FBI Science & Technology Branch

NIST Image Quality Workshop

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National Institute of Standards and Technology

Next Generation   Interoperability

Technology Evaluation

Standards Development

IAFIS Quality Assessment

§ The AFIS segment of IAFIS measures image quality based on an overall reference (**REF**) count

§ The REF count quality metric predicts the amount of work AFIS must perform in order to process the fingerprint submission

§ Since the right and left hands may be of different quality, AFIS computes these REF count values individually for each finger and then normalizes them into a cumulative total

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IAFIS Quality Assessment

§ Each image on a fingerprint submission contributes toward the overall REF count on a point-based system

§ The highest number of points possible per fingerprint image is eight

§ The points for each fingerprint image are added to obtain the overall REF count

- For a ten-print fingerprint submission, an overall REF count of 1 - 80 is possible

IAFIS Quality Assessment

§ Reference Counts:
   – 1 point for each AFIS pattern type the fingerprint might be
      § Arch (AU)
      § Left Slant (LS)
      § Right Slant (RS)
      § Whorl (WU)
   – 1 point for each core to delta ridge count that is indeterminate (maximum of 2 points for a loop and 4 points for a whorl)
   – Each scar (SR) or amp (XX) fingerprint image is given eight points
   – Missing fingerprint images (UP) do not count when calculating the overall REF count. When there are missing images, the overall REF count is normalized into a ten-finger count

SBDA

§ The FBI flags some submissions of sub-standard quality as "Search But Don't Add"

§ Different SBDA thresholds exist for civil vs. criminal submissions

 – Criminal quality threshold requirements are more stringent than civil

REF Count Thresholds

§ **Total Maximum possible = 80** (0 - 08 per finger)

  – Criminal Thresholds:

    § 80 – 72 = Rejected for low quality (L0008)

    § 71 – 66 = Search but don't add (SBDA)

    § 65 –   0 = Search (and add to file if applicable)

  – Civil Thresholds:

    § 80 – 70 = Rejected for low quality (L0008)

    § 69 – 64 = Search but don't add (SBDA)

    § 63 –   0 = Search (and add to file if applicable)

REF Count Thresholds

§ iDSM and TPRS Thresholds:

    – Criminal Thresholds:

        § 80 – 72 = Rejected for low quality

    – Civil Thresholds:

        § 80 – 70 = Rejected for low quality

§ RISC Threshold:

    – Criminal Threshold:

        § 80 – 75 = Rejected for low quality

IAFIS L0008 Rejects

FY 2007 Overall = 42.83%

Oct-06	41.71%
Nov-06	36.56%
Dec-06	39.31%
Jan-07	43.58%
Feb-07	45.90%
Mar-07	47.28%

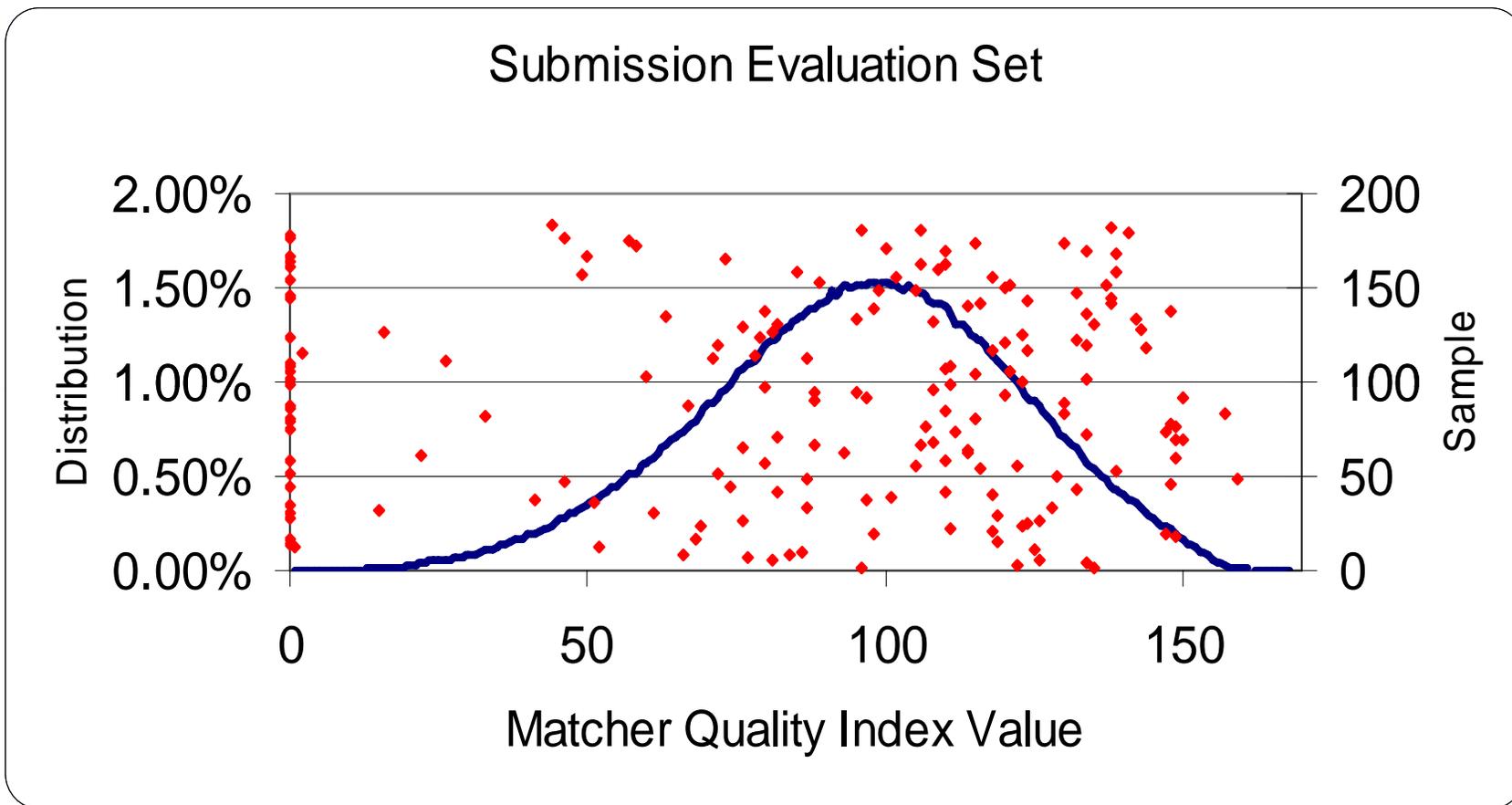| Apr-07	50.93%
May-07	47.18%
Jun-07	41.96%
Jul-07	40.29%
Aug-07	39.91%
Sep-07	39.48%

Segmentation Errors

§ High percentage of IAFIS ID Flats rejects derive from segmentation errors

§ Performing studies to assess the feasibility of detecting segmentation error solely from the segmentation coordinates by using supervised machine learning
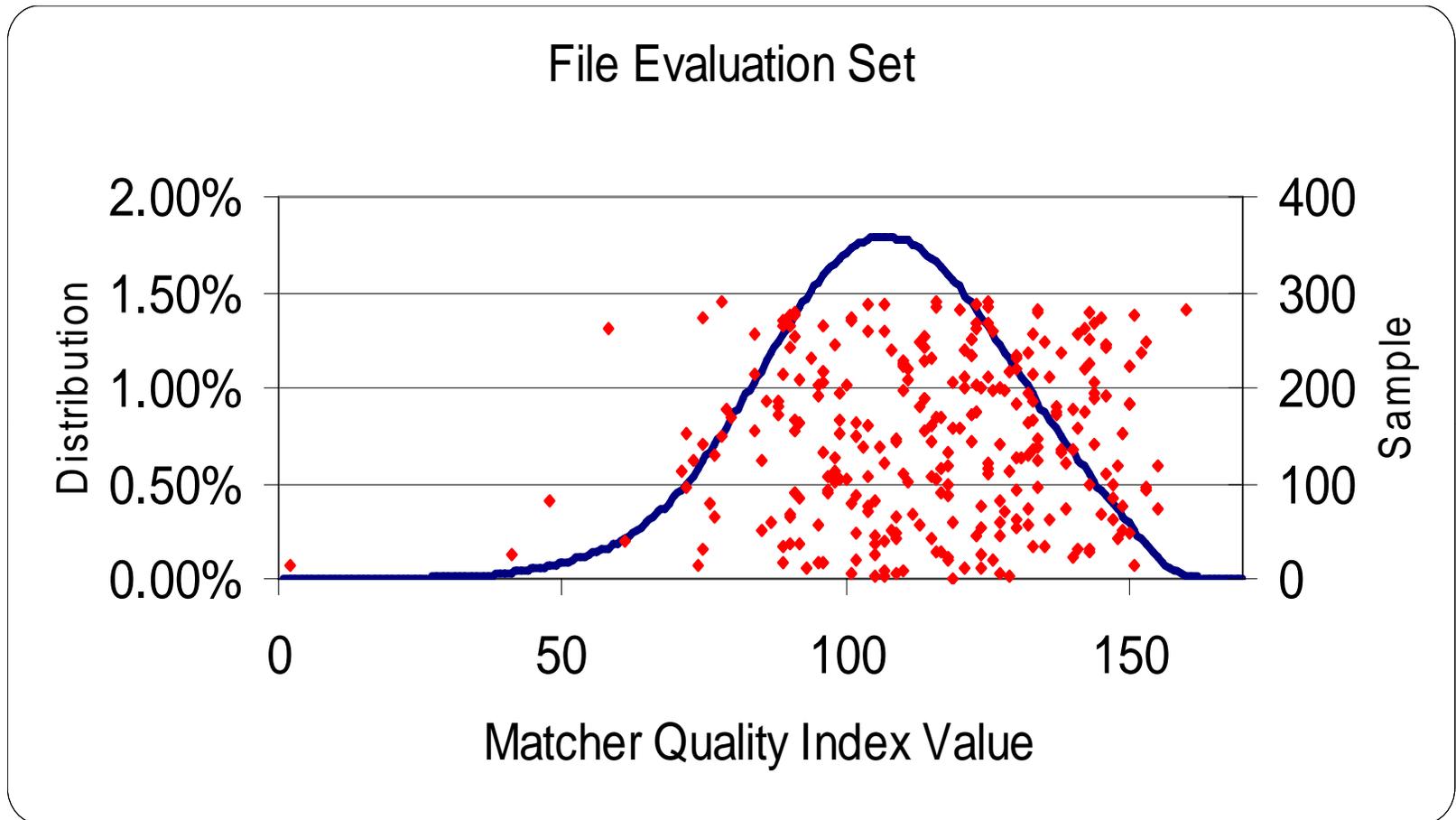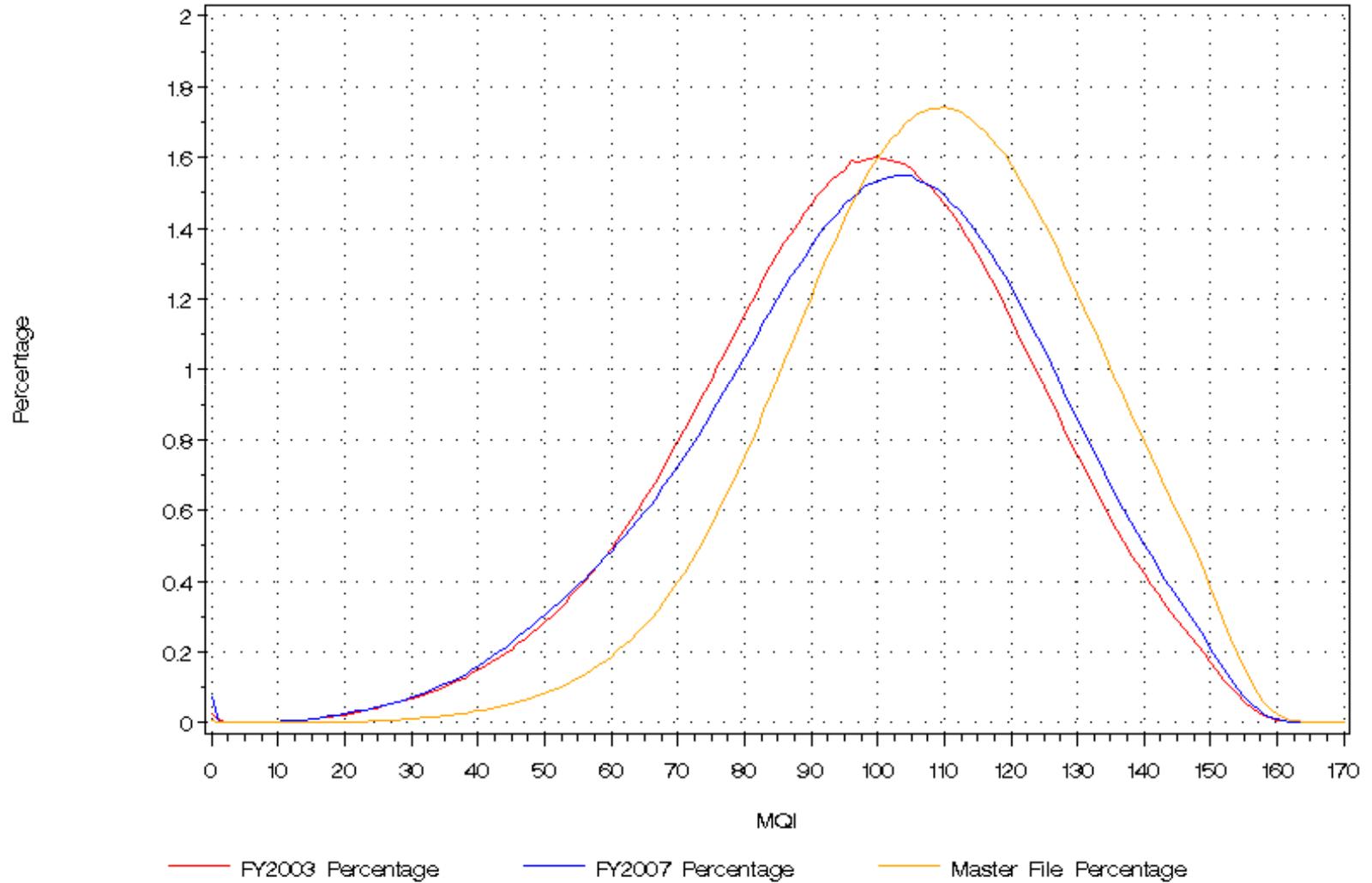
§ NIST SlagSeg

FBI IAFIS

2003 Submissions

Submission Evaluation Set

FBI IAFIS
2003 File

File Evaluation Set

Distribution (y-axis): 2.00%, 1.50%, 1.00%, 0.50%, 0.00%

Sample (right y-axis): 400, 300, 200, 100, 0

Matcher Quality Index Value (x-axis): 0, 50, 100, 150

FBI IAFIS

AFIS MQI Analysis
Created 22OCT07:13:25:34

Goals

Why standard image quality metrics?

1. Reduce failure to acquire errors for biometric devices
2. Improve overall accuracy and performance of biometric matching systems
3. Provides a common language that may not be available from biometric proprietary systems

Fingerprint Image Quality Scores

§ FBI/CJIS adopted NIST NFIQ predictor and requires its use for all ID flats submissions to AFIS

§ FBI EFTS 7.1 requires NFIQ finger score (1-5)

§ FBI EBTS 8.0 also allows additional Fingerprint Predictive Performance Metrics Data

– Finger Number

– Predictive Quality Score (0-100 254 & 255)

– Registered IBIA vendor Id,

– Vendor algorithm code

Other Biometric Modalities
(finger, face, iris, palm, latent)

§ Same approach should be expanded to include other biometric matching technologies

§ Assessing the quality of a captured image PRIOR to matching allows images to be corrected before being entered into the background database

§ An insufficient quality predictor derived from a captured sample can be used to trigger a recapture or reacquisition of that sample

  – And can be used to recalibrate a threshold setting to improve accuracy

§ If impossible to acquire a "good" sample, then select a different mode

Implementation

§ Fingerprint, face, and iris record types in the ANSI/NIST data format standard already have fields reserved to contain biometric quality indicators.

§ Agree on the meanings and develop values for these indicators and they can be used and transmitted within an ANSI/NIST transaction

§ Will require research and development

Potential Policy Outcomes

§ A sustained program of quality assessment and monitoring over time would provide a ongoing scorecard and monitoring tool for evaluating how each biometric contributing agency is controlling their quality
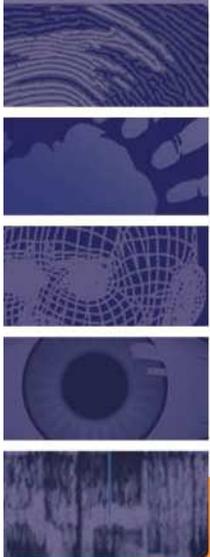
Thank you

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Backup Slides

Reliability of Fingerprints
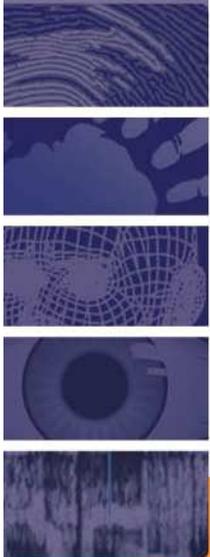
§ The reliability of fingerprints as a means of providing automated person identification is primarily determined by the amount and quality of data obtained at the point of fingerprint capture

§ Matching performance is quality sensitive and limited by the fingerprints of worse quality - submission or file

Algorithms

§ Fingerprint matcher algorithms commonly in use are sensitive to clarity of ridges and valleys, measures of number and quality of minutiae, and size of the image

§ The lack of consistent and uniform quality in the capture of the fingerprint images is a limiting factor in the improvement of fingerprint search accuracy/selectivity (true acceptance rate/false acceptance rate) in both ten fingerprint and latent fingerprint applications

Importance of Quality

§ When images are of high quality, all AFIS segmentation, minutiae extraction, and matcher software performs with comparable accuracies

§ When the data is of poor quality, there are significant differences among software

§ Any system designed to be more forgiving and enroll marginal fingerprints will result in increased error rates

Causes of Poor Quality

§ Every person can produce poor-quality fingerprints

§ Causes include:

- lack of trained staff collecting the impressions
- aging live or card scan equipment
- live or card scan equipment that is not being calibrated on a regular basis
- lack of proper equipment preventative maintenance
- multiple conversions from hardcopy to electronic copy
- or any combination of the above

Size Matters

§ As the size of the FBI's fingerprint database grows, the problems encountered with regard to degraded image quality will also grow proportionately

§ Enrolling images of undesirable quality can cause lasting and serious impacts on system accuracy

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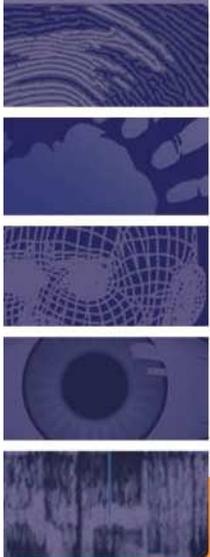
Reference Counts

§ The FBI's AFIS computes image quality thresholds (reference counts):

– Since the right and left hands may be of different quality, these could be utilized as values calculated for <u>each</u> finger rather than a cumulative total

– IAFIS candidate filtering is affected by fingerprint quality and may need adjusted (lessen the aggressiveness of the filtering processes) or allow more time to process low quality submissions to avoid mistakenly dropping the correct file candidate

– Another option may be for AFIS to utilize quality dependent algorithms to equalize detection probabilities across submissions of all quality levels