[redacted]

DoD ABIS: Quality Evaluation of Operational Multi-Modal Biometric Data

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DoD Biometrics

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Outline

- Motivation/Problem Statement
- Operational Setting
- Multi-Modal Biometric Data
  - Fingerprint
  - Face
  - Iris
- Challenges

Motivation

- Quality of data affects system performance
  - Processing time
  - Validity of results
- Quality-adaptive processing
  - Thresholds sensitive to quality of probe & gallery samples
- Multi-modal fusion
  - Quality drives order of processing
  - Quality a factor into score/decision combination
  - Quality-sensitive thresholds

Operational Setting

- DoD BMO Biometric Collection SOP
  - 10(14) finger images, 5 face photos, 2 iris images
- Overworked, under-trained, collectors
  - often under stressful (life-threatening) conditions
  - often in a harsh environment (lighting, temperature, etc.)
- Substantial amount of legacy data (10+ years old)
  - paper fingerprint cards that have been exposed to severe environmental conditions
  - scanned images of Polaroid photos that have been stapled and exposed to the elements
- Highest reliability desired
  - National security at stake

Fingerprint

[redacted]

- Evaluation methods
- Data sample
- Quality findings

Finger Image Quality Evaluation

[redacted]

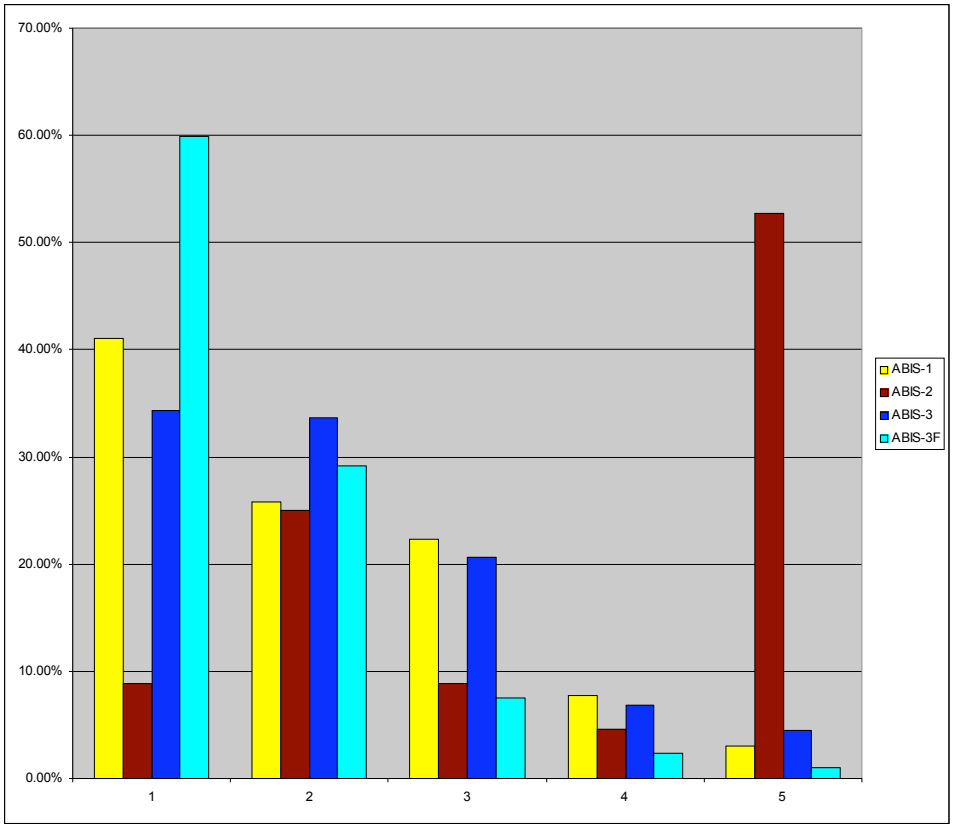
- NFIQ - NIST Finger Image Quality
  - Range of 1-5
  - Related to minutia matcher performance
- FIQM - Finger Image Quality Measurement
  - Range of 0-100
  - Related to human perception
- ENM - Equivalent Number of Minutia
  - Range of 0-85
  - Related to quality of print near each minutia and its neighbors

Quality Measures

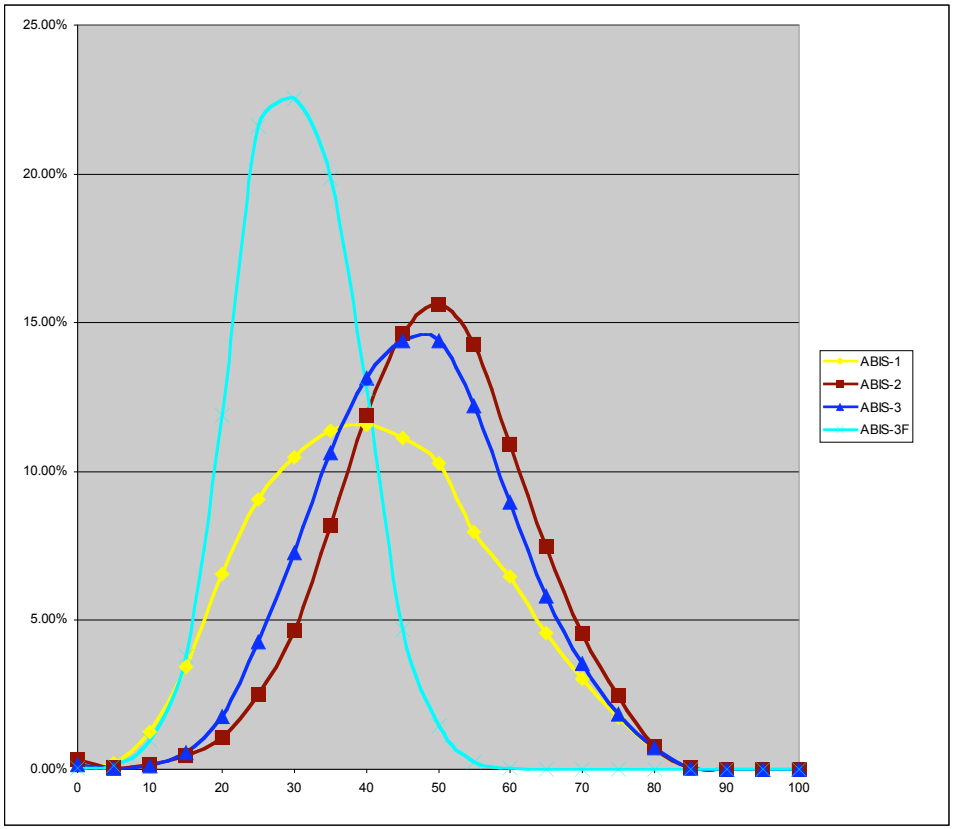
[redacted]

	NFIQ = 1	NFIQ = 5
ENM = 25		
ENM = 20		
ENM = 21		
ENM = 17		

Finger Quality Findings I [redacted]



NFIQ



ENM

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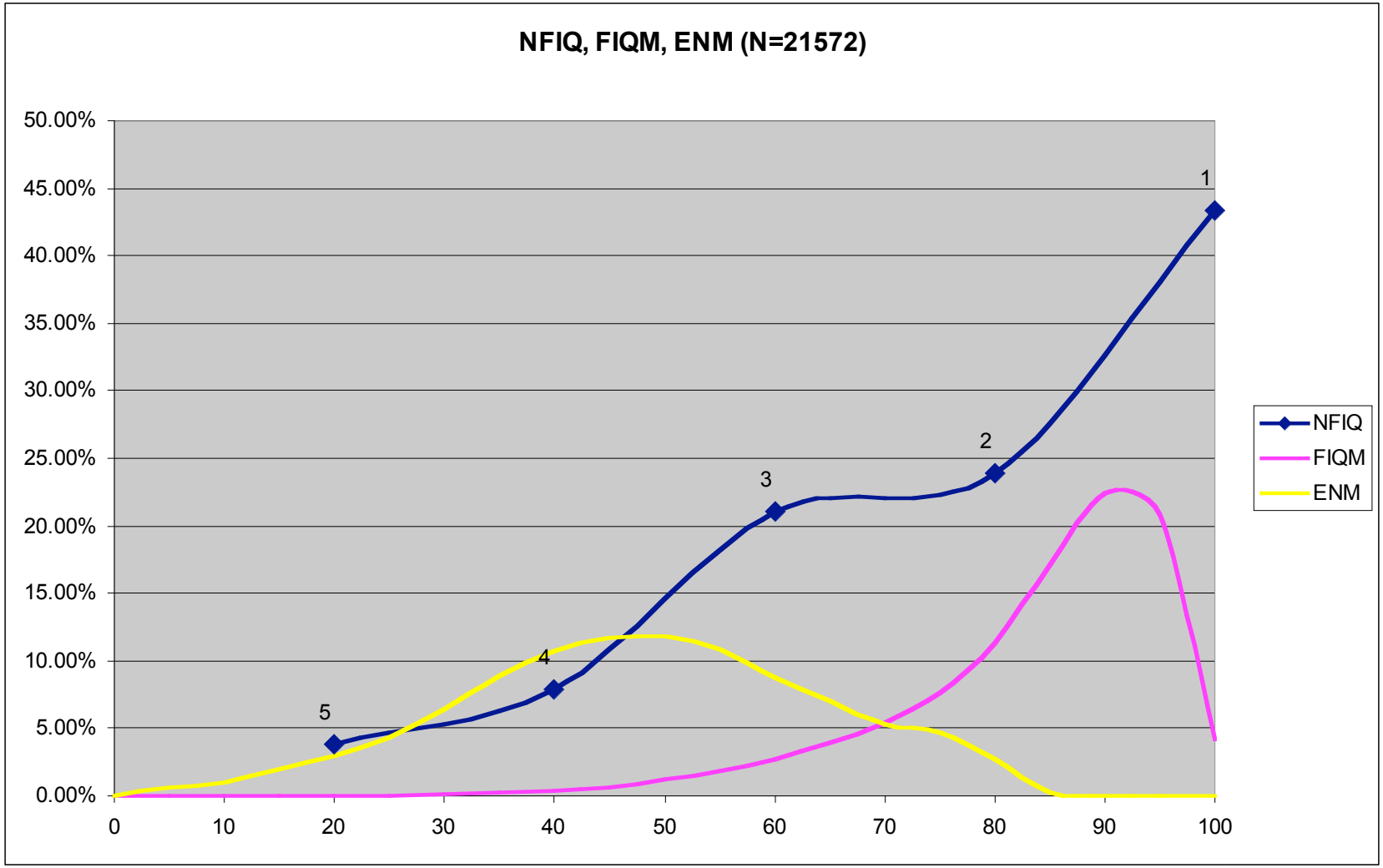
Finger Quality Findings II



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Finger Quality Correlation?

[redacted]

	NFIQ	ENM	ENM per Minutia	FIQM
NFIQ	1			
ENM	-0.355	1		
ENM per Minutia	-0.588	0.782	1	
FIQM	-0.775	0.434	0.687	1

Face

[redacted]

- Evaluation methods
- Data sample
- Quality findings

Face Image Quality Evaluation [redacted]

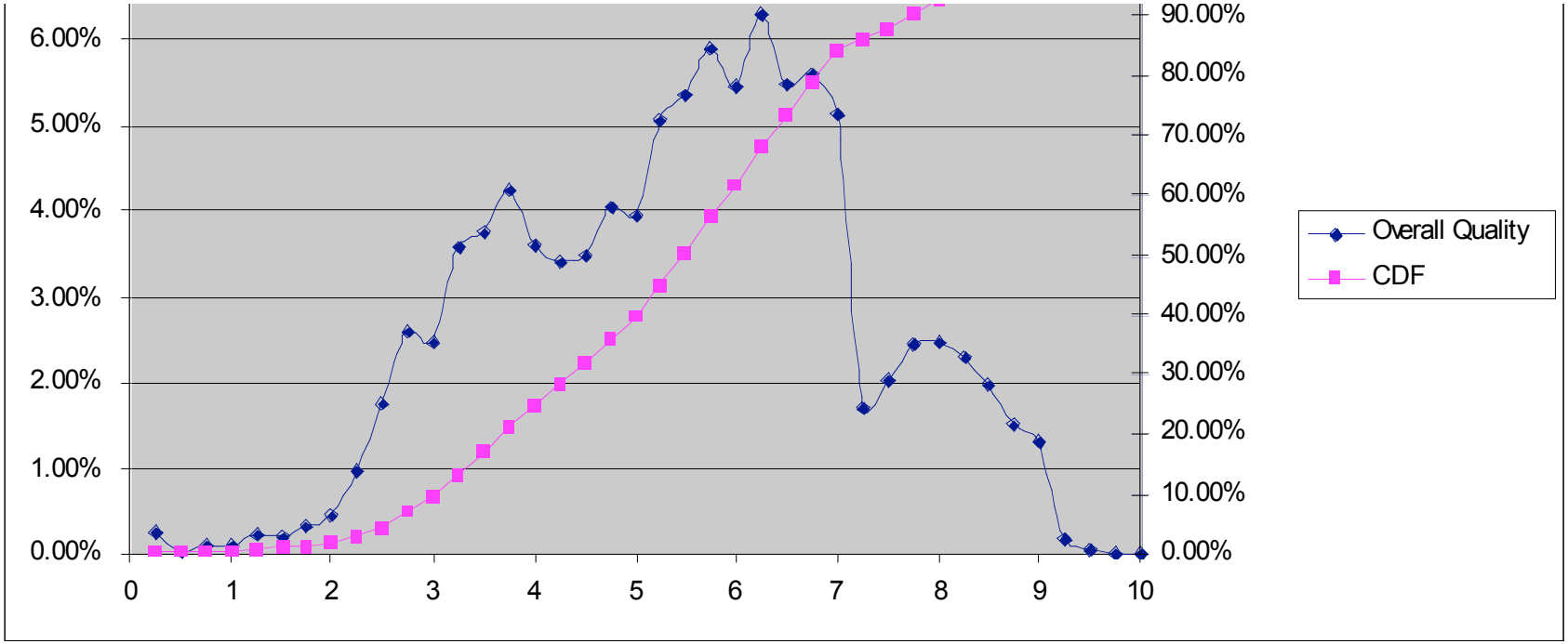
- Identix FaceIt Quality Assessment
  - 11 dimensions
    - darkness, brightness, exposure, focus, resolution, cropping, glasses, faceness, contrast, texture, and faceFindingConfidence
  - Overall Quality computed as:
    - minimum(darkness, brightness, focus, resolution, cropping, faceness, contrast)
    - 0.0-3.9 : Bad
    - 4.0-6.9 : Fair
    - 7.0-10.0 : Good

Face Data Quality Issues

[redacted]

- Cluttered background
- Legacy data – e.g. scans of 10+ year-old Polaroids
- Non-frontal pose
- Inconsistent lighting
- Multiple heads
- Low resolution

Face Quality Findings I



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Face Quality Findings II

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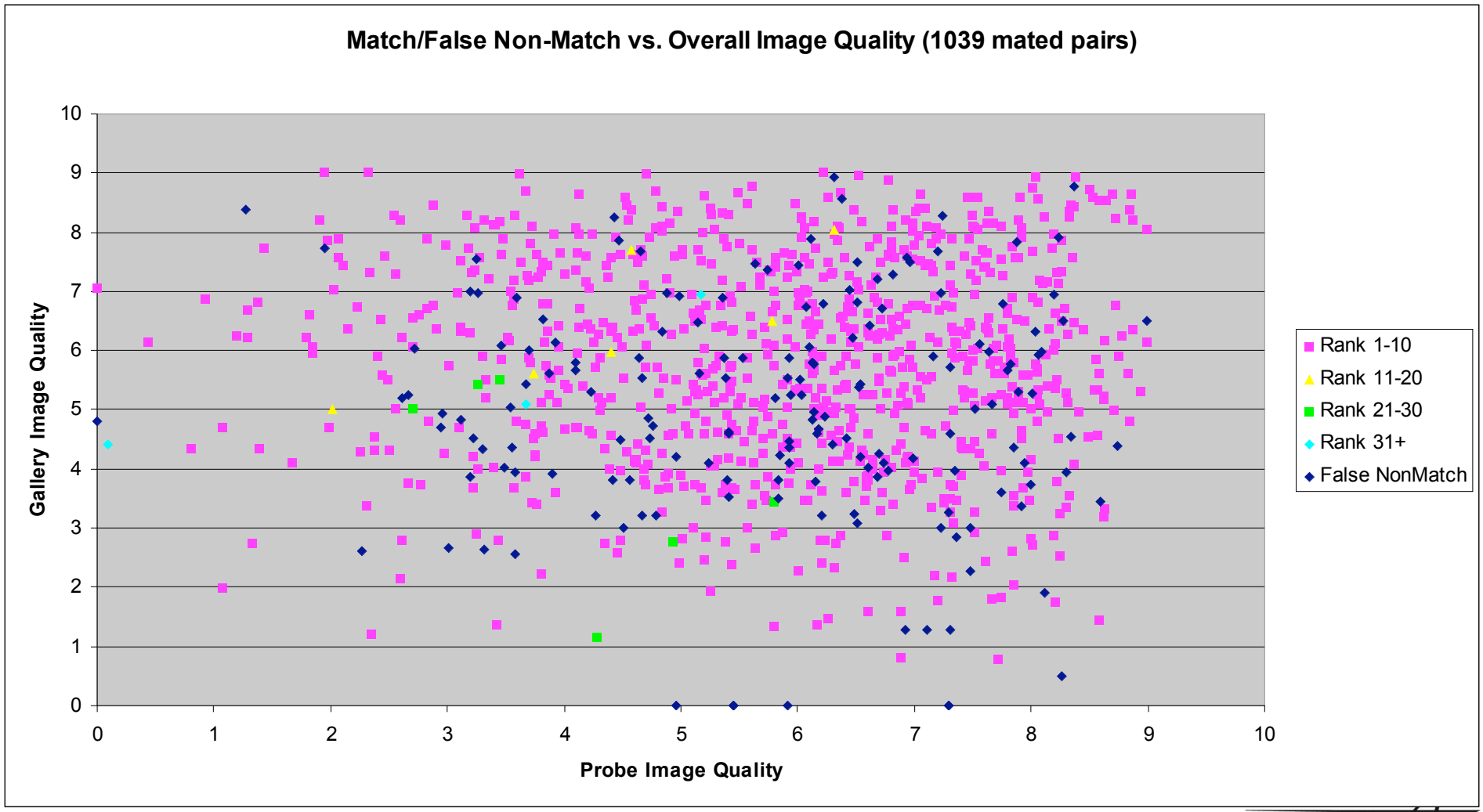
Face Identification Performance and Quality



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Iris

[redacted]

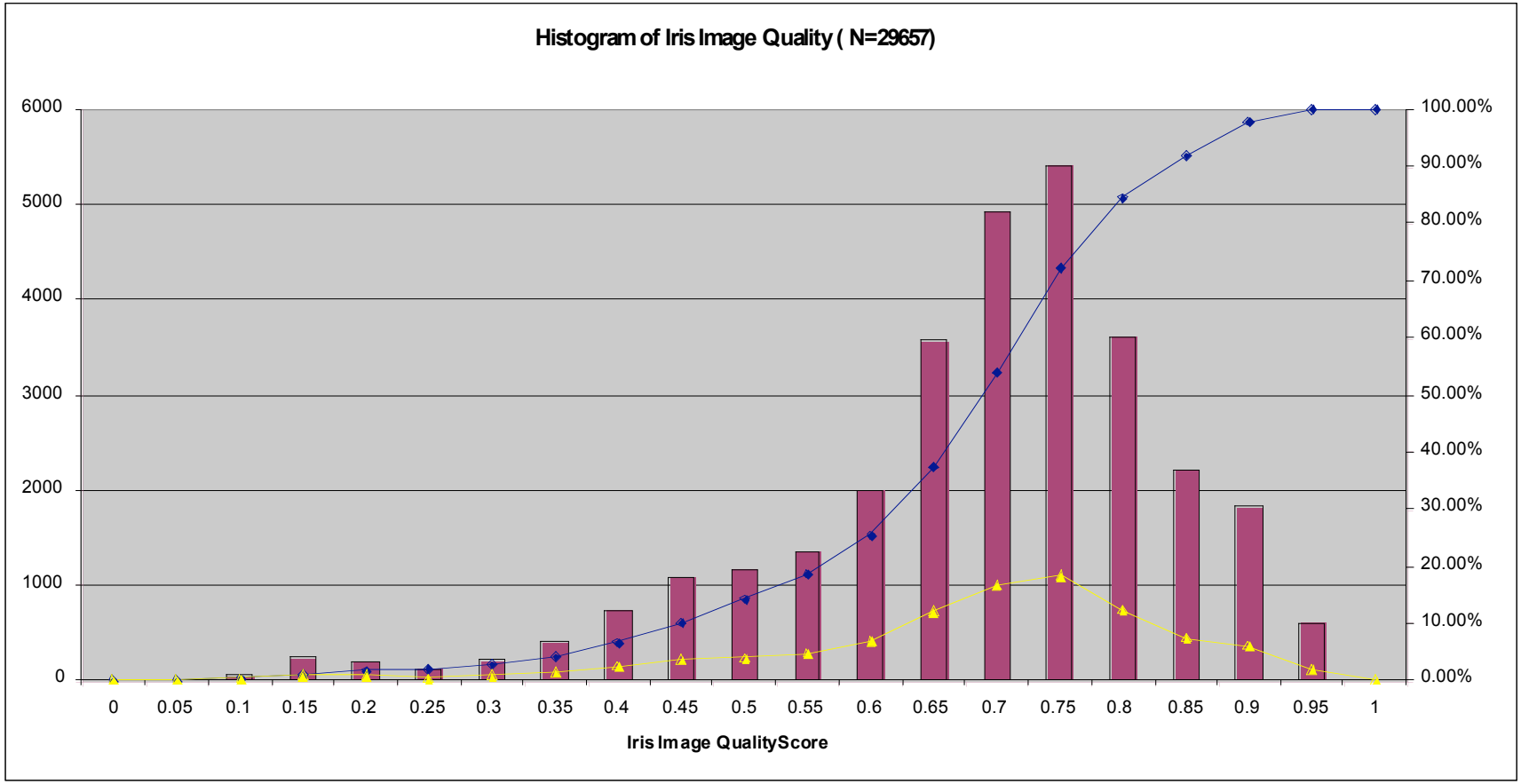
- Evaluation methods
- Quality findings

Iris Image Quality Evaluation

[redacted]

- Method of Kalka and Schmid from WVU
- 7 dimensions
  - Occlusion, motion blur, defocus blur, lighting, pixel counts, specular reflection and off-angle
  - Overall quality computed by applying Dempster-Shafer method using Murphy's rule to normalized (0.0-1.0) dimensions

Iris Quality Findings I



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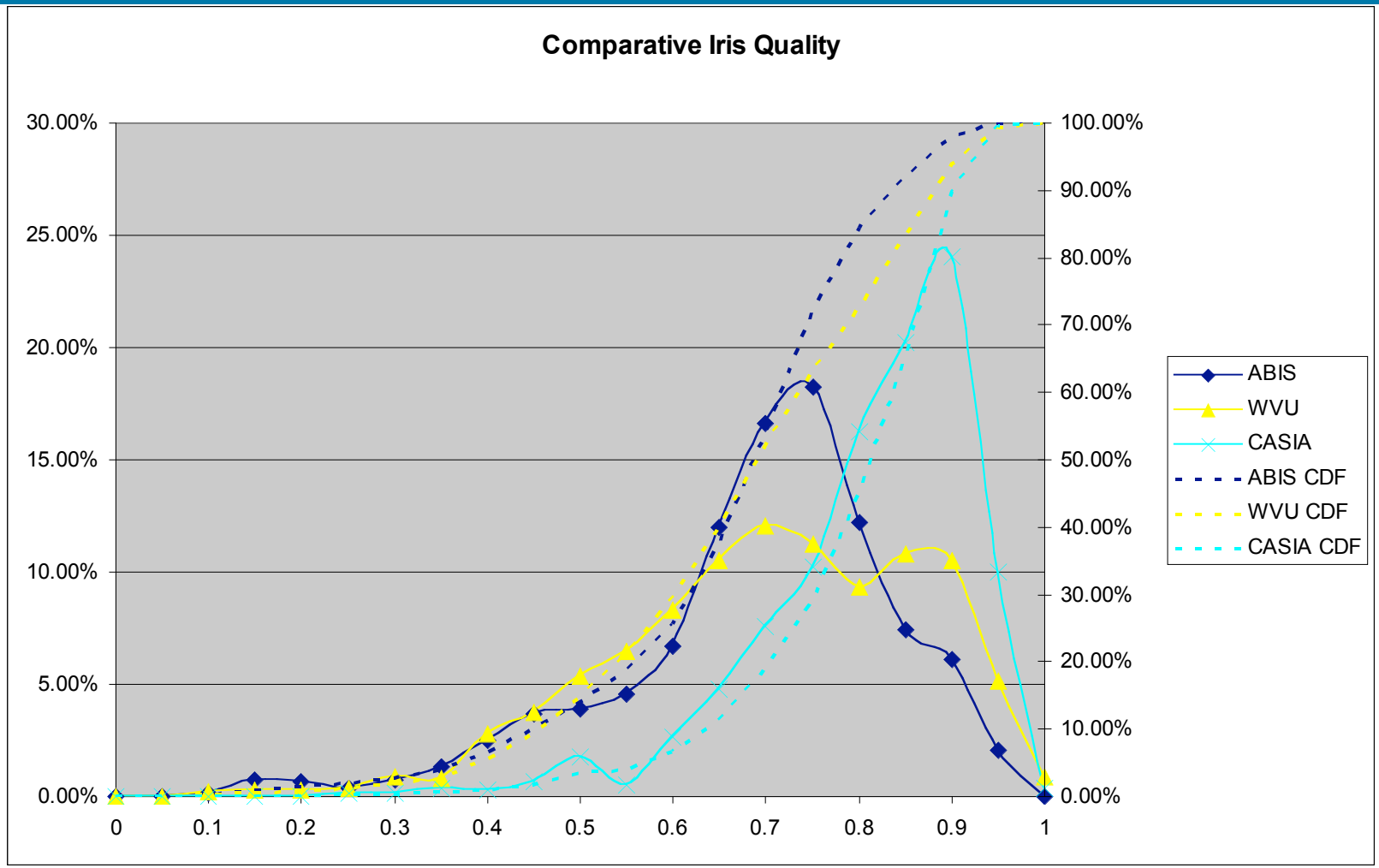
Relative Iris Quality



WVU and CASIA Iris Quality Scores courtesy of Nate Kalka, WVU

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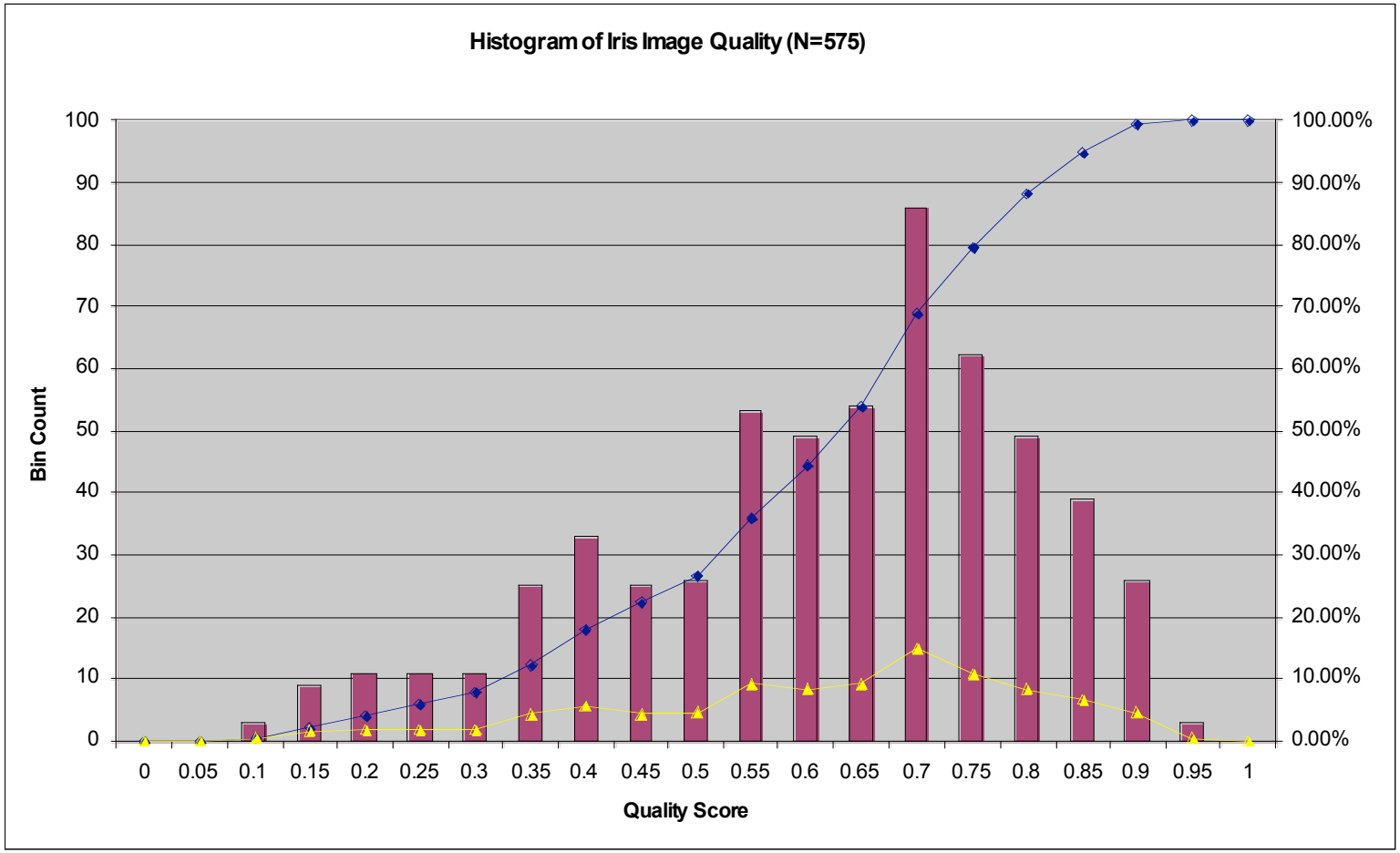
Iris Quality Findings II



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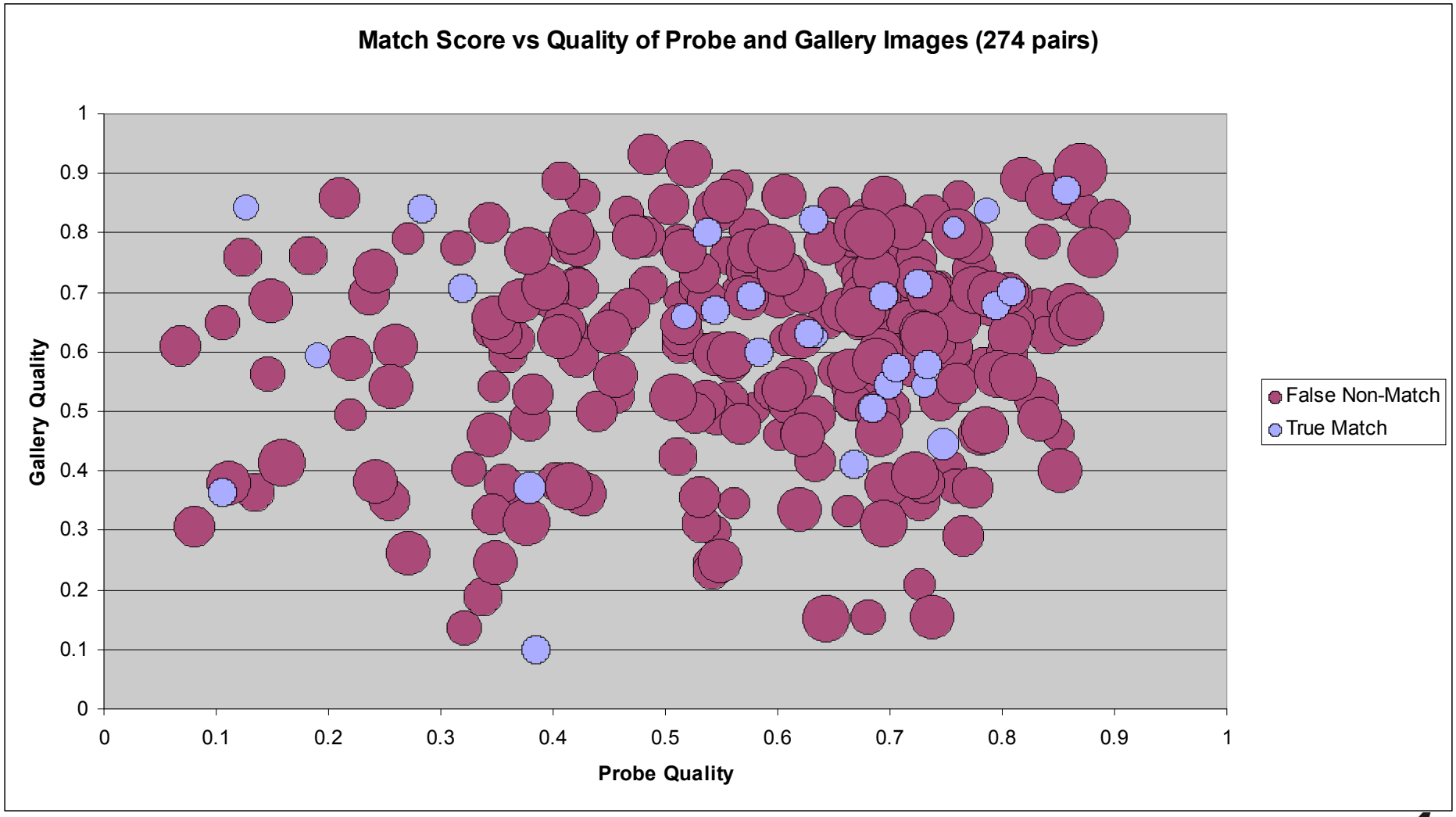
Iris Identification Performance and Quality

[redacted]



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Challenges

[redacted]

- Need real-time feedback at point of collection
- Need either
  - generic, algorithm-agnostic quality metrics
  - or, algorithm (vendor)-specific quality metrics
- Want performance-predictive metrics
- Machine perception and/or human perception?
- Need to understand tradeoff involving very low quality data
  - can we quantify diminishing returns?
  - can we justify excluding some samples?

Collaboration Opportunity [redacted]

- We have plenty of real-world data.
  - Unfortunately, not for public dissemination
- However, we welcome the chance to evaluate new ideas using our data set for mutual benefit.
  - WVU – iris image quality assessment
  - BAH – finger image quality assessment
- POC:

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Questions?