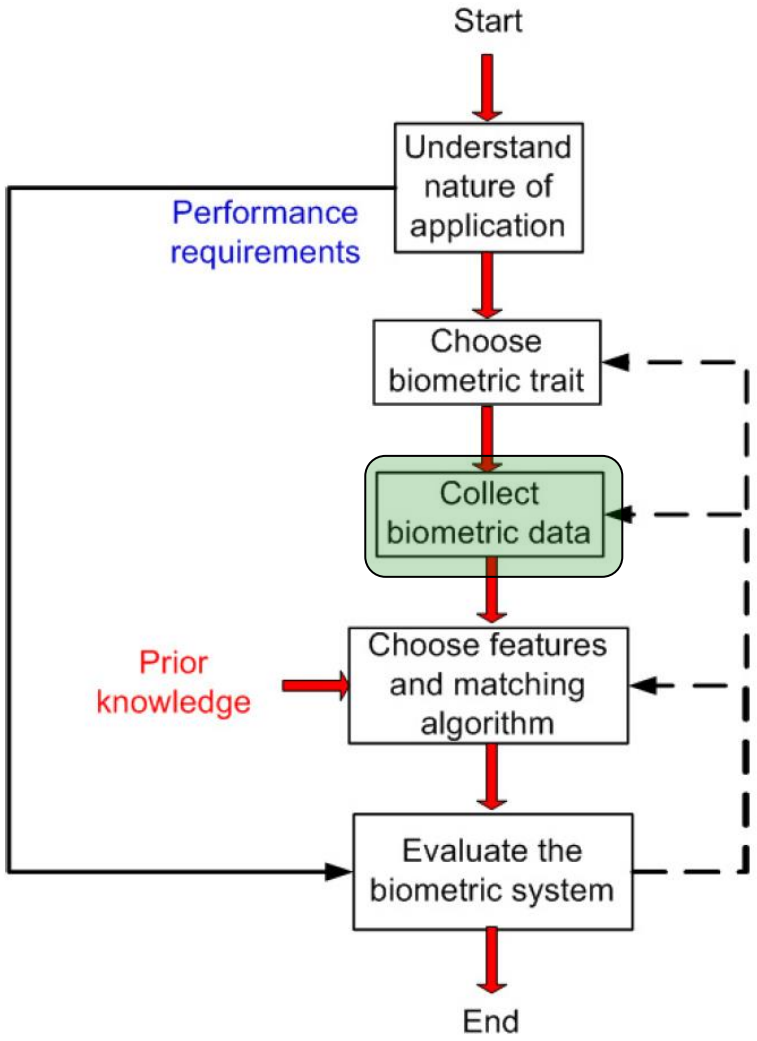
Requirements on biometric traits

Biometrics	Universality	Uniqueness	Permanence	Collectability	Performance	Acceptability	Circumvention
Face	H	L	M	H	L	H	L
Fingerprint	M	H	H	M	H	M	H
Hand Geometry	M	M	M	H	M	M	M
Keystroke Dynamics	L	L	L	M	L	M	M
Hand vein	M	M	M	M	M	M	H
Iris	H	H	H	M	H	L	H
Retina	H	H	M	L	H	L	H
Signature	L	L	L	H	L	H	L
Voice	M	L	L	M	L	H	L
Facial Thermogram	H	H	L	H	M	H	H
DNA	H	H	H	L	H	L	L

H=High, M=Medium, L=Low

Attempt to classify methods according to how they meet all seven criteria. Valid today? Do you agree in general? Look closely and make your own assessment! There is no “correct” answer…

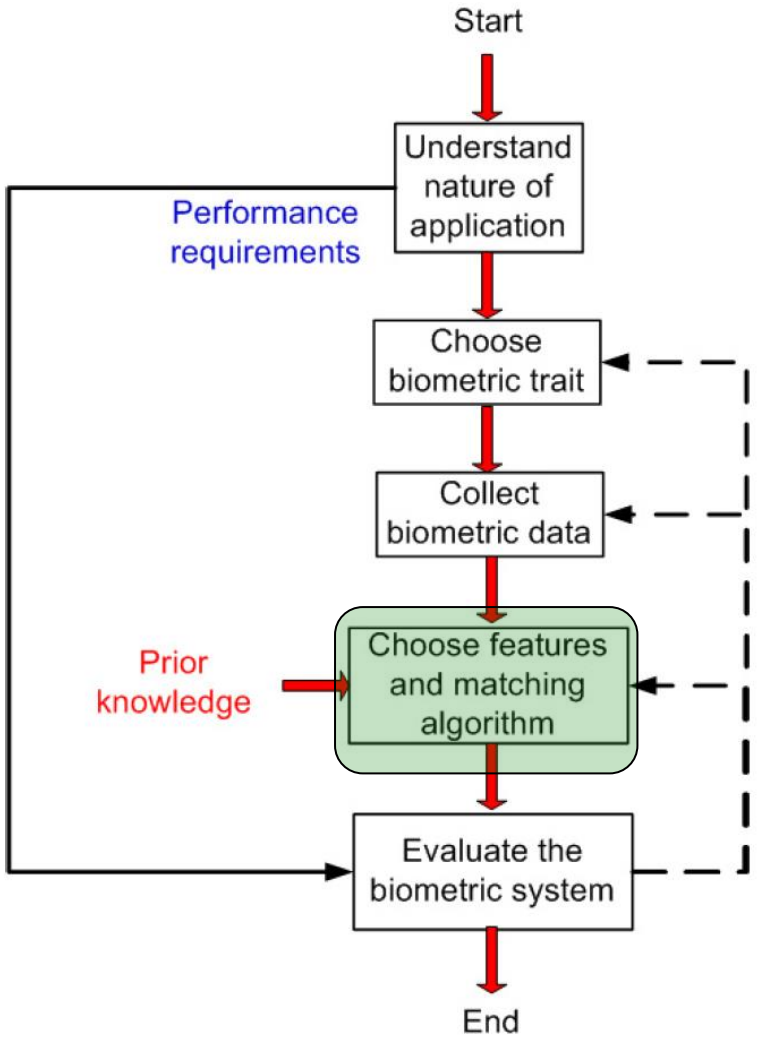
Design cycle of biometric systems



Collecting biometric data

- Appropriate sensors
  - Size, cost, ruggedness, high quality biometric samples
- Collection environment
- Sample population
  - Representative of the population
  - Exhibit realistic intra-class variations
- User habituation
- Legal, privacy & ethical issues

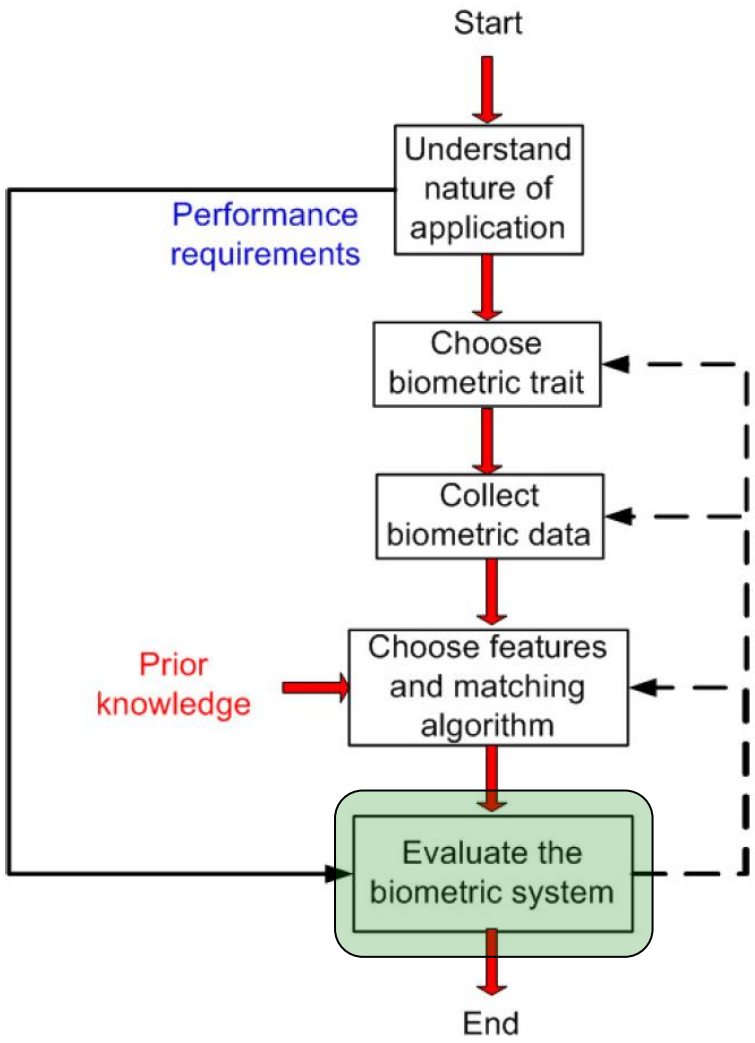
Design cycle of biometric systems



Choice of features/matching algorithm

- Prior knowledge of the biometric trait
  - Uniqueness
- Mimic human ability to discriminate
- Interoperability between biometric systems
- Common data exchange formats …

Design cycle of biometric systems



Evaluation of biometric systems

- Technology evaluation
- Scenario evaluation
- Operational evaluation

- Error rates
- System reliability, availability, maintainability
- Vulnerabilities
- User acceptability
- Cost, throughput, benefits
- Return on investment

How to cheat a biometric system?

Cheat the sensor

Picture of another persons face

Voice recordings

...

Cheat the system

False user permission

Intrude/manipulate communication

...

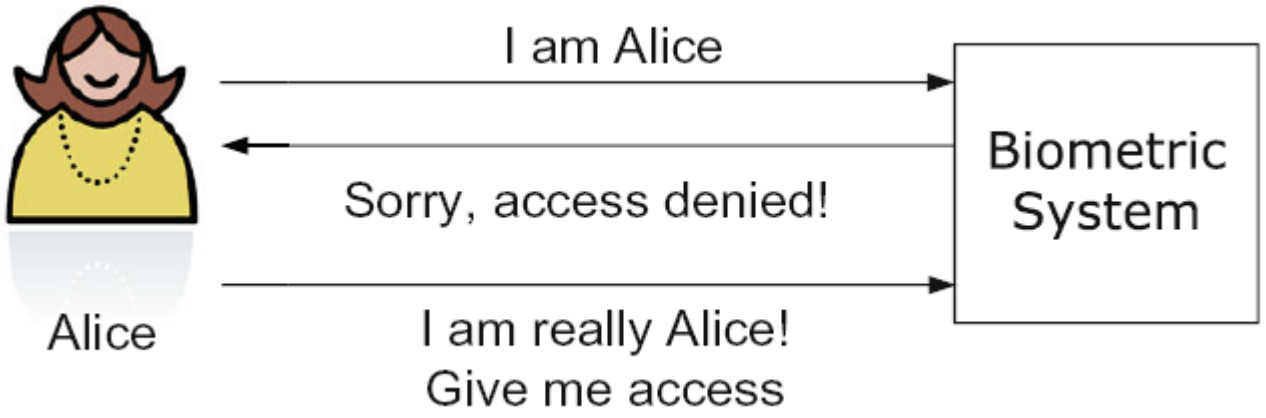
What are the disadvantages of biometric systems

Sensors of low quality and sensitive to noise

Biometrical features needs to be uniqe

Temporal variations (ageing, beards, weight etc…) complicates the use

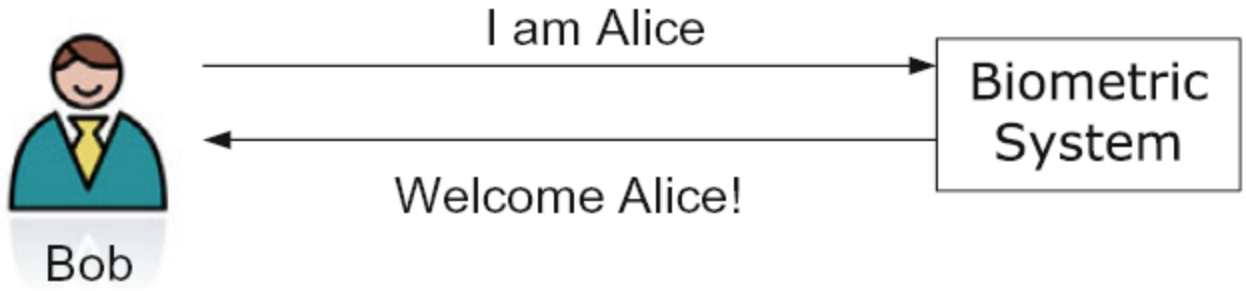
Security threats: Denial-of-service (DoS)



Legitimate users are prevented from obtaining access to the system or resource that they are entitled to

Violates availability

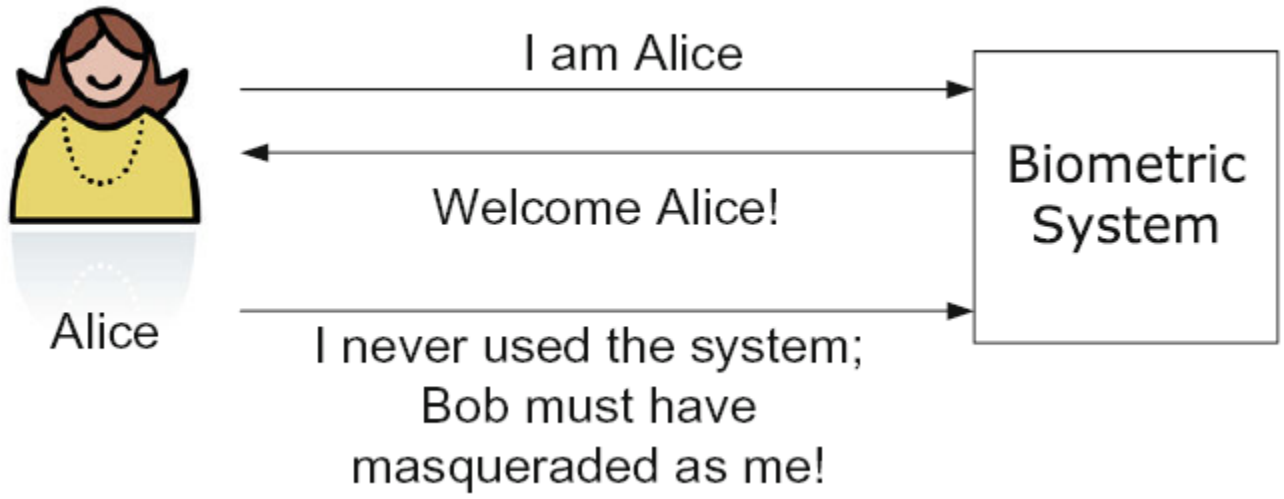
Security threats: Intrusion



An unauthorized user gains illegitimate access to the system

Affects integrity of the biometric system

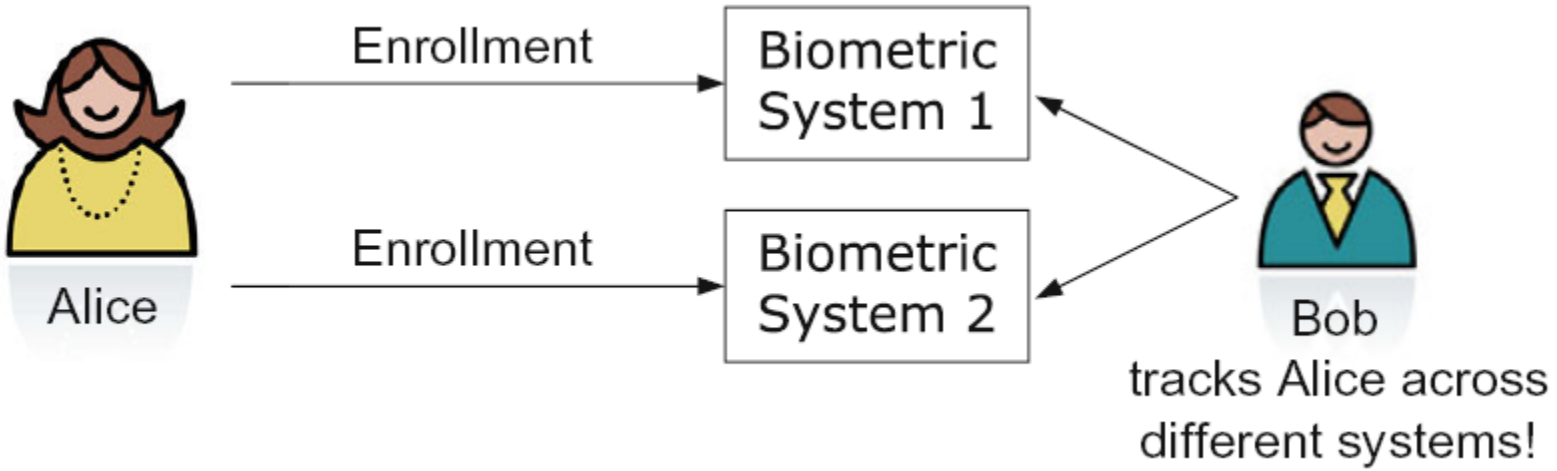
Security threats: Repudiation



A legitimate user denies using the system after having accessed it.

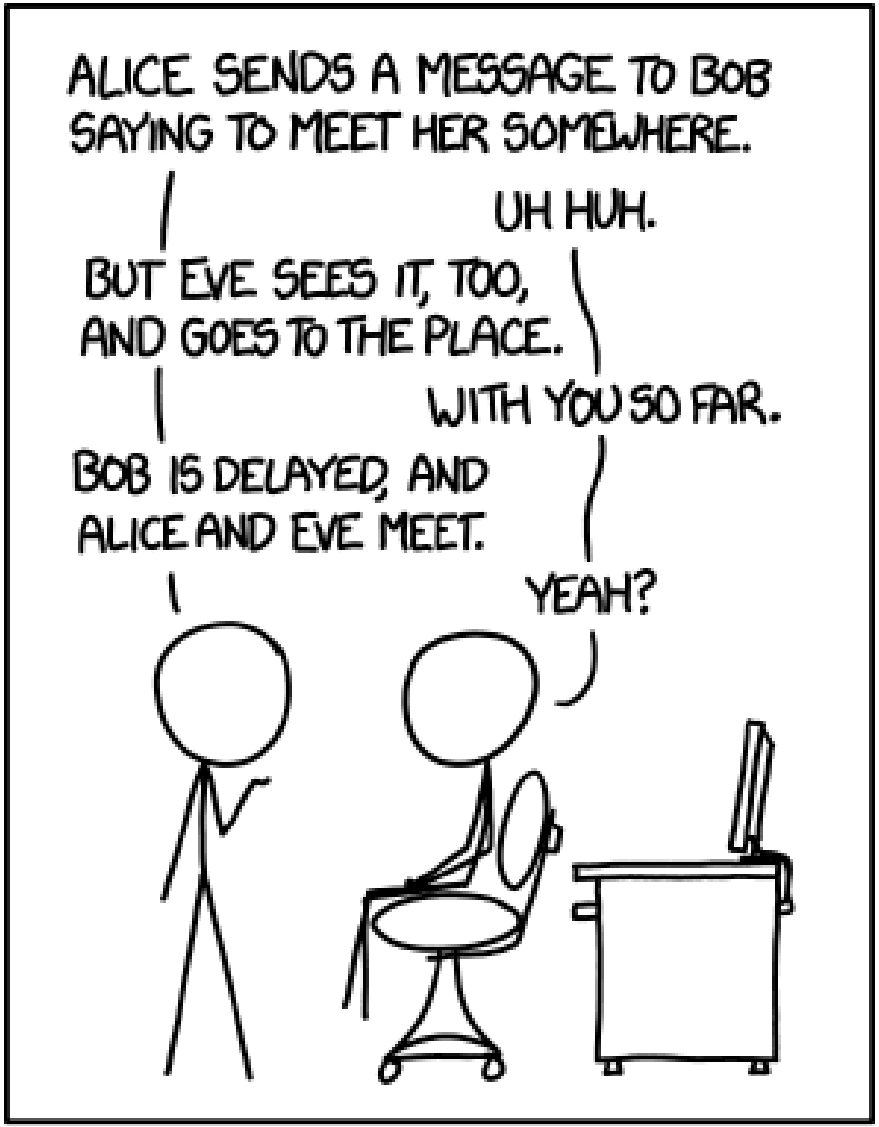
Corrupt users may deny their actions by claiming that illegitimate users could have intruded the system using their identity

Security threats: Function creep



An adversary exploits the biometric system designed to provide access control to a certain resource to serve another application, for example, a fingerprint template obtained from a bank's database may be used to search for that person's health records in a medical database

Violates confidentiality and privacy.



I'VE DISCOVERED A WAY TO GET COMPUTER SCIENTISTS TO LISTEN TO ANY BORING STORY.

… but is really the story boring?

- Possible security threats
  - Threat agents
- Public confidence and acceptance
- What if the application is
  - Border control
  - Management of welfare schemes
  - …

Agenda for lecture II within this part of the course

Background

Statistics in user authentication

Biometric systems

Tokens

Statistics✔

Generic biometric system✔

Design cycle✔

Multibiometrics

Security threats✔

Attacks

A. Jain, A. Ross and K. Nandakumar, Chapters 1, 6 & 7 in "Introduction to Biometrics"

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