1st Coding Class

COMP 388-002/488-002 Biometrics

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Fall 2025

LOYOLA UNIVERSITY CHICAGO

Today we will…

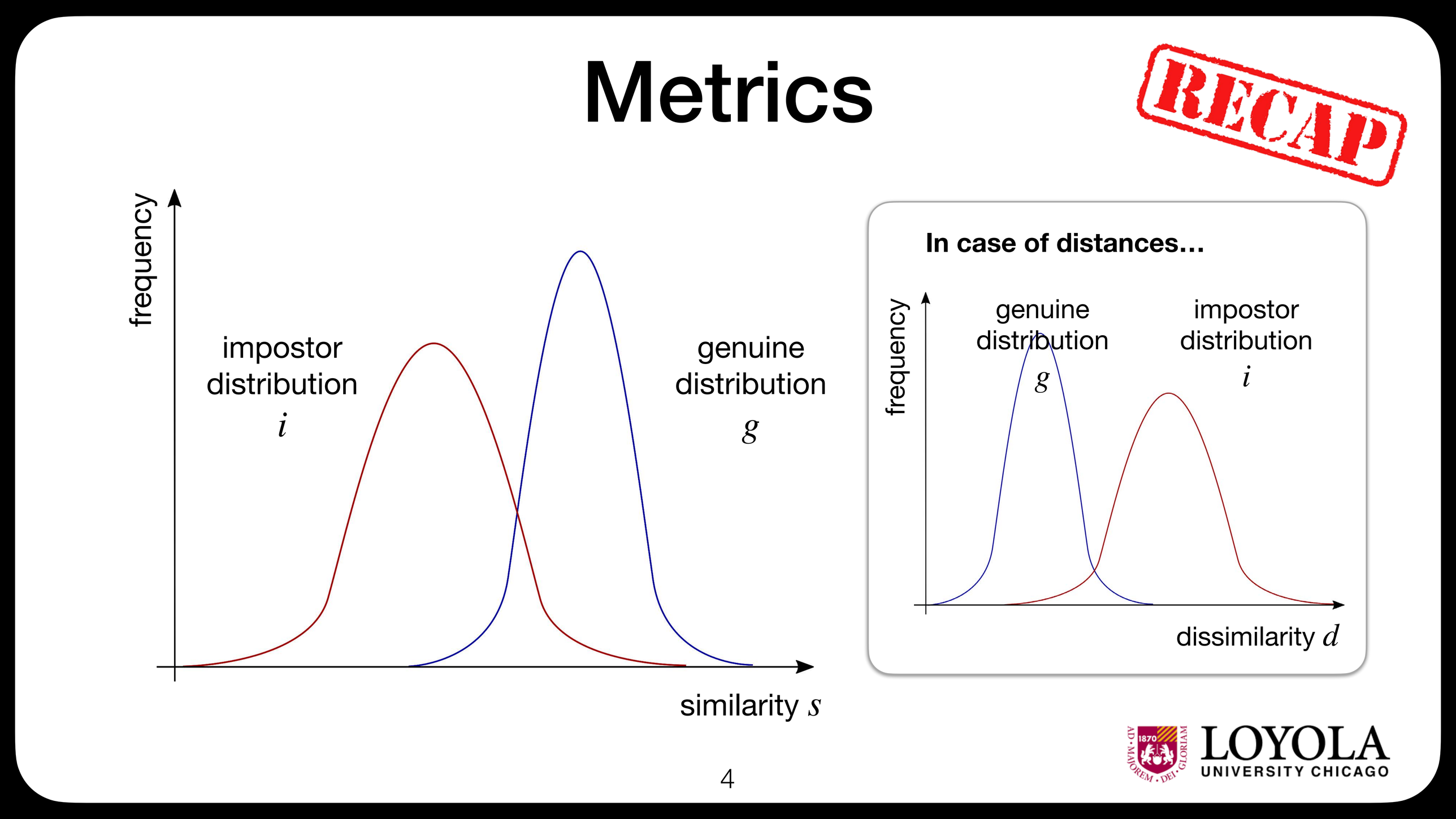
Inspect the
Implementation of metrics to compare Biometric systems.

Today's Attendance

Please fill out the form

forms.gle/VZPeQoNwP6TmME8U8

Metrics



In case of distances…

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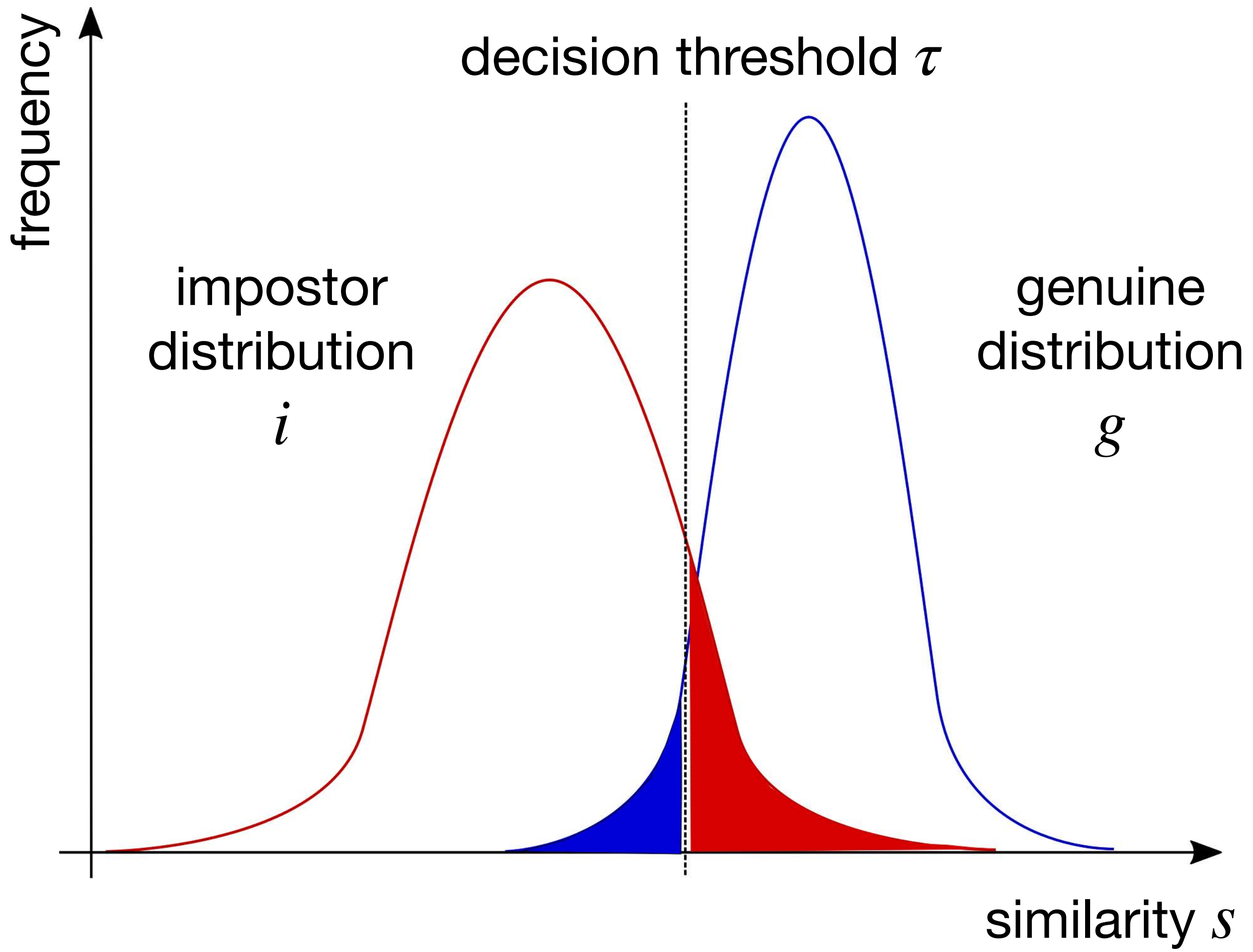
Metrics

RECAP



$$FNM(\tau) = \int_{-\infty}^{\tau} g(s)\ ds$$

$$FM(\tau) = \int_{\tau}^{\infty} i(s)\ ds$$

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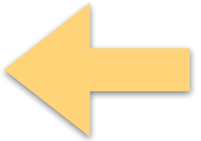
Metrics

In Practice

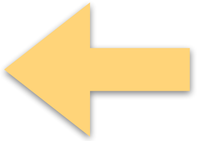
False Non-Match Rate (FNMR) and False Match Rate (FMR)

$$FNMR(\tau) = \frac{\#(false\ nonmatches\ for\ \tau)}{\#(genuine\ comparisons)}$$



$$FNM(\tau) = \int_{-\infty}^{\tau} g(s)\ ds$$

$$FMR(\tau) = \frac{\#(false\ matches\ for\ \tau)}{\#(impostor\ comparisons)}$$



$$FM(\tau) = \int_{\tau}^{\infty} i(s)\ ds$$

Metrics

In Practice

False Non-Match Rate (FNMR) and False Match Rate (FMR)

$$FNMR(\tau) = \frac{\#(false\ nonmatches\ for\ \tau)}{\#(genuine\ comparisons)}$$

How many of the genuine comparisons are wrongly computed by the system?

$$FMR(\tau) = \frac{\#(false\ matches\ for\ \tau)}{\#(impostor\ comparisons)}$$

How many of the impostor comparisons are wrongly computed by the system?

Metrics

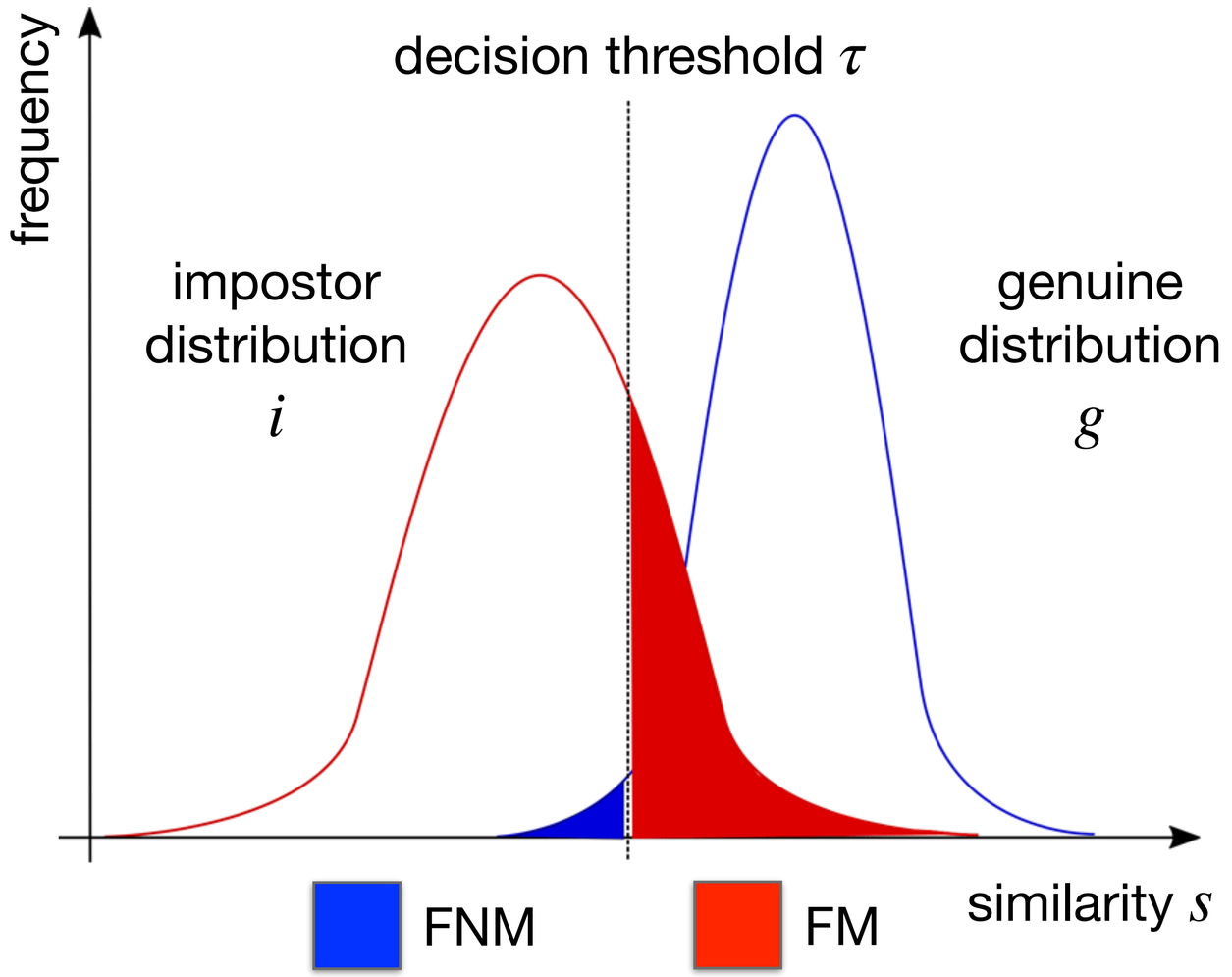
In Practice
Interpretation of *R values.

Suppose a face recognition system with FMR=0.1%
FMR=0.001, one error in every 1K comparisons.
Is it good?

Suppose the Newark airport
5K people per hour, 14h per day (70K people per day)
Suppose a suspect watch list with 100K people: 7 billion comparisons per day.
Average number of false matches per day: 7 million people to double check every day.

Terrorist watch list in 2016: 1,8 million people

Metrics



What is the impact of changing the decision threshold?

The larger the value of τ:
The larger the value of FNM;
The smaller the value of FM.

FNM and FM are inversely proportional.

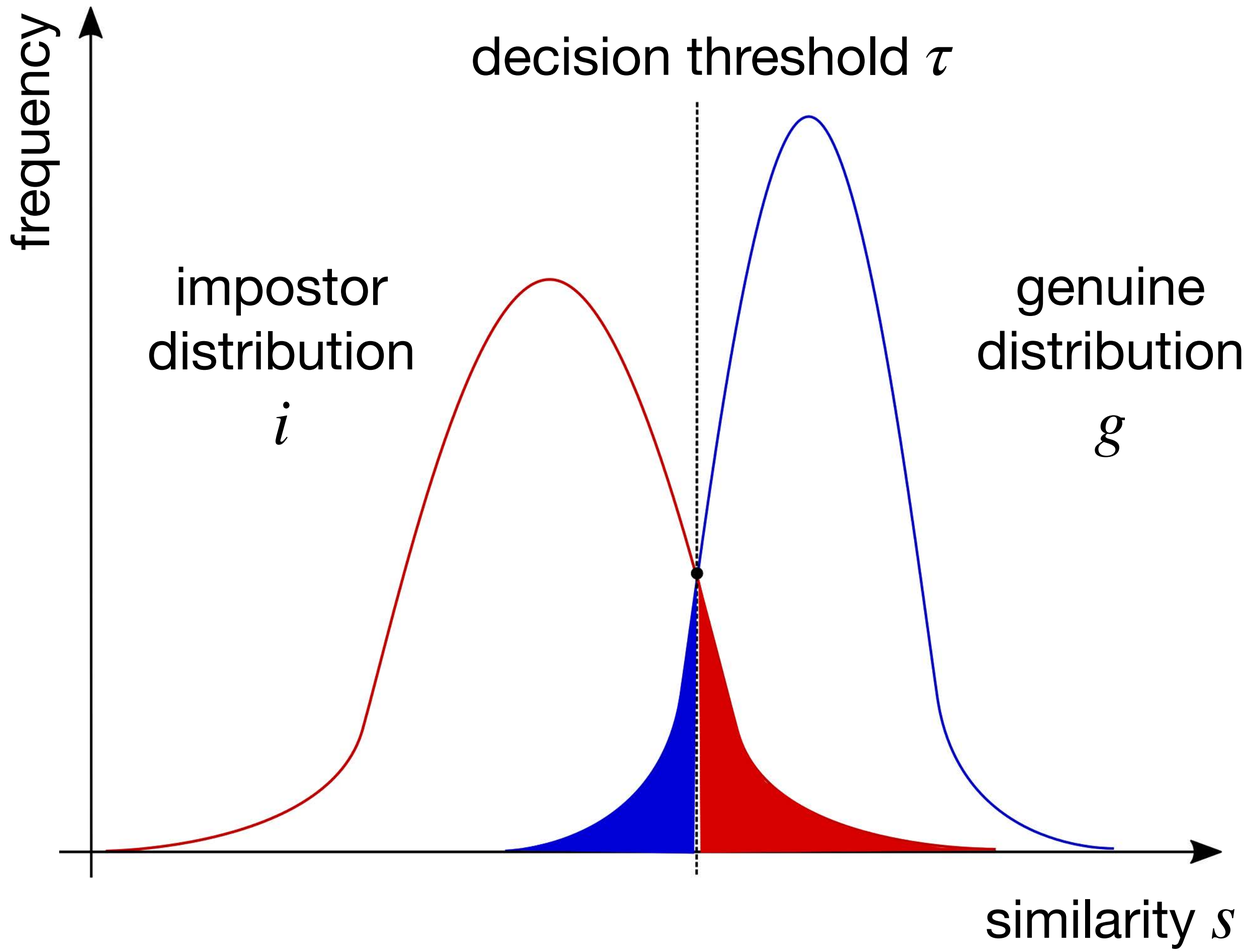
Metrics

What to choose?

Small FNMR
Suitable to avoid denial of access
and repudiation.
Increases intrusion probability, though.

Small FMR
Suitable to avoid intrusion.
Increases denial of service and
repudiation probability, though.

Metrics



What to choose?

Equal Error Rate (EER)
Common practice.
Pick the threshold where FNMR = FMR.

Metrics

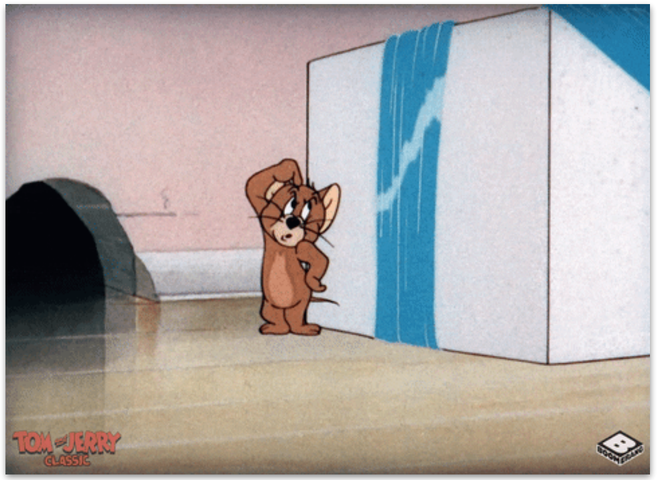
How to compare two different systems?
Biometric systems *A* and *B.*

Compare both systems' FNMR and FMR at EER (1/3)
Take the one with smaller FNMR and FMR values.

Metrics

How to compare two different systems?
Biometric systems *A* and *B.*

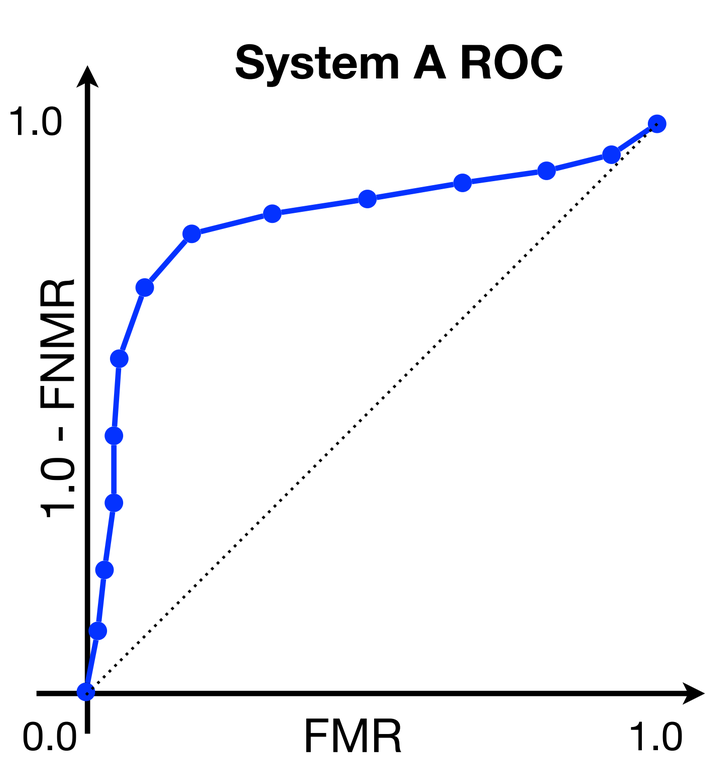
Use a Receiver Operating Characteristic (ROC) curve (2/3)

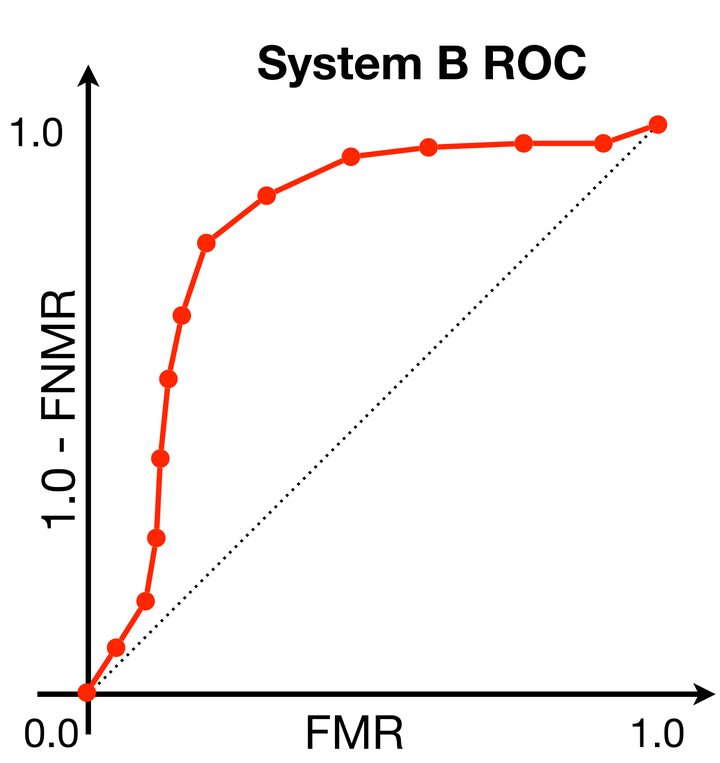


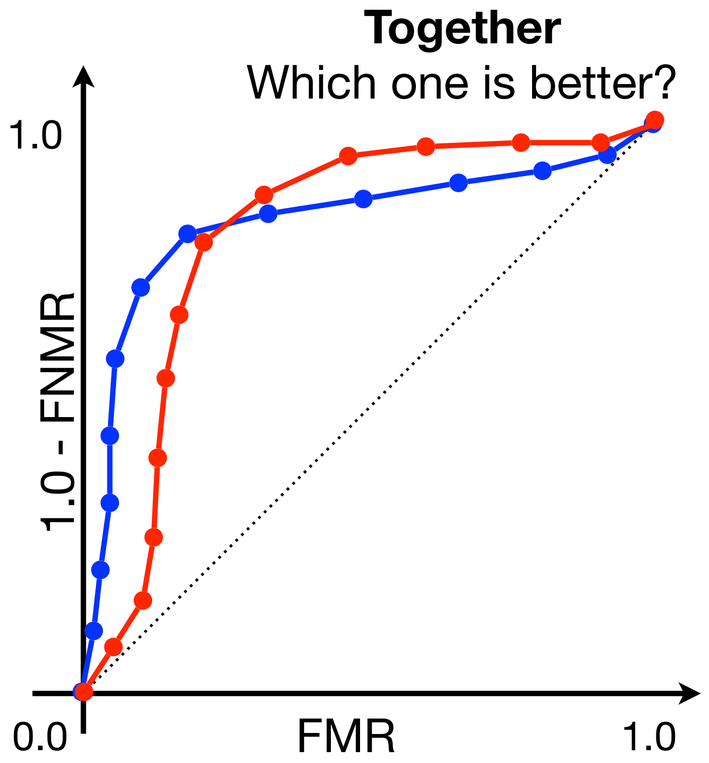
Metrics

How to compare two different systems?
Biometric systems *A* and *B.*

Compute FMR and FNMR for a variety of thresholds.

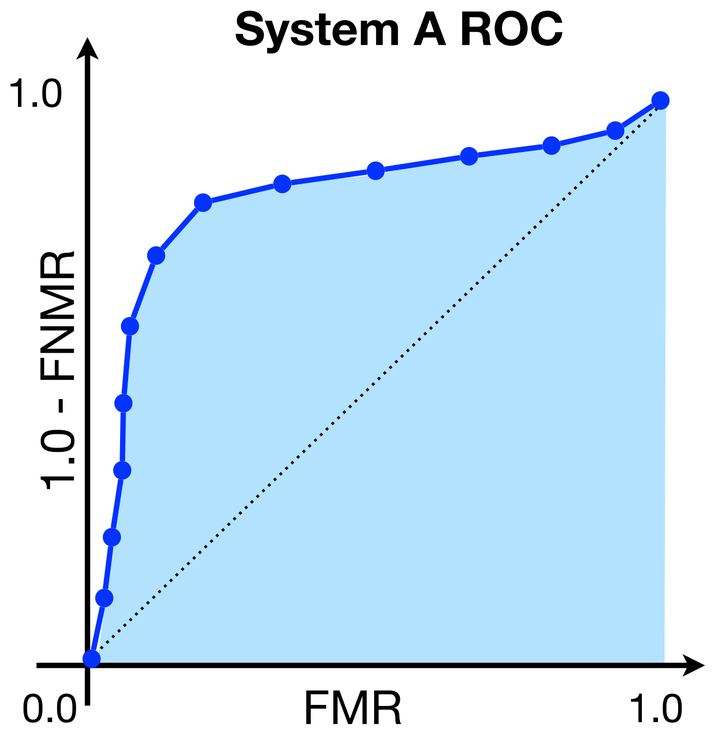


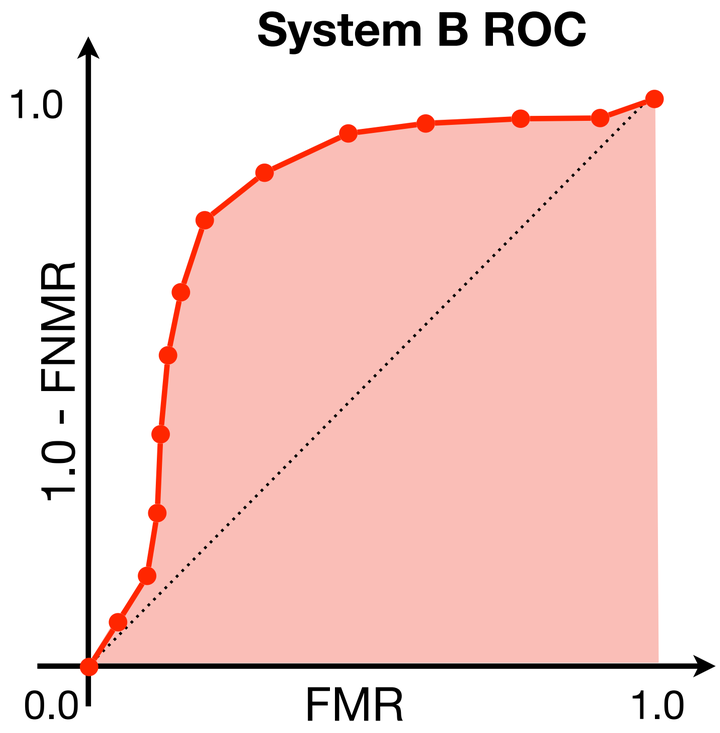




Metrics

How to compare two different systems?
Biometric systems *A* and *B.*





Which one is better?
Compute the
Area Under The Curve
(AUC).
The best solution
presents larger AUC.

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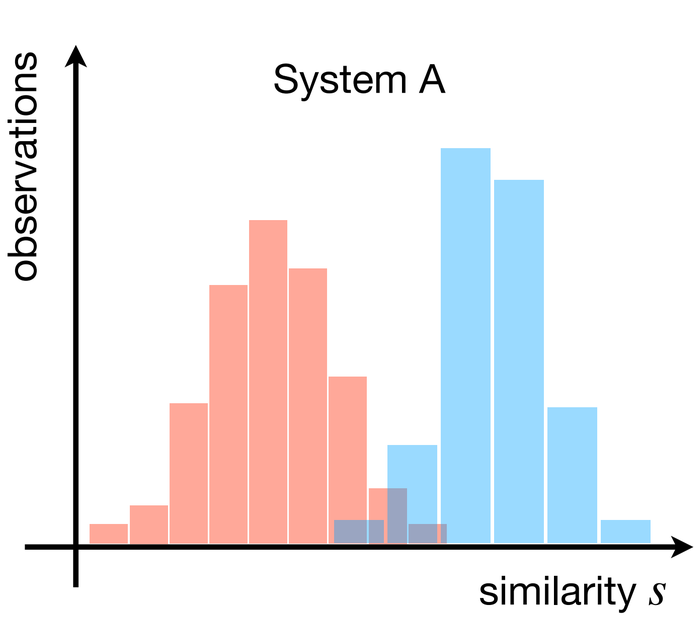
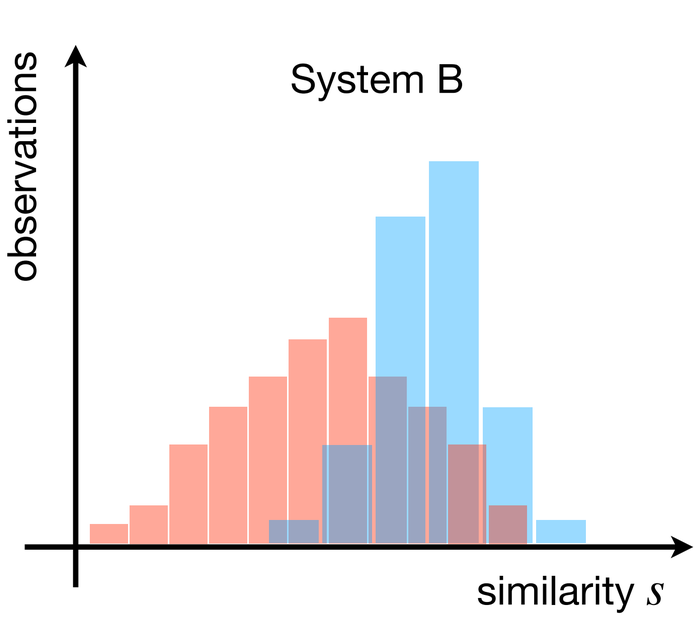
Metrics

How to compare two different systems?
Biometric systems *A* and *B.*

Compute the difference between impostor and genuine distributions for each system (3/3)





impostor genuine

Which one is better?
Take the one with better separation of impostor and genuine observations.

It is System A!
How do we compute it?

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Metrics

How to compare two different systems?
Biometric systems *A* and *B.*

Compute the difference between impostor and genuine distributions for each system (3/3)

Which one is better?
Take the system with
larger **d-prime**:

$$d' = \frac{\sqrt{2} \times |\mu_{genuine} - \mu_{impostor}|}{\sqrt{\sigma^2_{genuine} + \sigma^2_{impostor}}}$$

Hypothesis: the distributions are Gaussians (with mean μ and standard deviation σ).

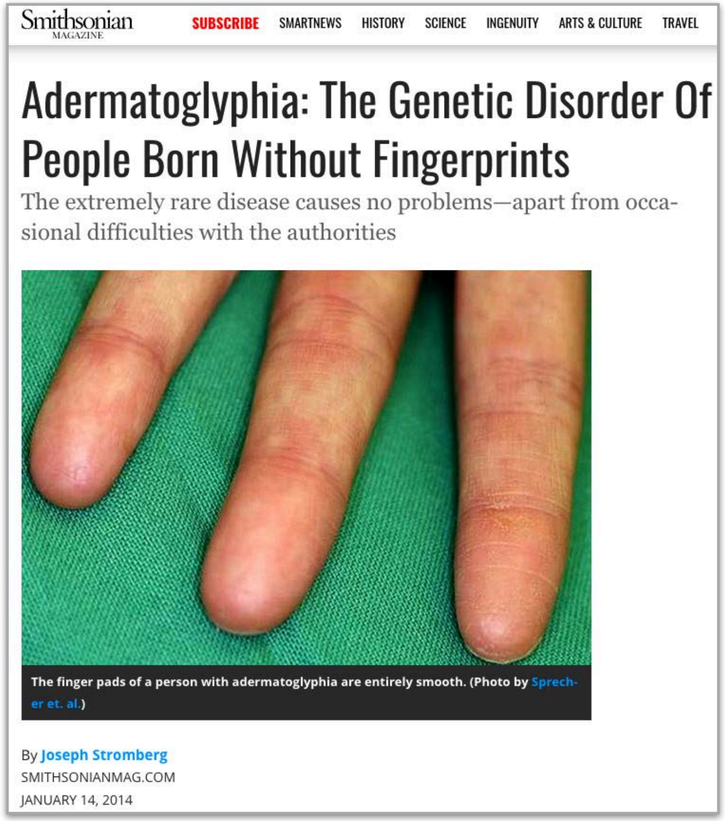
The larger the separation between the distributions, the larger the value of d-prime.

Metrics

Other Metrics (1/4, 2/4)

Failure to Acquire (FTA)
Rate of falsely rejected biometric samples due to problems in acquisition.

Failure to Enroll (FTE)
The same as FTA, but during enrollment.



https://www.smithsonianmag.com/science-nature/adermatoglyphia-genetic-disorder-people-born-without-fingerprints-180949338/

Metrics

Other Metrics (3/4, 4/4)

Positive Metrics
True Non-Match Rate (TNMR)
TNMR = 1.0 - FMR

True Match Rate (TMR)
TMR = 1.0 - FNMR

You want to maximize these instead of minimizing.

Metrics

How to compare two different systems?
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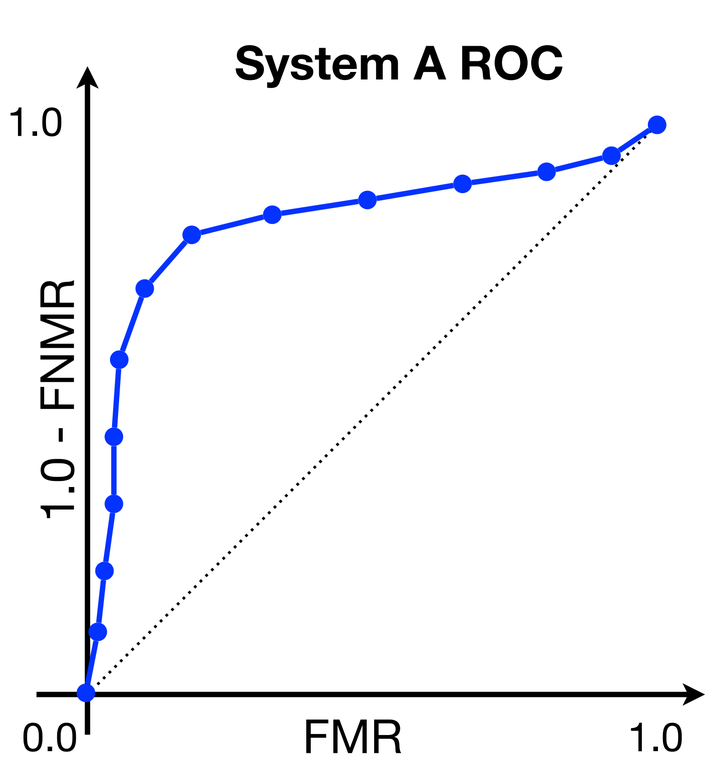
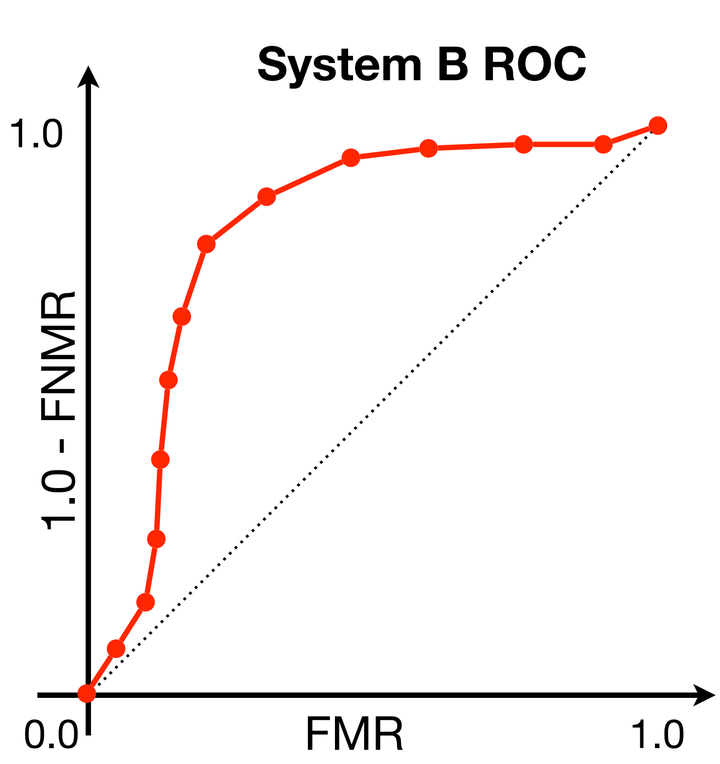
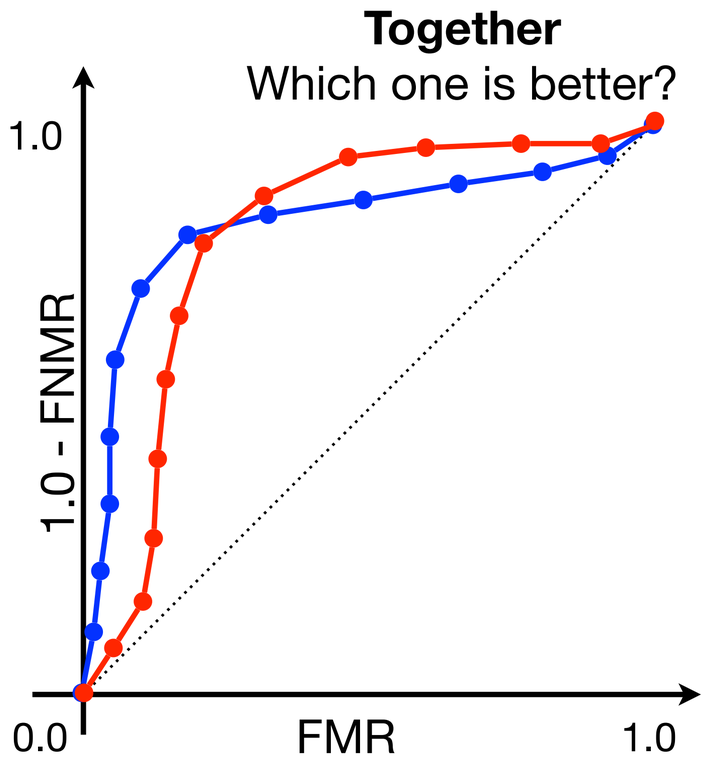
Compute FMR and FNMR for a variety of thresholds.







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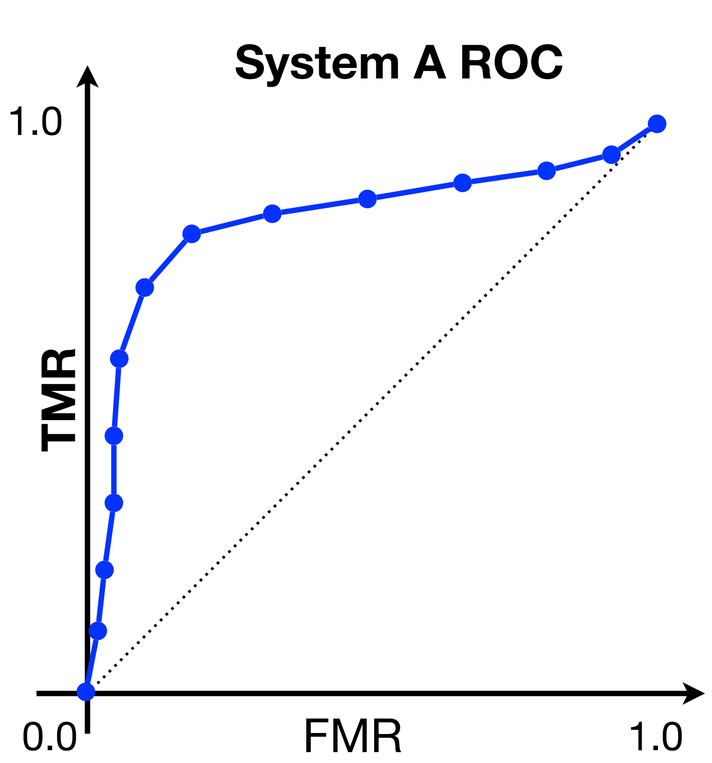

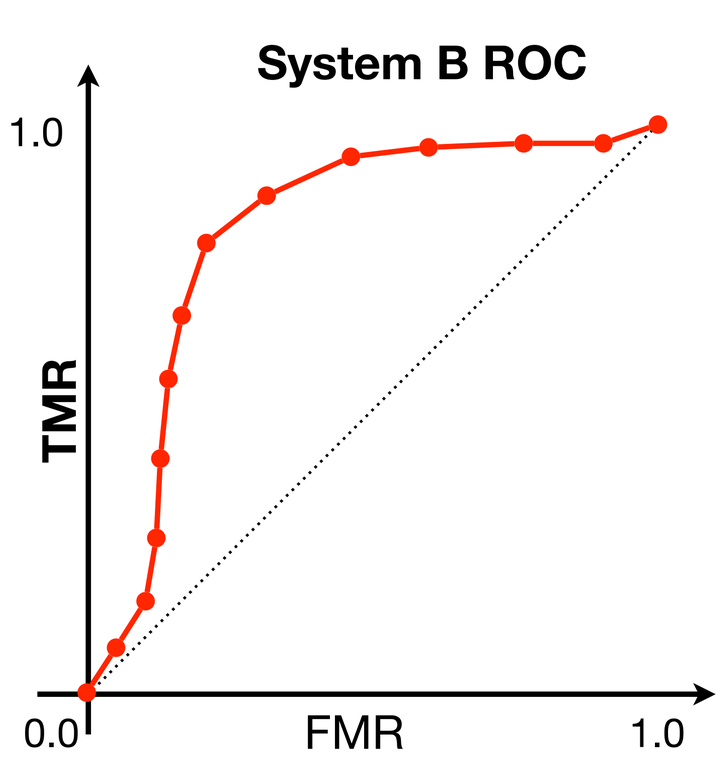

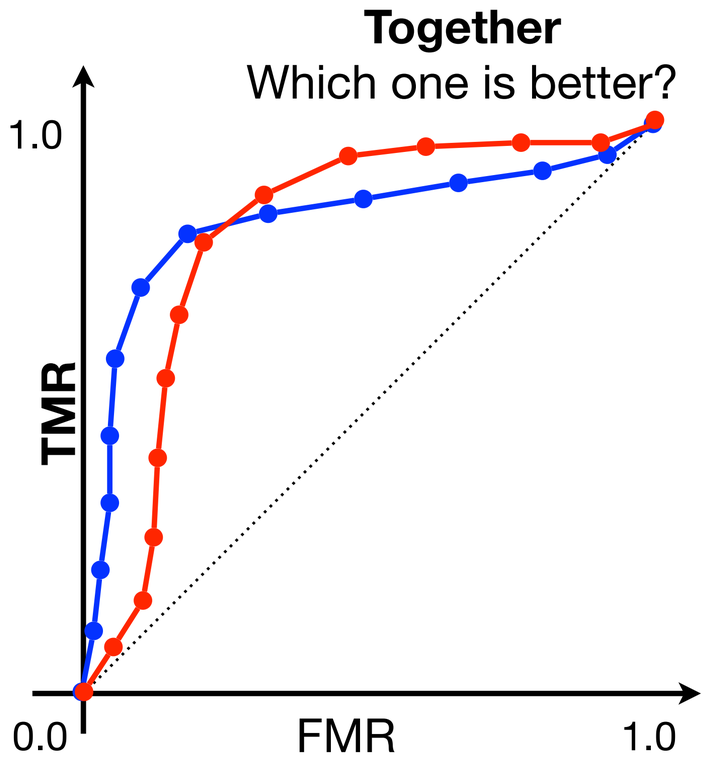

Implementation

Please open

https://tinyurl.com/
53knr8y5

What's Next?

Biometric System Attacks
Threat model and attack types.

Fingerprint Recognition
History and features.

Start filling out your *Today-I-missed* Statement
Please visit sakai.luc.edu/x/BCJs8K.