Application Environments

- Overt vs. covert
- Habituated vs. non-habituated
- Attended vs. non-attended
- Standard vs. non-standard
- Public vs. private
- Open vs. closed

Overt vs. covert

- Overt:
  - User is aware that the biometric feature is being measured (e.g. finger on a fingerprint reader)
- Covert:
  - User is unaware that the biometric feature is being measured (e.g. face recognition)

Habituated vs. non-habituated

- Habituated:
  - System is used on a daily basis (e.g. to have access to the PC at work)
- Non-habituated:
  - System is used irregularly (e.g. to access a personal safe in a bank)

Attended vs. non-attended

- Attended:
  - Use is observed and guided by system management (e.g. access to a building)
- Non-attended:
  - No observation or (regular) help is provided (e.g. access to PC)

Standard vs. non-standard

- Standard:
  - System is in a static environment with controlled conditions (e.g. fixed lightning and background for face recognition)
- Non-standard:
  - System in a dynamic environment (e.g. background noise for voice recognition)

Public vs. private

- Public:
  - "Anybody" can use the system (e.g. voice recognition for bank transfers via phone)
- Private:
  - Only employees can use the system (e.g. access to a factory or office building)

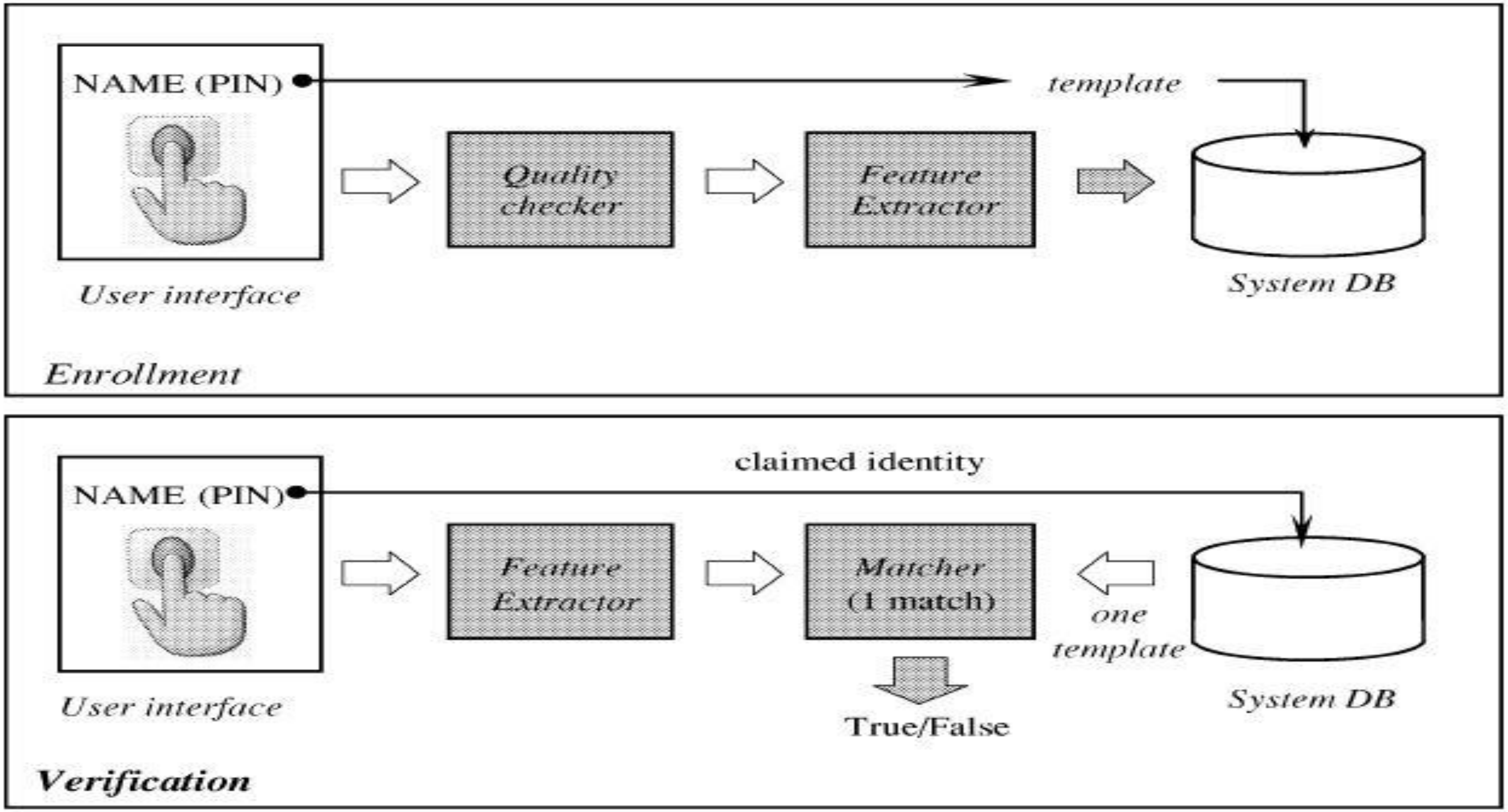
Open vs. closed

- Open:
  - System can interact with other (biometric) system (e.g. biometric passport)
- Closed:
  - System is stand-alone and no information is shared (e.g. systems to access classified information)

Biometrical Systems

- A biometrical systems consists of 2 modules:
  - Enrollment module
    - Template created and stored in database
  - Authentication module
    - Checked against stored template

Biometrical Systems



Errors

- False Non-Match Rate (FNMR)
- False Match Rate (FMR)
- False Rejection Rate (FRR) (used wrongly in literature). USE (FNMR) instead
- False Acceptance Rate (FAR) used wrongly in literature. USE (FMR) instead
- Failure to Enroll Rate (FER)
- Failure to Capture Rate (FCR)

Hypotheses and decisions

- H_0 : input biometric does **not** belong to the same person as the template biometric
- H_1 : input biometric does belong to the same person as the template biometric
- D_0 : Person is **not** who he claims to be
- D_1 : Person is who he claims to be

False Match Rate (FMR)

- Probability that a false claimed identity is not recognized as false
- Also called *Type I Error*
- Probability that D_1 is decided, given that H_0 is true:
  - Prob(D_1 | H_0)
- Depends on a threshold t

False Non-Match Rate (FNMR)

- Probability that a correctly claimed identity is not recognized as true
- Also called *Type II Error*
- Probability that D_0 is decided, given that H_1 is true:
  - Prob(D_0 | H_1)
- Depends on a threshold t

Failure to Enroll Rate (FER)

- Probability that a person cannot enroll in the biometric system
- Person doesn't have biometric feature
- Person has poor quality biometric feature
- Trade-off between FMR/FNMR and FER

Failure to Capture Rate (FCR)

- Probability of failure to capture the biometric feature when trying to authenticate
- Bad capturing conditions
  - Too dark for face recognition
  - Dirty fingerprint reader
  - Background noise for voice recognition

Equal Error Rate (EER)

- EER is the point where FMR and FNMR are equal

Distance metrics - 1

- In biometrics we need to compare extracted features that will differ a bit every time they are measured
- Need a way to compare extracted features
- ”Inter person” distance must be large
- ”Intra person” distance must be small

Distance metrics - 2

- We want to know how far 2 sequences **x** and **y** are apart or how close together they are.
- Let **x** = $(x_1,x_2,\ldots,x_n)$
- Let **y** = $(y_1,y_2,\ldots,y_n)$
- Assume **x** can be compared to **y**

Absolute Distance

- Sum the absolute differences between each of the components of **x** and **y**
- $d_1(\mathbf{x},\mathbf{y}) = \Sigma \mid x_i - y_i \mid$
- Extremely easy to calculate

Euclidean Distance

- Sum the squares of the differences between each of the components of **x** and **y**

- $d_2(\mathbf{x},\mathbf{y}) = \sqrt{\left[\Sigma (x_i - y_i)^2 \right]}$

- Also easy to calculate

Maximum Difference Distance

- The distance between **x** and **y** is defined as the maximum absolute difference of its components

- $d_3(\mathbf{x},\mathbf{y}) = \max | x_i - y_i |$

- Extremely easy to calculate

More distance metrics?

- Many more distance metrics possible
- Sometimes first a mathematical transformation of the data is needed
- Not all parts of the data need to be taken into account

Threshold

- Features are extracted from biometric characteristic
- Features are compared to template
- Distance metric gives distance d
- Use of threshold t
- $d \leq t$: authentication OK
- $d > t$: authentication NOT OK

Example - Distance scores

	Templ 1	Templ 2	Templ 3	Templ 4	Templ 5
Test 1	**0,182**	0,588	0,435	0,208	0,909
Test 2	0,323	**0,213**	0,286	0,476	0,244
Test 3	0,909	0,625	**0,147**	0,476	1,111
Test 4	0,238	0,294	0,476	**0,256**	0,526
Test 5	0,588	0,454	1,250	0,526	**0,130**

Example – FNMR/FMR

- If t=0.256 we see that
  - (FNMR,FMR) = (0/5 , 3/20)
- If t=0.213 we see that
  - (FNMR,FMR) = (1/5 , 1/20)
- If t=0.212 we see that
  - (FNMR,FMR) = (2/5 , 1/20)
- If t=0.207 we see that
  - (FNMR,FMR) = (2/5 , 0/20)