NIST Fingerprint Image Quality
and relation to latent prints

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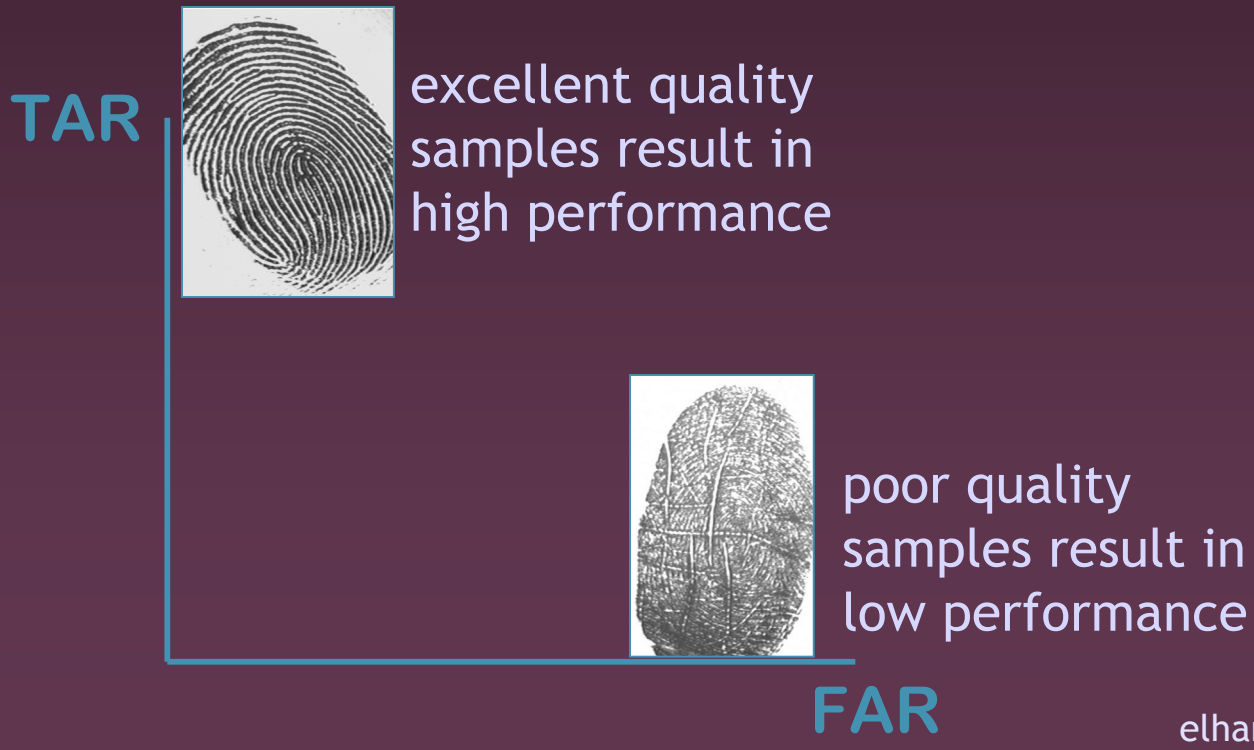
quality as prediction of performance

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.



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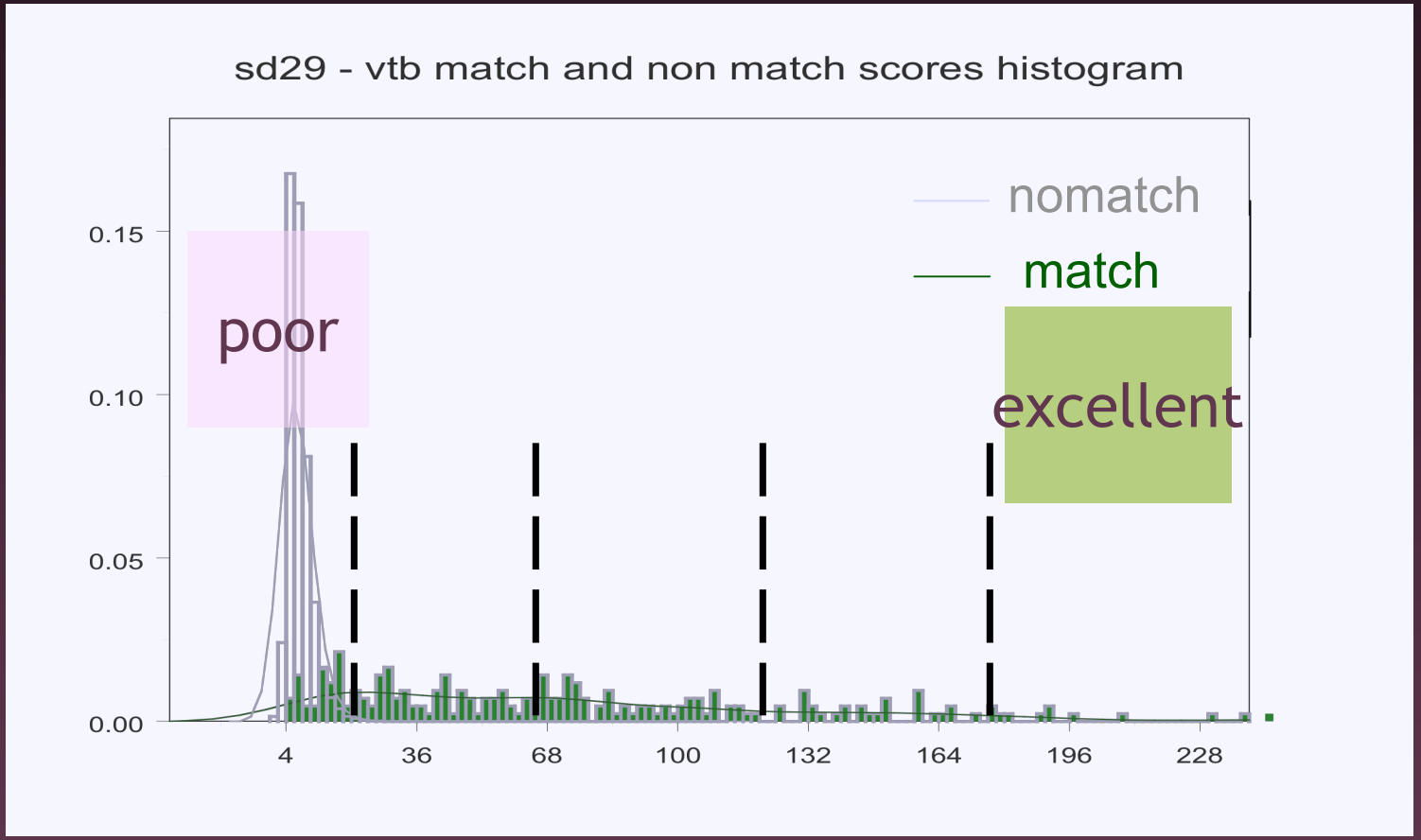
Statement of performance



the quality measure should be indicative of the degree to which the distribution of match scores is separated from the distribution of non-match scores.

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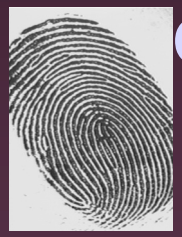
… but it is not easy

Q_1



Q_2

pairwise quality
$H(Q_1, Q_2)$

Q_{12}

because matching involves two samples, but quality is defined and measured per sample

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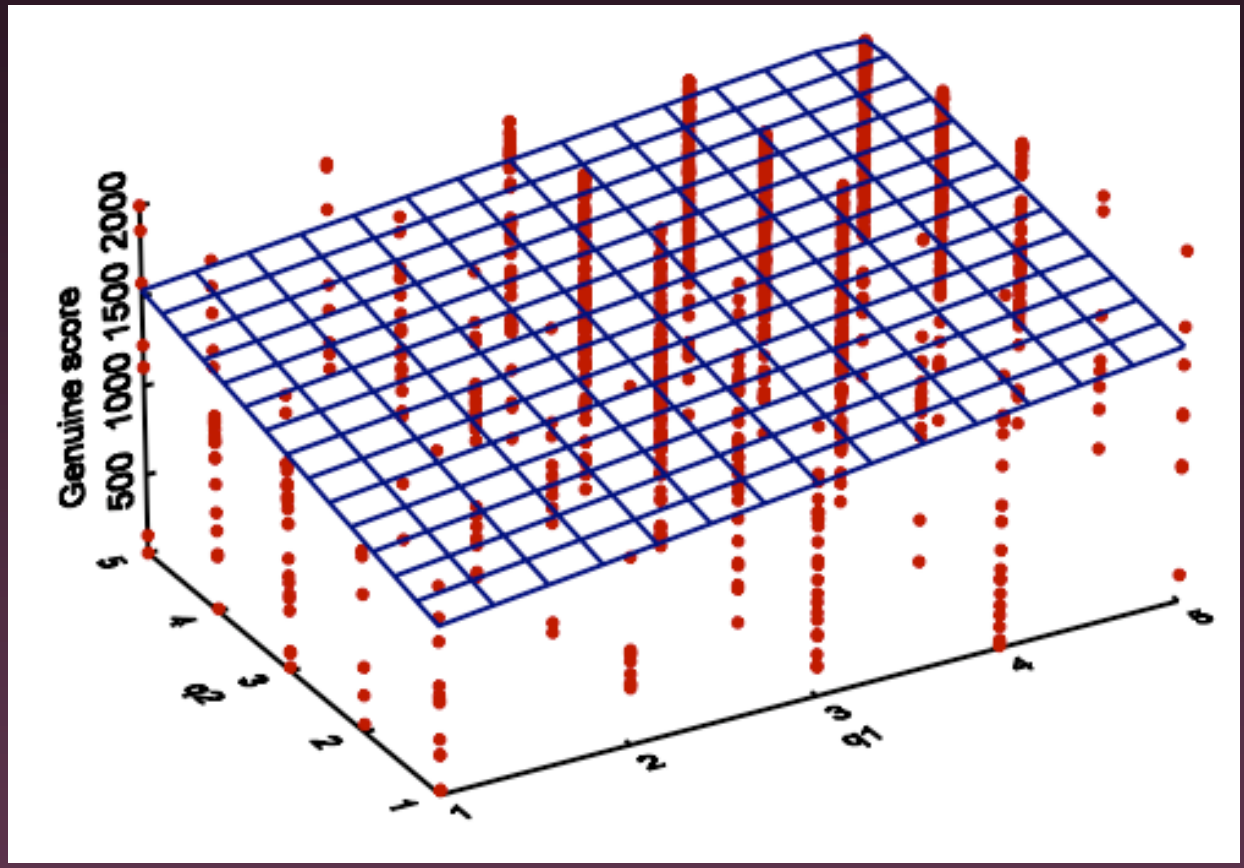
pair-wise quality



when the enrollment sample is of good quality and better than that of the authentication sample, the authentication sample's quality is sufficient to predict performance.

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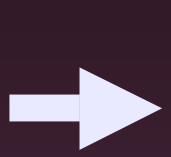
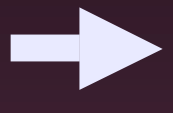
NIST Fingerprint Image Quality (NFIQ)

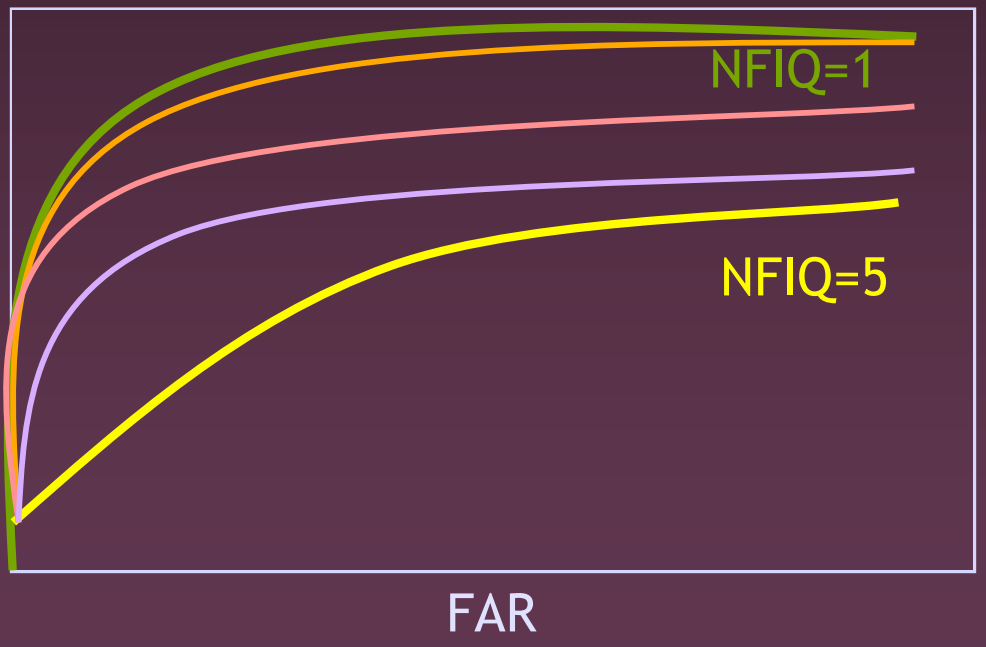


NFIQ



quality number =5

poor quality samples result in low performance



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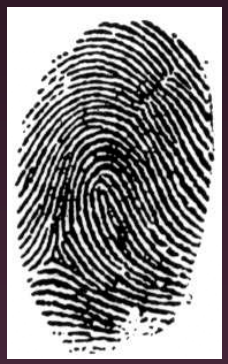
NIST Fingerprint Image Quality



feature extraction → neural network → quality number {1,2,3,4,5}

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).

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poor quality samples

distorted source e.g. scars on a fingertip

nfiq=5

distortion in one or more steps of the process e.g. capture or compression

nfiq=5

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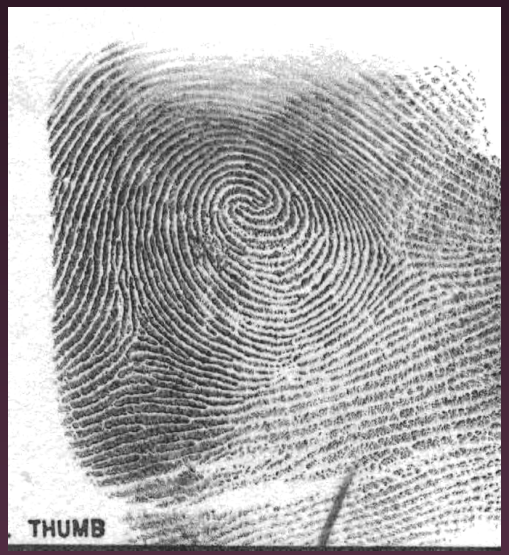
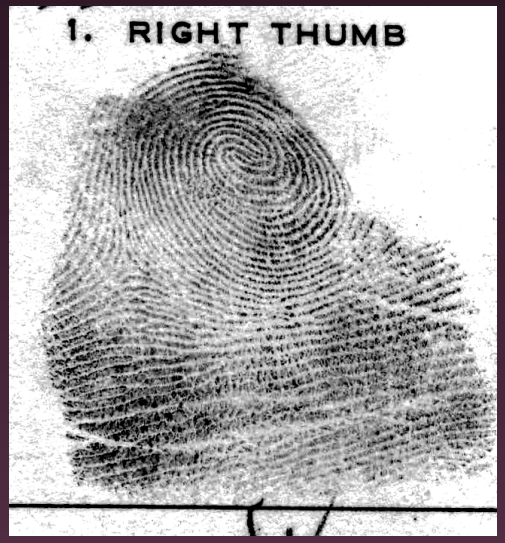
NFIQ is not about human perception



nfiq=5



nfiq=2

low character source the sample may subjectively be assessed as “good” quality, but a matcher may not be able to match it to its mate.

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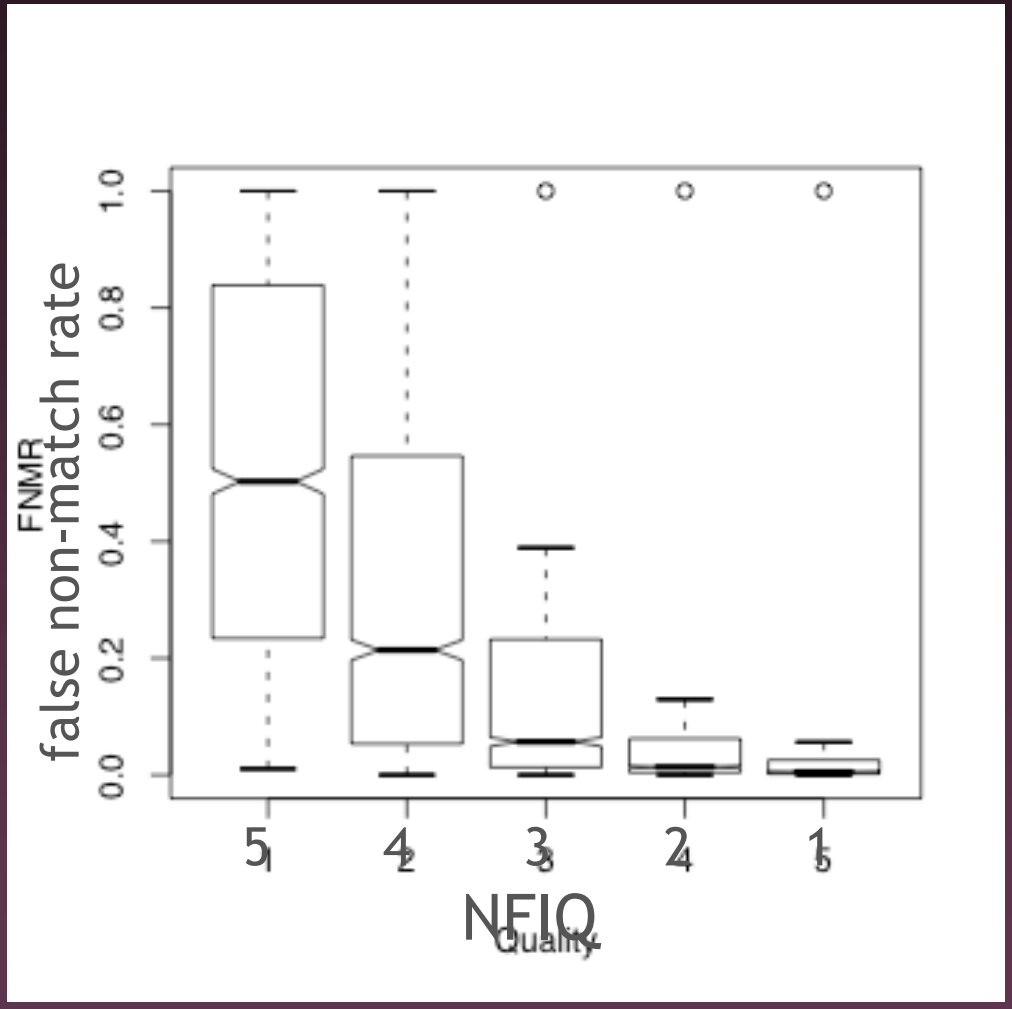
NFIQ effectiveness



1 - better quality samples i.e. higher NFIQ numbers give lower false rejection rates

2- five levels of are statistically separate

public release

technical report:

ftp://sequoyah.nist.gov/pub/nist_internal_reports/ir_7151/ir_7151.pdf

open source

Uses of NFIQ to improve performance

- Conditional reacquisition
  - pruning the poorest quality samples (1.65% of dataset) reduced EER from .0047 t0 .0024 (sdkI - dos - ri)
- Initiate invocation of special processing or matching algorithms
- collect relevant statistics
  - compare capture devices and/or environments
  - correlation among fingers

  $p(nfiq(ri)=5) = 0.011$ $p(nfiq(li)=5) = 0.016$

  $p(nfiq(li)=5 \mid nfiq(ri)=5) = 0.22$
- Multi-biometic fusion

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Q - can we apply NFIQ approach to latent quality?

- perhaps not today!
  - Because NFIQ predicts performance of an automated fingerprint matcher, but “currently all comparisons of latents with candidate matches are performed by human examiners” i.e. no automated matching algorithm exists for latents.
    - unknowns: feature set, ground truth quality
    - unavailable: large enough dataset to train and test a quality apparatus

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Q -what are uses of latent quality?

- NFIQ - Conditional reacquisition
  - Recapture of latent is extremely unlikely if not impossible
- NFIQ - Initiate invocation of special processing or matching algorithms
  - No latent algorithm currently exist
- NFIQ - collect relevant statistics
  - compare capture devices and/or environments
    - This might be the only use of latent quality to compare different methods and/or chemical to lift latent prints
  - correlation among fingers
    - we do not care about it in latent.
- NFIQ - Multi-biometic fusion
  - quite unlikely
- What else?

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conclusion

- latent quality is difficult
- research is lacking on automated latent matching
- limited data is available
- many open questions:
  - should latent quality be defined as prediction of performance?
  - should latent quality be a vector or just a scalar? If scalar is a binary (good/bad) enough?
  - what are the uses of latent quality?
  - ….

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thanks

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extra

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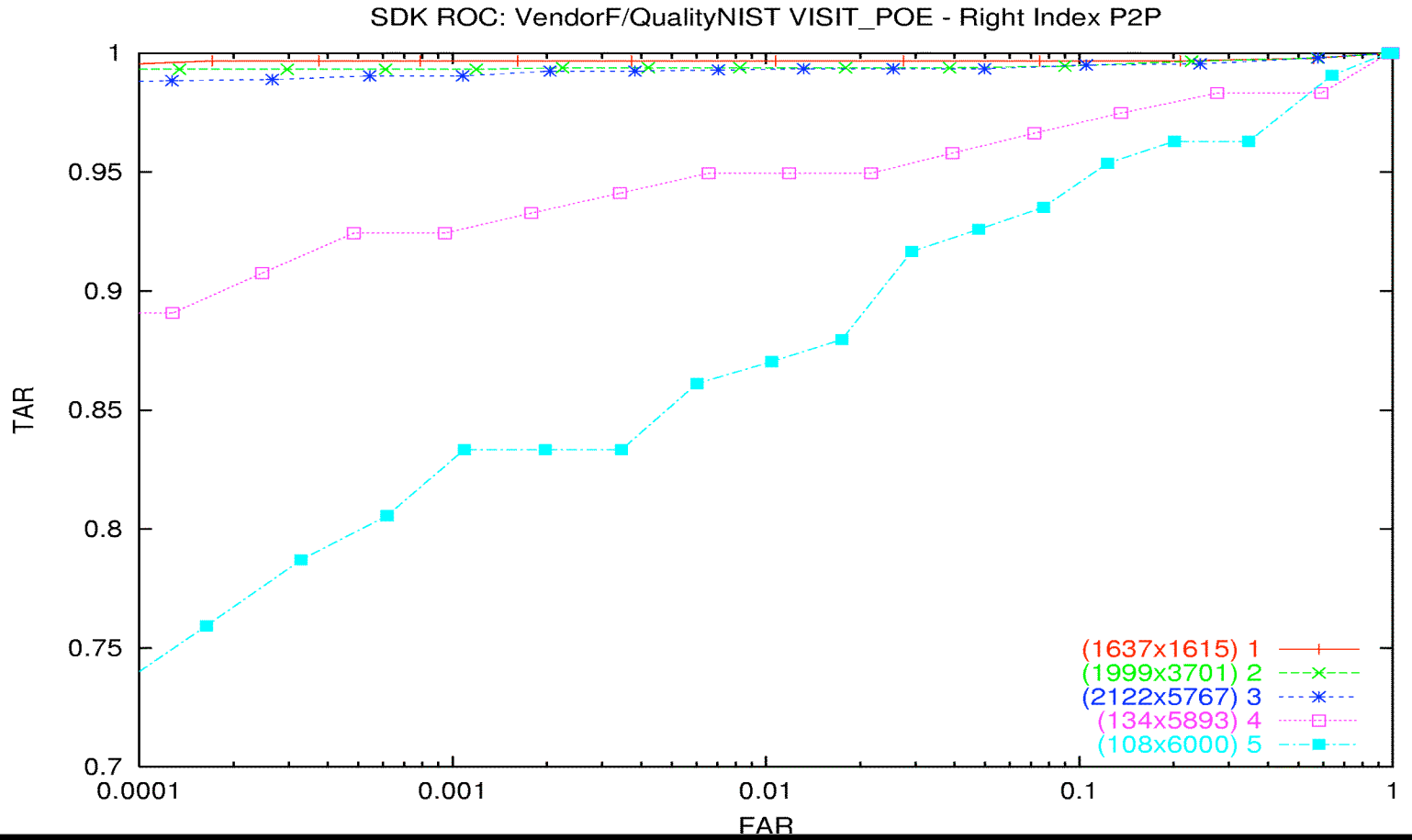

Vendor F – VISIT_POE – Right index
threshold=350 (far,tar)=(0.012,0.99)

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