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FACE RECOGNITION

VENDOR TEST 2002

New Evaluation Statistics for Measuring the Performance of Biometric Technologies

Patrick Grother,

P. Jonathon Phillips, Ross Michaels

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Goals

- Assess performance on large real-world data sets
- Identify new promising approaches
- Measuring progress on hard problems
  - Pose variation
  - Images taken months/years apart
  - Video sequences

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Team

- Conducted by NIST
- Principals
  - Dr. Jonathon Phillips, Test Director
  - Duane Blackburn
  - Mike Bone
  - Patrick Grother
  - Ross Micheals
- Principals from FERET and FRVT 2000
- Twenty people supporting






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Team

- **Supporters**
  - Counterdrug Technology Assessment Center
  - U.S. Customs Service
  - Department of Energy
  - Drug Enforcement Administration
  - U.S. Secret Service
  - Technical Support Working Group
  - Immigration and Naturalization Service
  - Canadian Passport Office
  - UK Biometrics Working Group
  - Australian Customs
- **Sponsors**
  - National Institute of Standards and Technology
  - Defense Advanced Research Projects Agency
  - Department of State
  - National Institute of Justice
  - Transportation Security Administration
  - Federal Bureau of Investigation

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Participants

- AcSys Biometrics
- Cognitec Systems GmbH
- C-VIS
- Dream Mirh Co.
- Electronic System Products
- Eyematic Interfaces
- Iconquest
- Imagis Technologies
- IRID
- Phoenix Systems Corporation
- VicarVision
- Viisage
- Visionics
- VisionSphere

Terminology

Rank	Value	
1	6.6	
2	5.3	
3	5.2	
4	4.8	
5	3.1	
6	2.7	
7	2.0	
8	1.6	

Probe (unknown image)

Match (same ID as probe)

Gallery (known images)

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Human ID Evaluation Framework

- HEF allows measurement of biometric performance **empirically**:
  - Available to other biometrics (face, fingerprint, iris …)
  - Composite biometrics (face + fingerprint, face + gait …)
  - Off-line (live human subjects not required)
  - Repeatable (across many vendors)
  - Proctored (real ids hidden from vendors)
  - Very large numbers of subjects
  - FERET Protocol as previously in FERET, FRVT 2000
  - Suitable for
    - Identification, Verification, Watch List
    - Different scenarios

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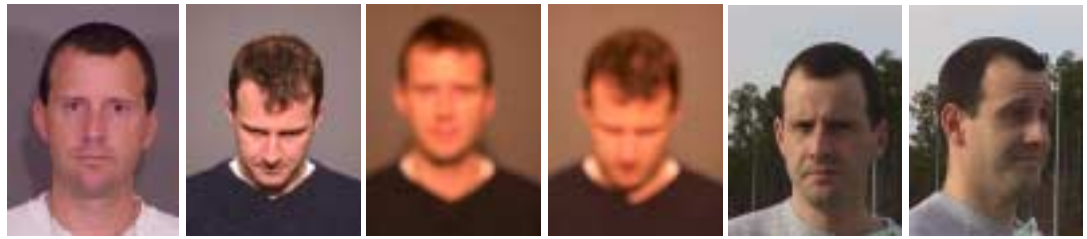
Human ID Evaluation Framework



0.10	0.05	0.19	0.01	0.03	0.01
0.22	0.09	0.11	0.02	0.15	0.02
0.98	0.44	0.88	0.29	0.77	0.21
0.39	0.19	0.34	0.09	0.31	0.02

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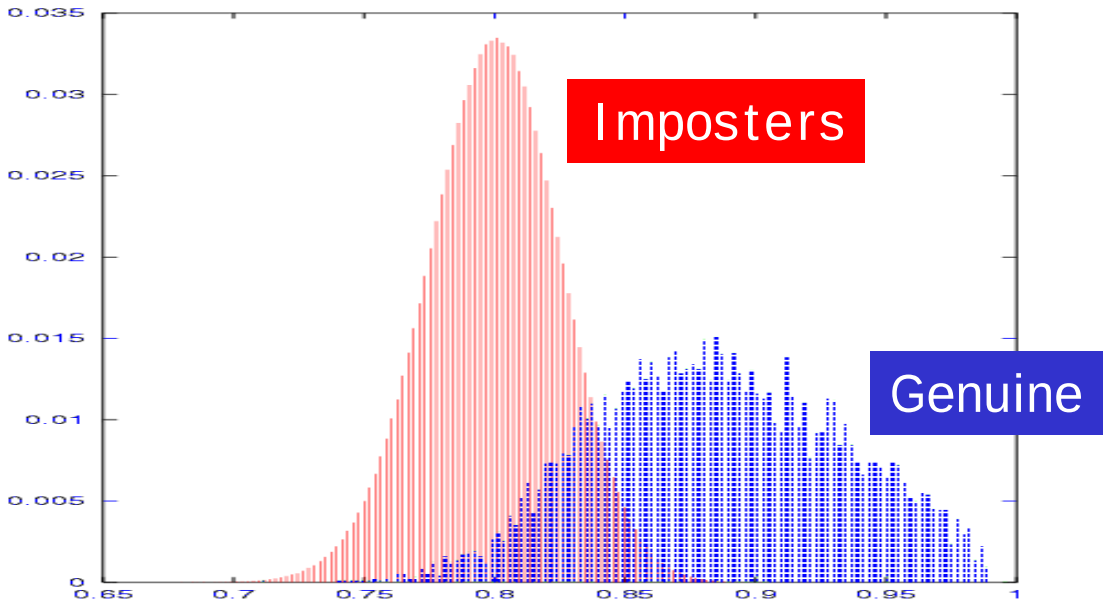
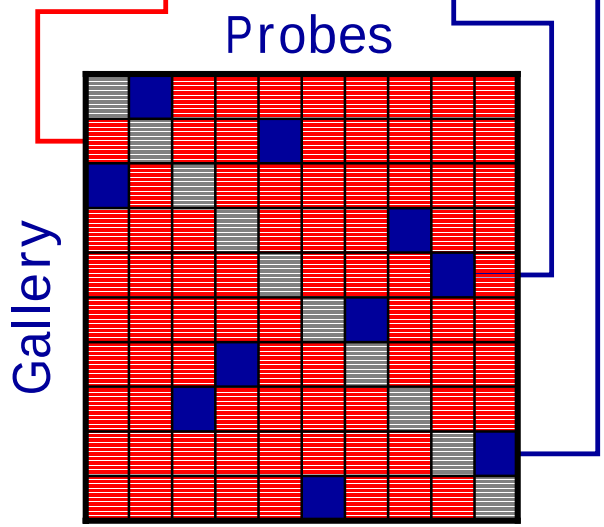
Biometrics : The Problem





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Biometric Uses

- Identification (1-N)
  - Who is that?
- Verification (1-1)
  - Is he who he claims to be?
- Watch list (1-N)
  - Is he on the watch list, and if so, who is he?

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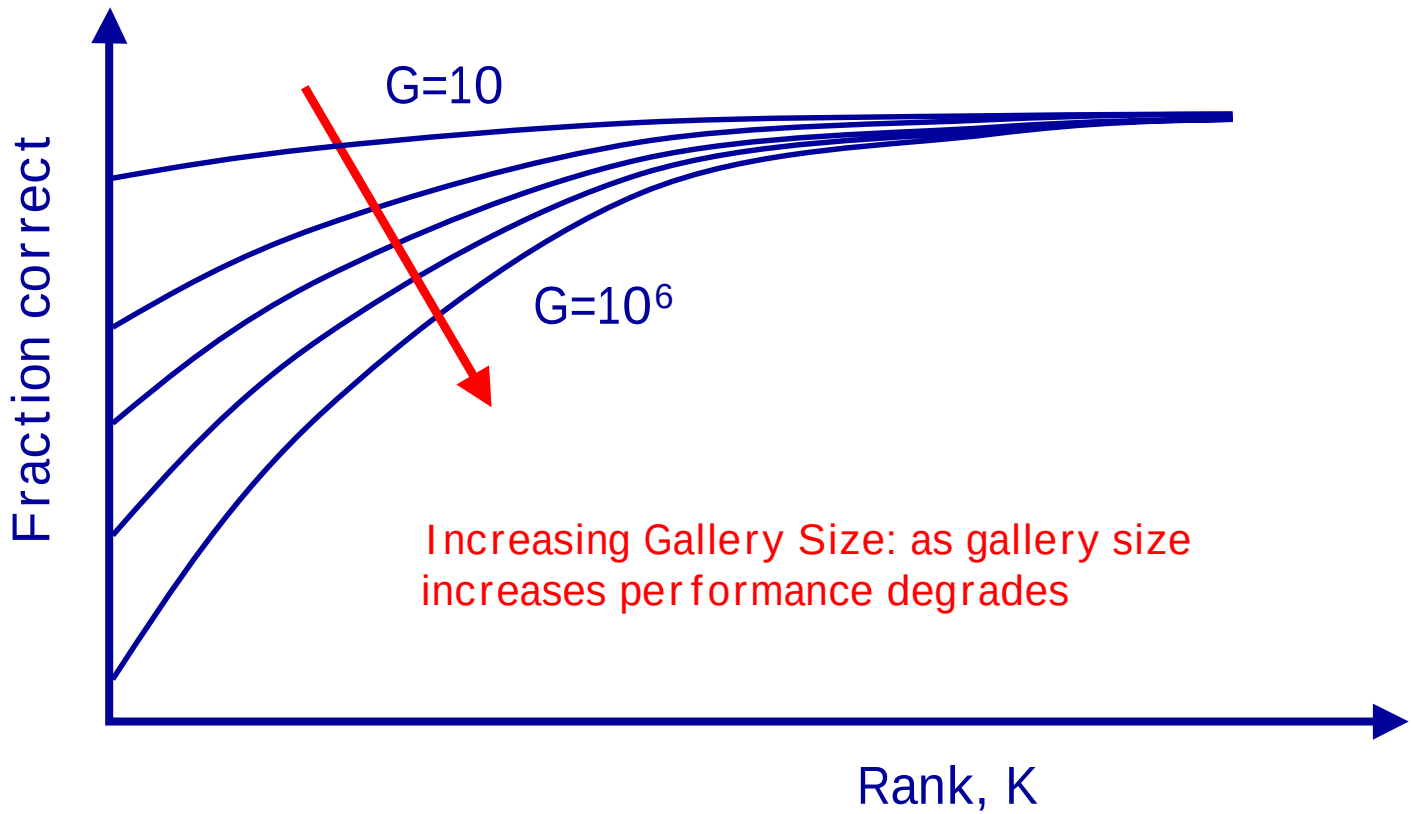
Identification (1-N)

Operationally: Compare current image with all images.
How many are matched within top K guesses



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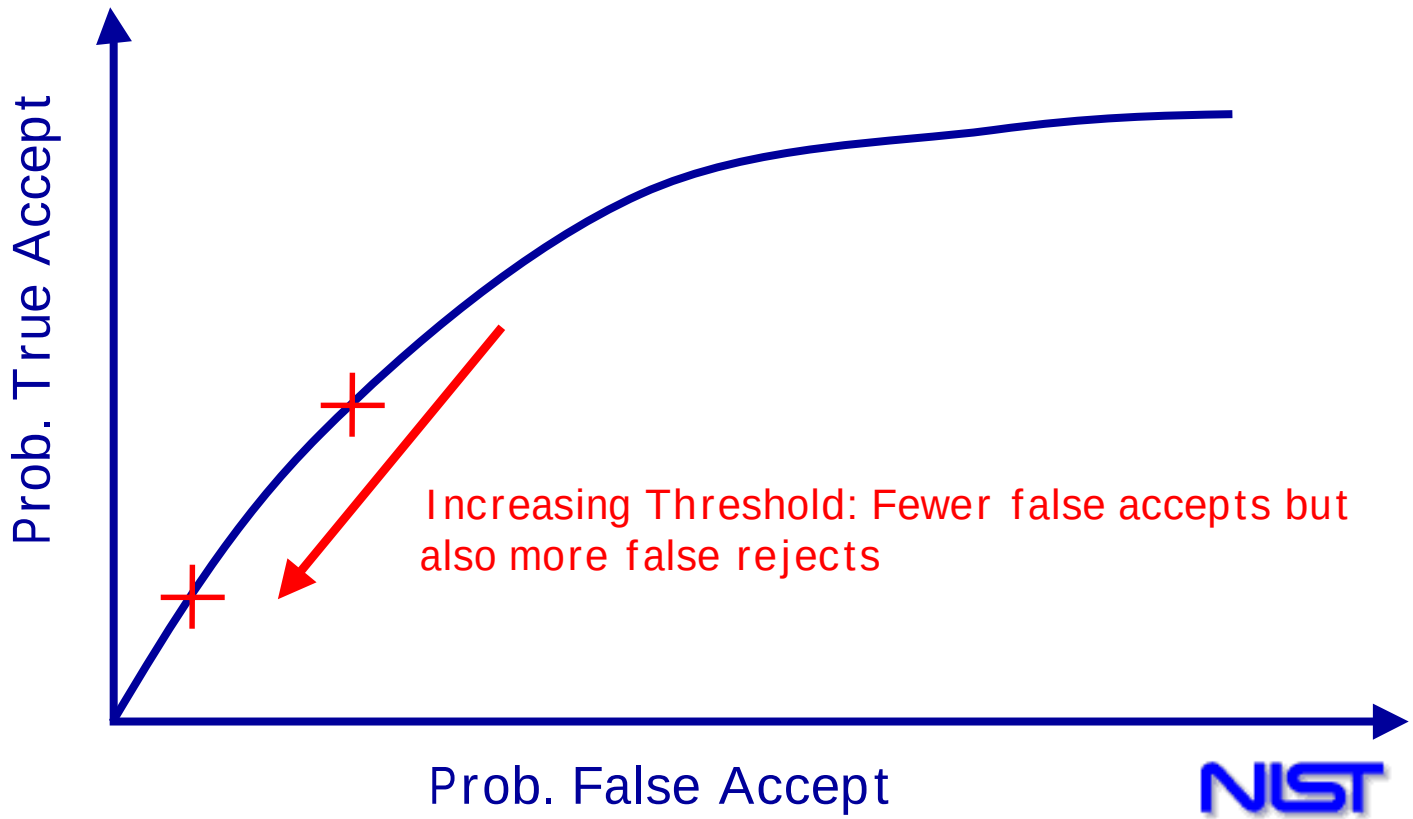
Verification (1-1)

Operationally: Compare current image with previous image.
Decision: Accept or reject a claim?
Vary Threshold: Tradeoff bad guys in vs good guys out



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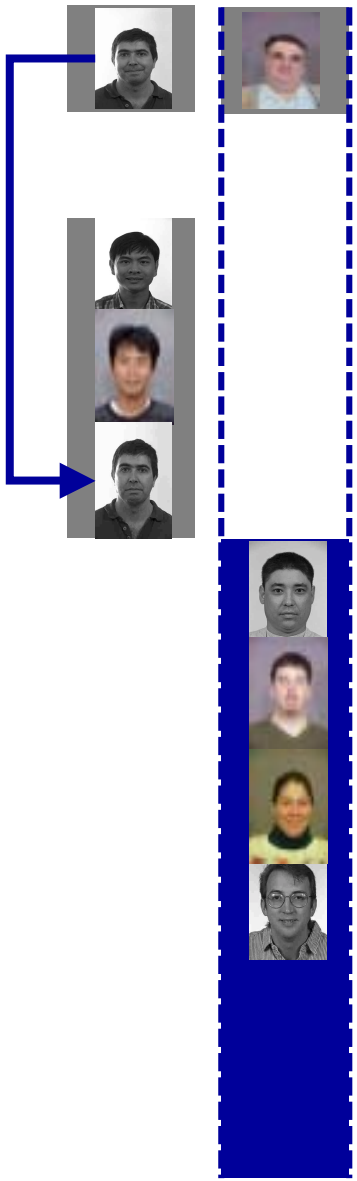
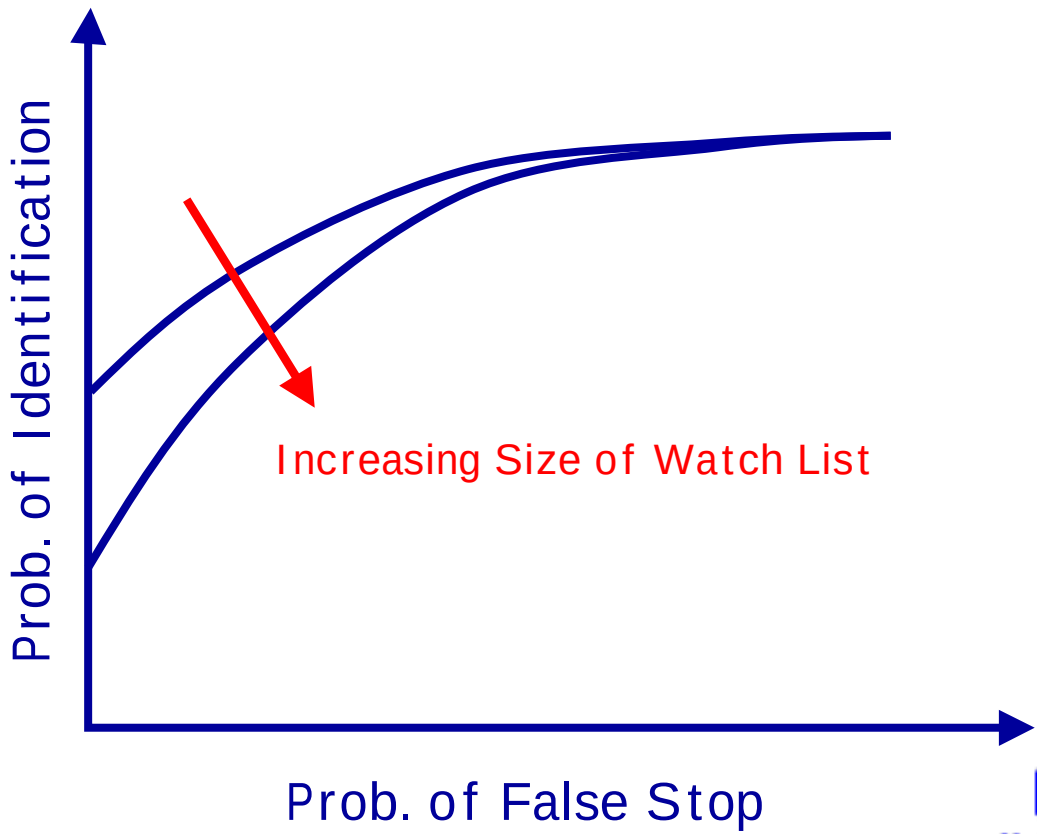
Watch List (1-M < N)



Operationally: Compare current image all in watch list
Decision: Accept or reject a claim? If rejected, then who is it?
Threshold: Tradeoff stopping friends vs missing bad guys



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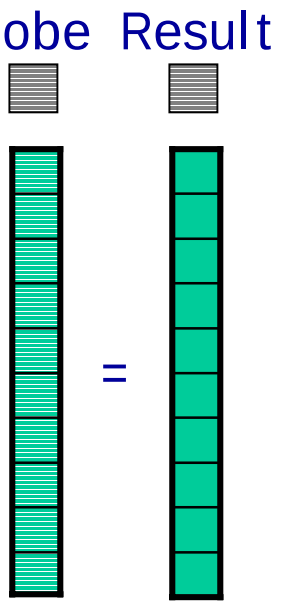
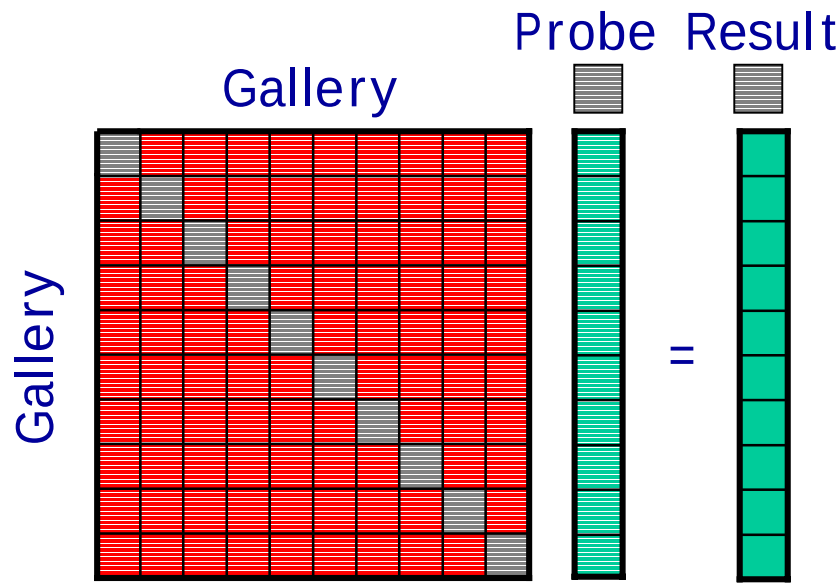
Normalization

Similarity element $s_{ij} = f(x_i, x_j)$ i.e. just a function of two images. But there is information in the other scores.

Option 1: Use information in the probe to gallery elements



Option 2: Use information in both probe to gallery and gallery x gallery elements



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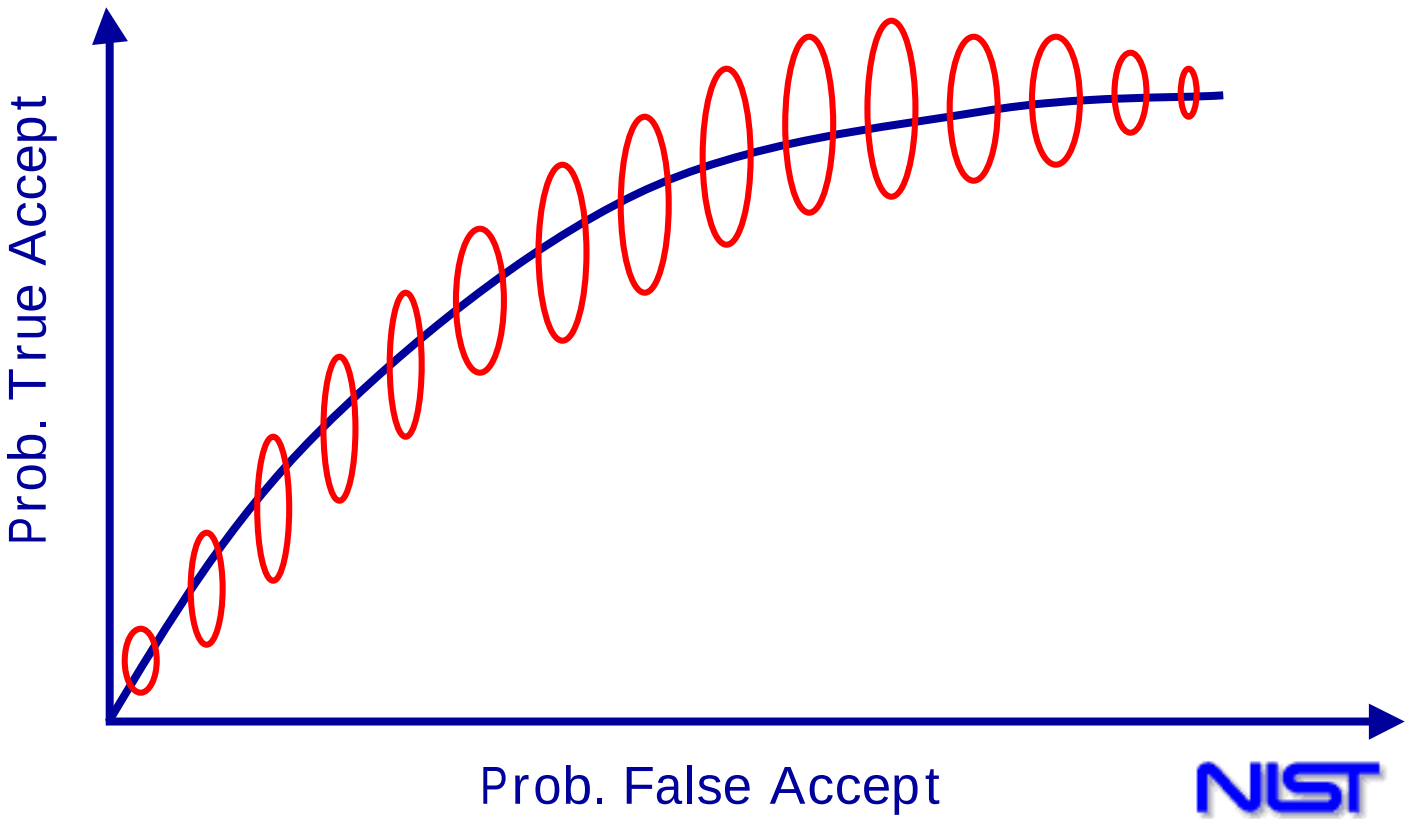
Standard Error

Problem: How Stable are the Estimates of Performance
Method: Divide the data; make multiple estimates.



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Standard Error & Confidence

- Observed Statistical Differences Between Standard Error & Confidence

Standard Error

- measurable observed variation

Confidential Interval requires

- distributional assumptions
- no accepted distributional assumptions

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Conclusion

- Thorough measures of performance
  - Identification
  - Verification
  - Watch List
  - Normalization
  - Standard Error Estimation
- Applicable to other biometric technology
- Basis for evaluation protocol standard

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Back-Up Slides

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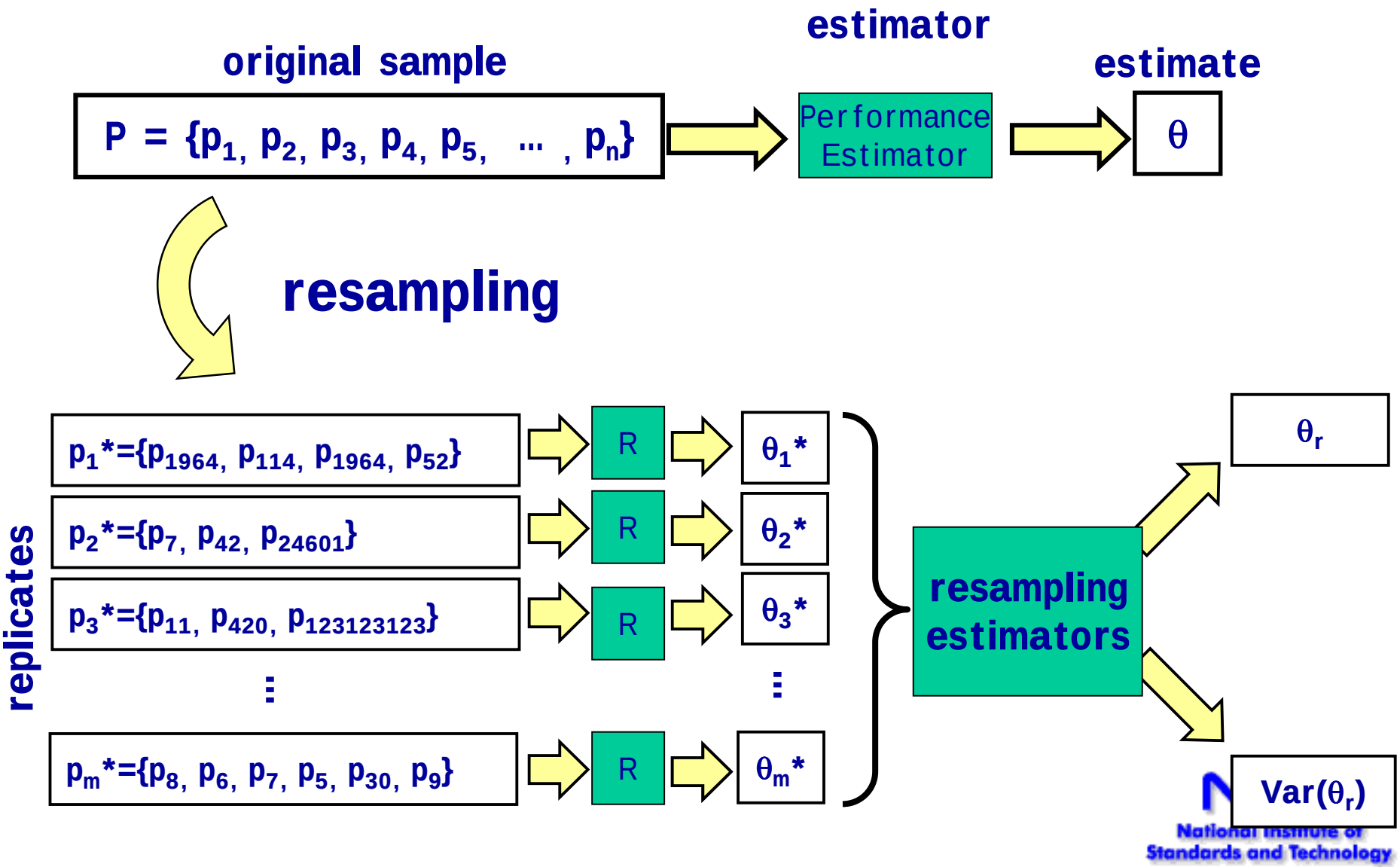
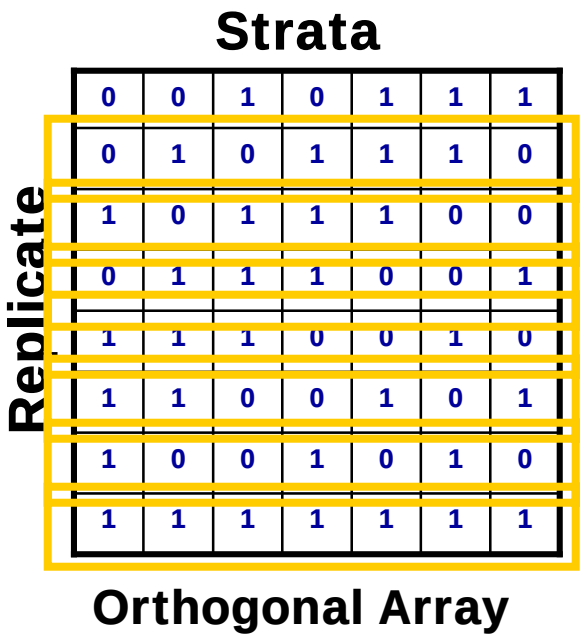
Resampling Techniques

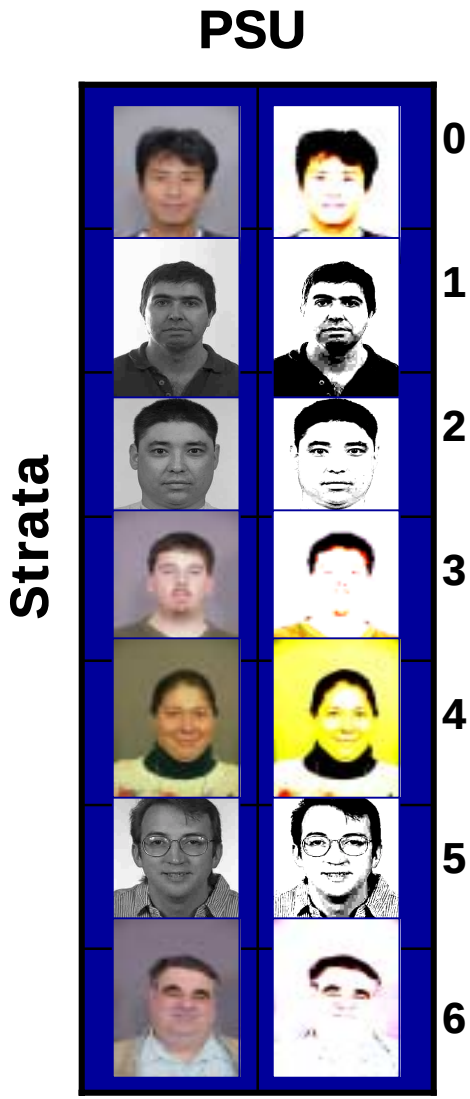


Resampling Techniques

- **Resampling** techniques examine statistics of subsets, combinations, and permutations of the original data.
- Resampling techniques are almost always **computer intensive**.
- The most common resampling methods are the **bootstrap** and the **jackknife**.
- However, these require **iid**.

Balanced Repeated Replication (BRR)





$\alpha_0 = \{$  $\}$

$\alpha_1 = \{\ldots\}$

$\alpha_2 = \{\ldots\}$

$\alpha_3 = \{\ldots\}$

$\alpha_4 = \{\ldots\}$

$\alpha_5 = \{\ldots\}$

$\alpha_6 = \{\ldots\}$

$\alpha_7 = \{\ldots\}$

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Alternative Titles Perhaps

Biometric Systems: Do they work? How do you find out?

Beyond The Hype:
Measuring Performance of Biometric Systems

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Balanced Repeated Replication (BRR)

Strata

Replicate							
0	0	0	1	0	1	1	1
1	0	1	0	1	1	1	0
2	1	0	1	1	1	0	0
3	0	1	1	1	0	0	1
4	1	1	1	0	0	1	0
5	1	1	0	0	1	0	1
6	1	0	0	1	0	1	0
	1	1	1	1	1	1	1

Orthogonal Array