

NIST Fingerprint Image Quality

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background

- quality is important
 - previous research
 - mostly defined as a measure of the extractability of the features used for recognition such as minutiae.
 - local orientation information (Bolle et al, Shen et al, Hong et al., ...)
 - global features (Hong et al, Lim & Yao, Nill & Bouzas, ...)
 - almost all used subjective quality assessment to evaluate their quality algorithm
 - size of fingerprint, pressure, humidity, amount of dirt, ...
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quality as prediction of performance

we define fingerprint image quality as a prediction of a matcher performance, e.g. a sample's quality score reflects the predictive positive or negative contribution of an individual sample to the overall performance of a fingerprint matching system.

TAR



excellent quality
samples result in
high performance



poor quality
samples result in
low performance

FAR

use of quality to improve performance

- recapture samples of insufficient quality
 - pruning the poorest quality samples (1.65% of dataset) reduced EER from .0047 to .0024 (sdkl - dos - ri)
- process samples differently based on their qualities
- collect relevant statistics
 - compare capture devices and/or environments
 - correlation among fingers
$$p(nfiq(ri)=5) = 0.011 \quad p(nfiq(li)=5) = 0.016$$
$$p(nfiq(li)=5 \mid nfiq(ri)=5) = 0.22$$
- cause higher quality sample dominate fusion

NIST Fingerprint Image Quality

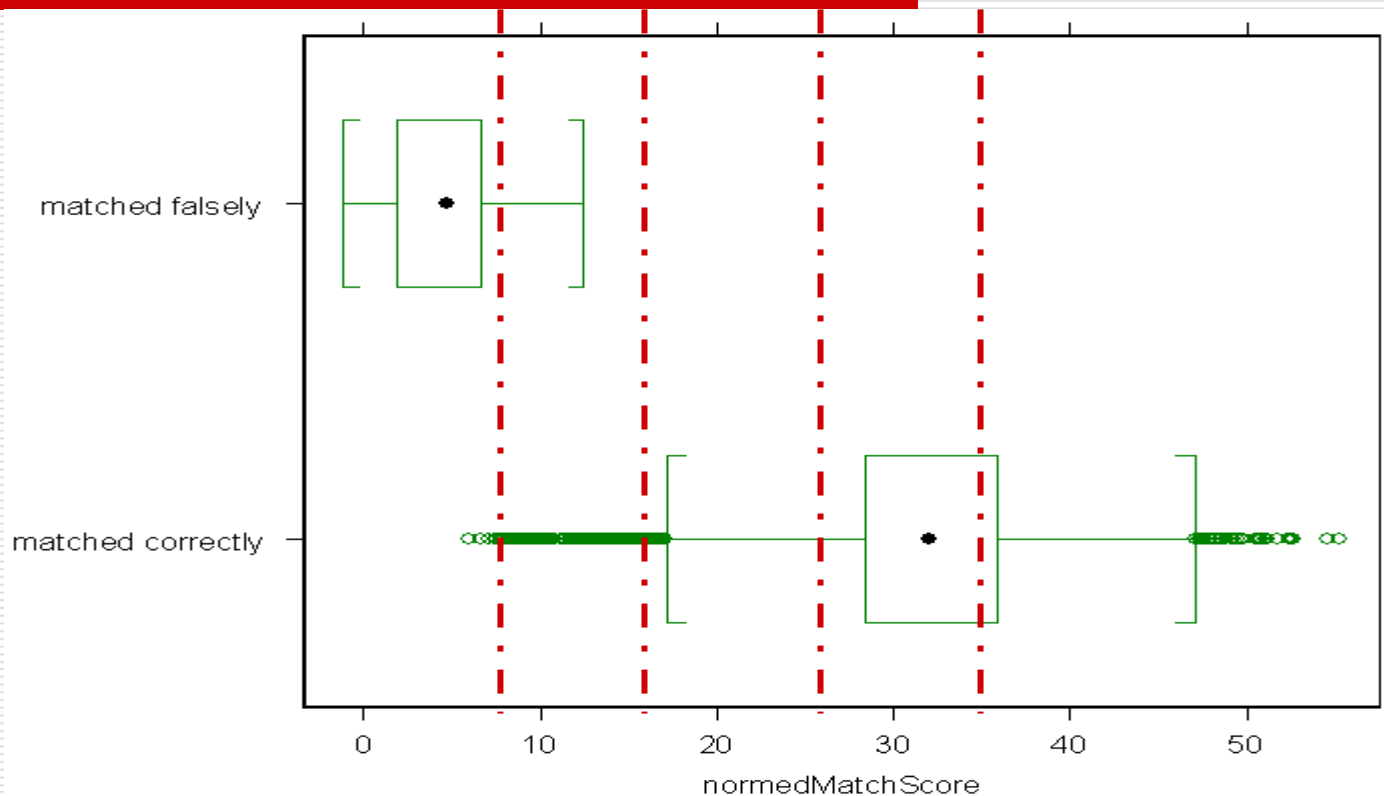


NFIQ's 5 levels of quality are intended to be predictive of the relative performance of a minutia based fingerprint matching system.

- NFIQ=1 indicates high quality samples, so lower FMR and/or FNMR is expected.
- NFIQ=5 indicates poor quality samples, so higher FMR and/or FNMR is expected.

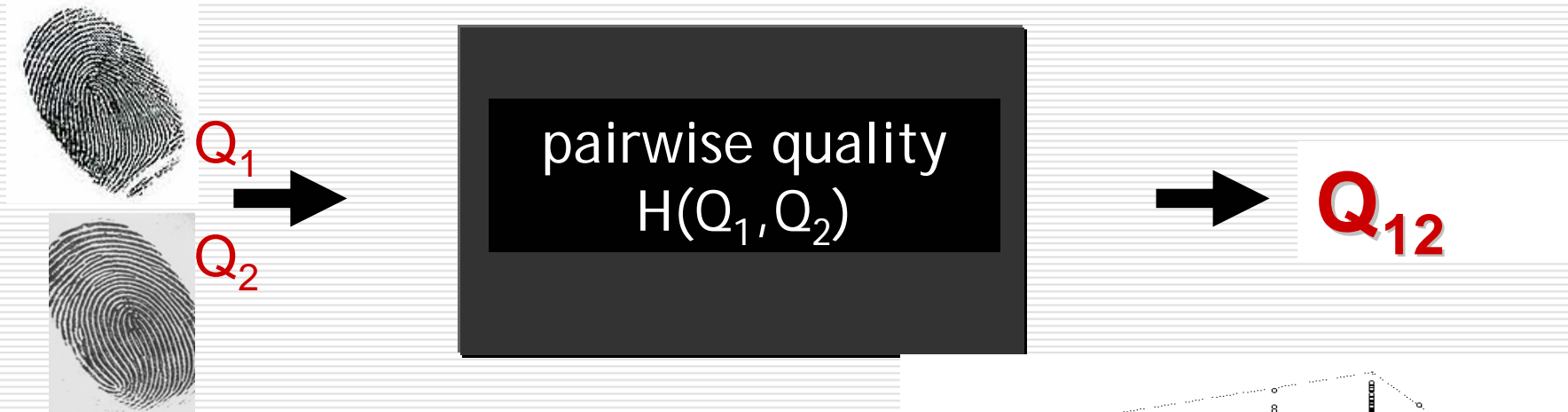
performance target

degree of separation between a sample's genuine and imposter distributions

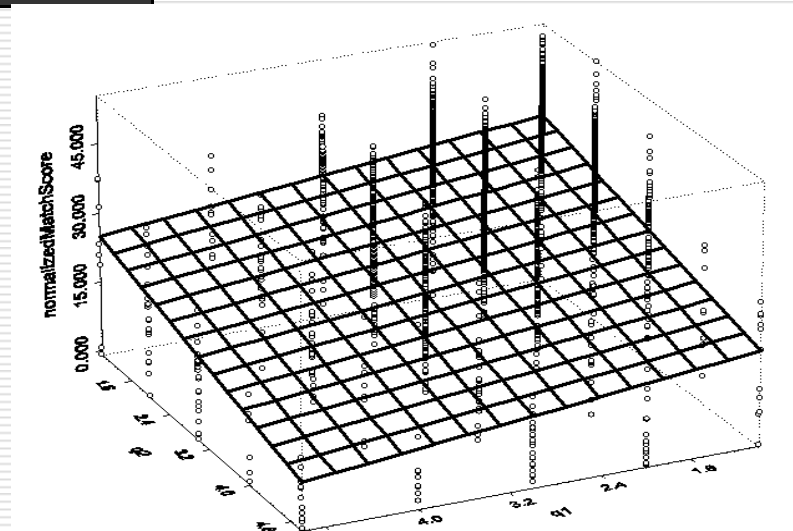


quality of a biometric sample $x_i \triangleq$ prediction of the bin its normalized match score falls

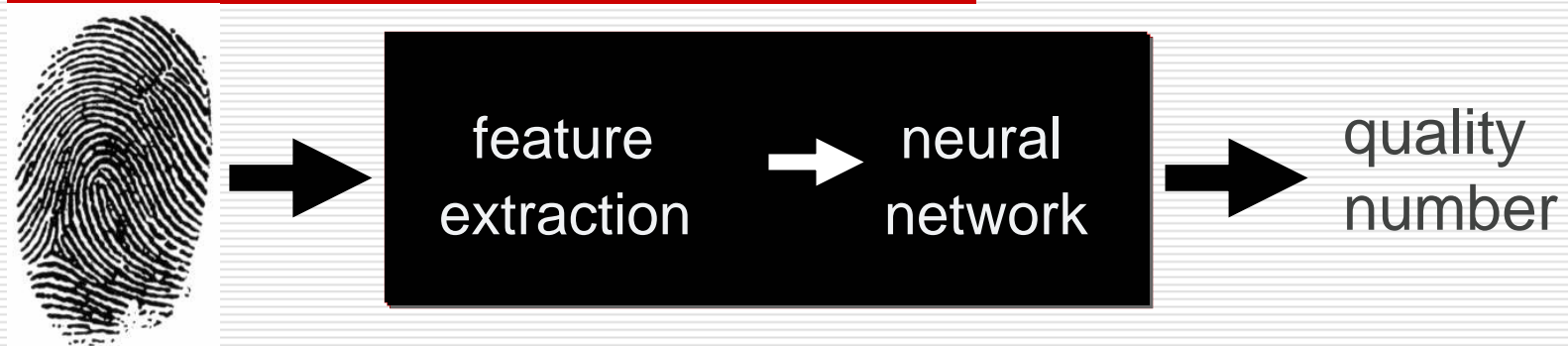
pair-wise quality



when the enrollment sample is of good quality and better than that of the use phase (search) sample, the search sample's quality is sufficient to predict performance.



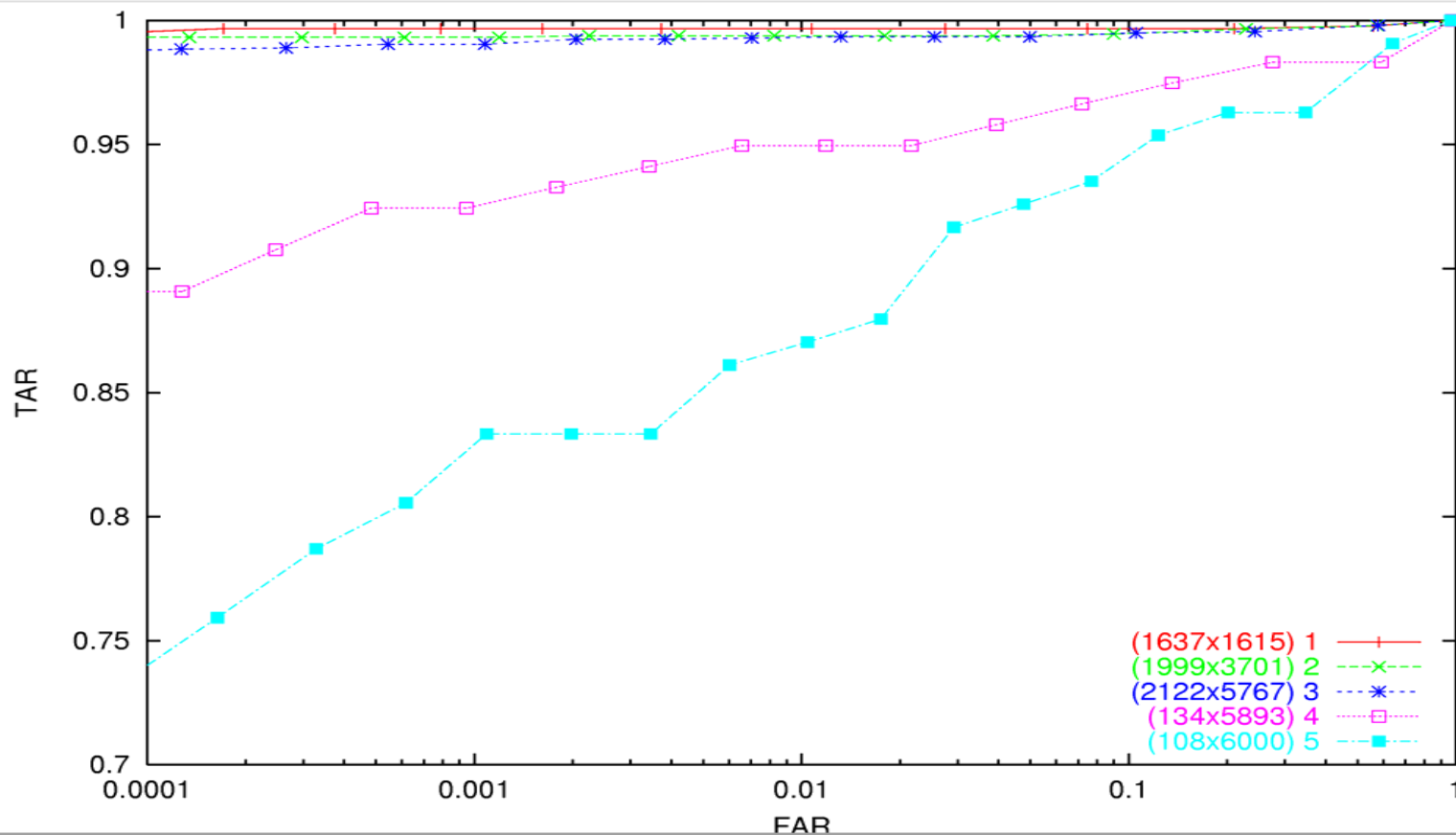
NIST Fingerprint Image Quality



- **feature extraction:** computes appropriate signal or image fidelity characteristics and results in an 11-dimensional feature vector.
- **neural network:** classifies feature vectors into five classes of quality based on various quantiles of the normalized match score distribution.
- **quality number:** an integer value between 1 (highest) and 5 (poorest).

NFIQ effectiveness

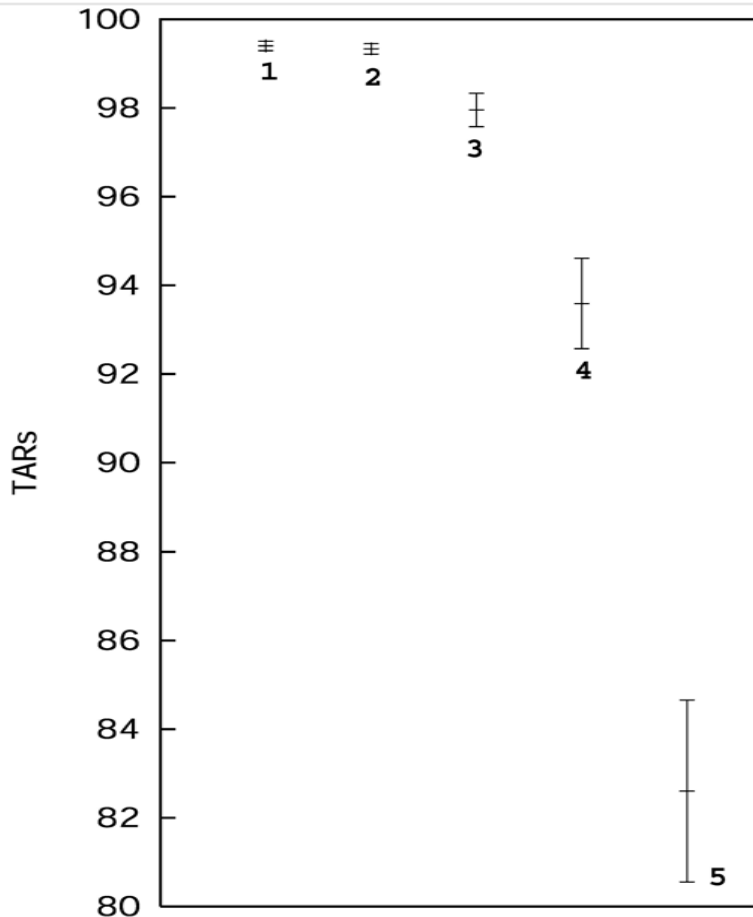
- evaluation criterion is rank ROC as a function of image quality
- used various fingerprint matching algorithms and various datasets to evaluate NFIQ
 - 15 different COTS fingerprint matching algorithms
 - 22 different datasets of different fingers captured by various devices and at different operational settings
 - each test dataset has 2 fingerprint images of 6000 person
- compared (TAR,FAR) of levels of quality at a fixed threshold
 - as quality degrades, true accept rate decreases for all the matchers, FAR increase for some.
- levels 2,3,4, and 5 are statistically separable.
- It takes about one third of a second to compute quality of a flat fingerprint image.



6000 subjects - Right index
Threshold @ (far,tar)=(0.012,0.99)

	1	2	3	4	5
quality	excellent	veryGood	good	fair	poor
FAR	0.0037	0.0083	0.0131	0.0216	0.0477
TAR	0.997	0.994	0.993	0.9496	0.926

separable levels of quality



For each quality level, we calculated 95% confidence intervals of TARs @ FAR=0.1% for six matchers and sixteen datasets.

nfiq levels 2,3,4, and 5 are statistically separate.

conclusion

- a novel definition of fingerprint image quality
- NFIQ works as a rank statistic for performance for all 330 combinations of COTS fingerprint matchers and operational datasets tested
- NFIQ levels 2,3,4, and 5 are statistically independent
- NFIQ can be used for real-time quality assessment
- NFIQ is publicly available but subject to US export control laws (fingerprint.nist.gov)

thanks

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