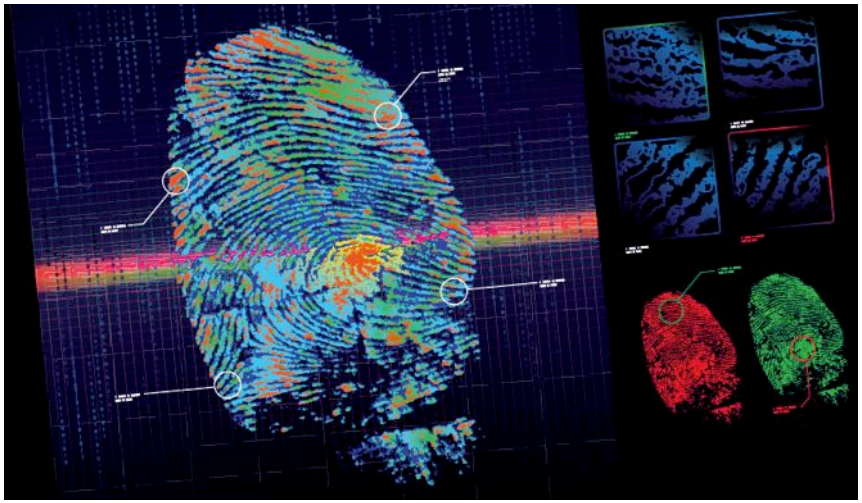


Development of NFIQ 2.0

elham.tabassi@nist.gov

http://www.nist.gov/itl/iad/ig/development_nfiq_2.cfm

April 26, 2013

Winchester, UK

NIST

2004 - present

2004

- Release of NFIQ 1.0
- Novel definition of biometric quality
  - performance related
  - accepted by the community
- Interoperability
  - uniform interpretation
  - tuned to a class of matcher
- Open source
- Extensively examined
  - by NIST and others
  - tools for quality summarization, slap, …

2010 workshop

- Workshop on March 6, 2010 (IBPC 2010)
- **NFIQ 2.0 wish-list as of March 2010**
- Several options for NFIQ 2.0 were discussed
  - http://biometrics.nist.gov/cs_links/ibpc2010/options_for_NFIQ2.0.pdf
- The community overwhelmingly recommended a new, open source, generalized version of NFIQ to be developed in consultation and collaboration with users and industry.
  - Same technical approach, but better, bigger, faster, etc.

2012 workshop

- Workshop on March 5, 2012 (IBPC 2012)

NFIQ 2.0 ~~wish-list as of March 2010~~ **Components as of March 2012**

- Community asked for:
  - Actionable flags
  - providerID
  - Versioning
  - Latent?

NFIQ 2.0 Community

Team Members

- NIST (US)
- BSI (Germany)
- BKA (Germany)
- Fraunhofer IGD
- Hochschule Darmstadt / CASED
- Secunet Security Networks AG
- NFIQ 2.0 Participants
- *...and the whole biometrics community*

Sponsors

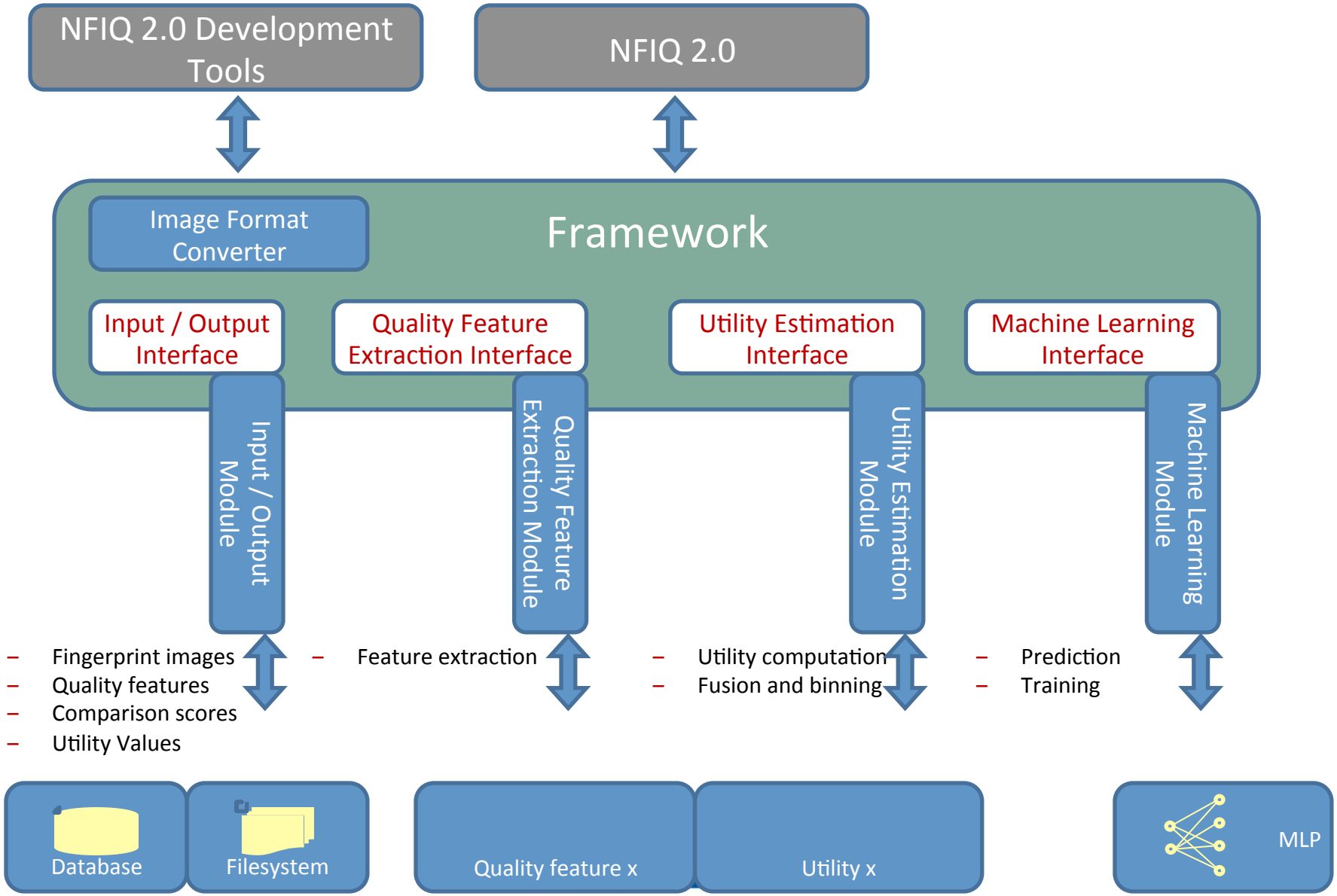
Homeland Security

Science and Technology

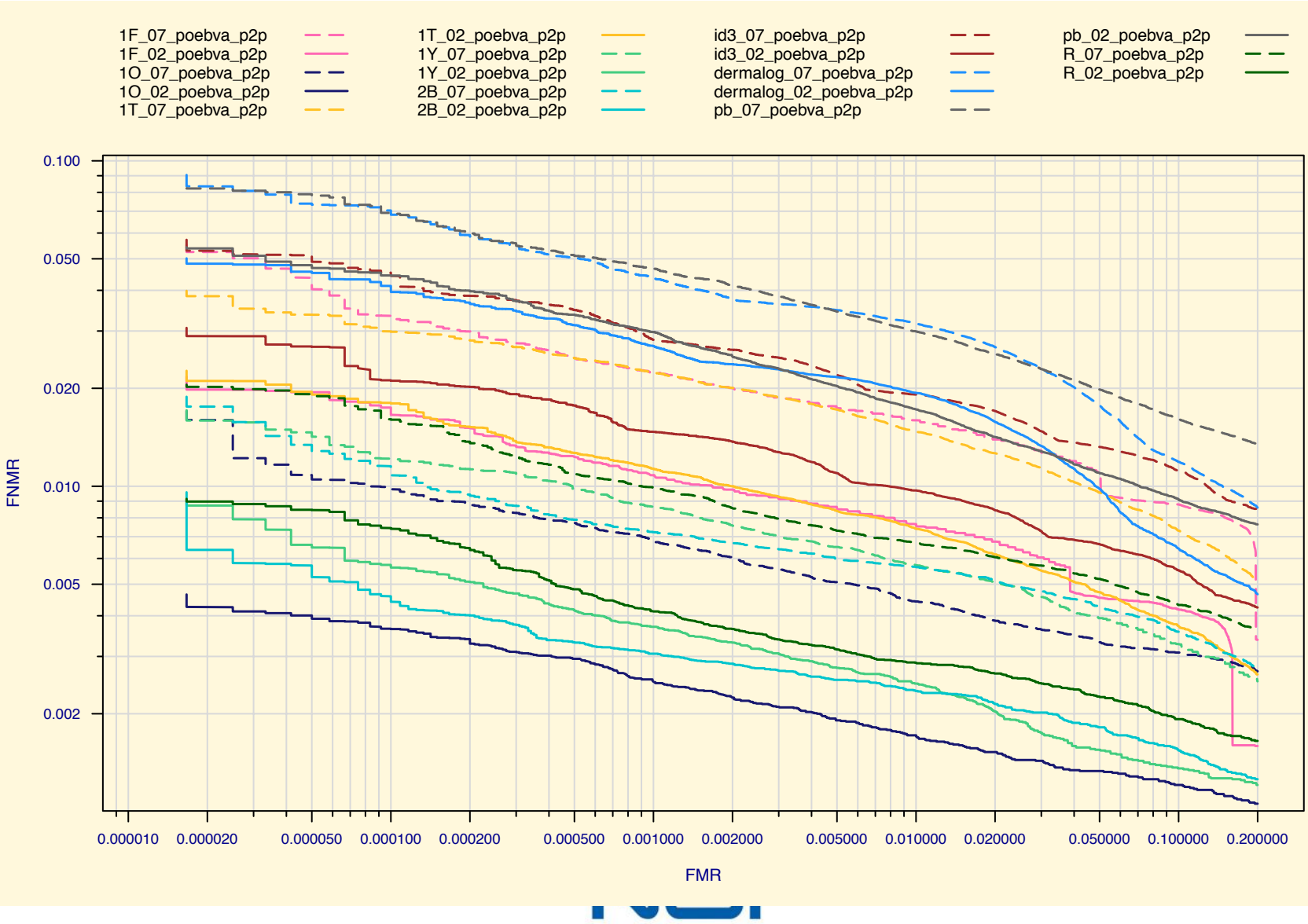
Federal Office for Information Security

NIST

Architecture of NFIQ 2.0 Framework



NFIQ 2.0 comparison score provider



NFIQ 2.0 features

Image/signal processing

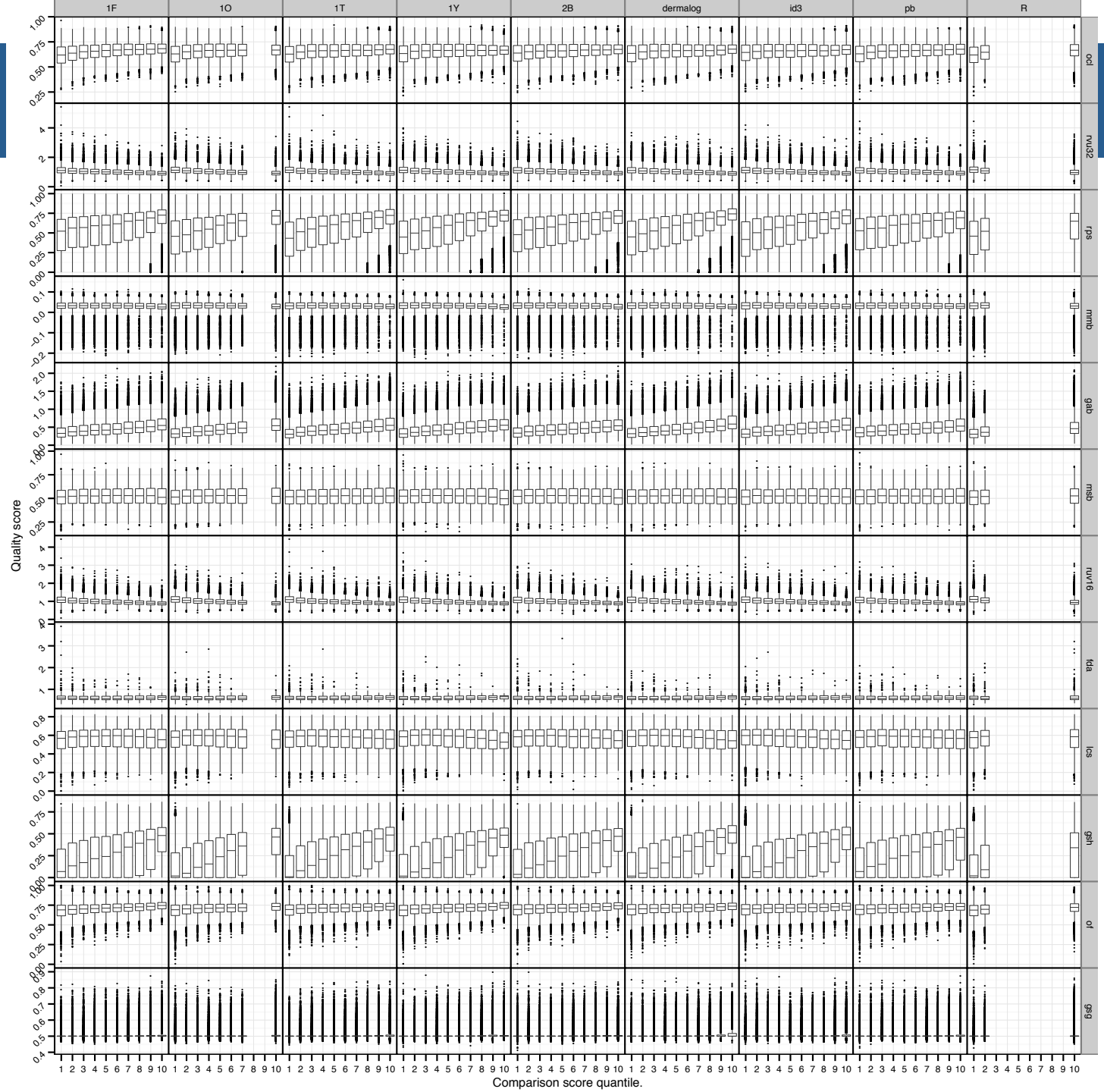
- Local clarity score
- Ridge valley uniformity
- Orientation certainty level
- Orientation flow
- Frequency domain analysis
- Radial power spectrum
- Gabor filters (several variants)

Minutiae based

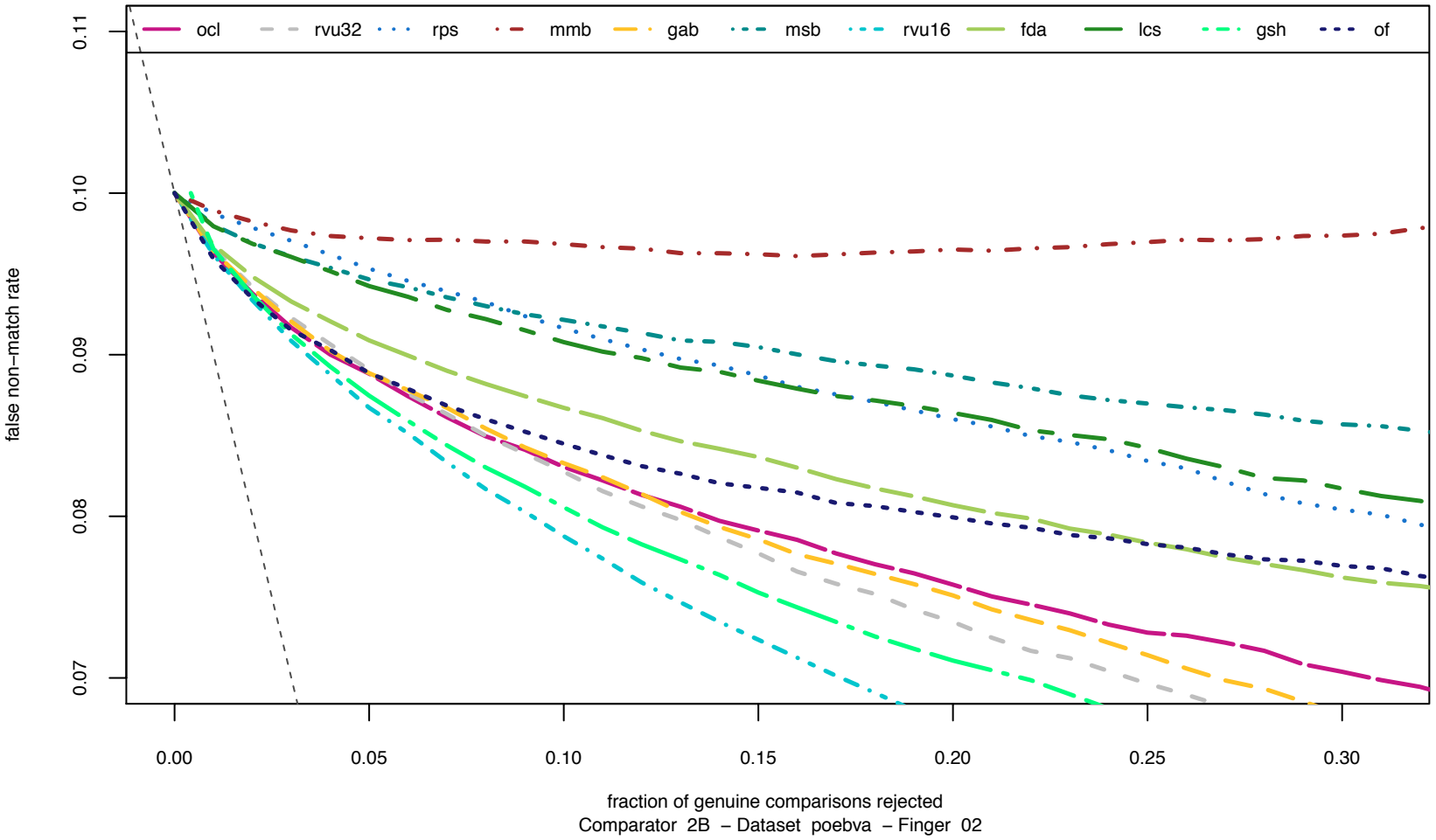
- FingerjetFx
  - Open source implementation from digitalPersona
  - Digitalpersona.com/fingerjetfx
- Total count of minutia
- Count of minutia in region of interest
  - Various selection of ROI

Standardized features allow for plug and play of feature computation implementations that are semantically conformant to the standard (i.e., ISO/IEC 29794-4 and ISO/IEC 19794-4).
Different implementations are distinguished via providerID.

NIST


1F
1O
1T
1Y
2B
dermalog
id3
pb
R
ocl
nvu32
rps
mmb
gab
msb
nuv16
fda
lcs
gsh
of
gsg
Quality score
Comparison score quantile.

NFIQ 2.0 features - 3



Machine Learning

Random Forest

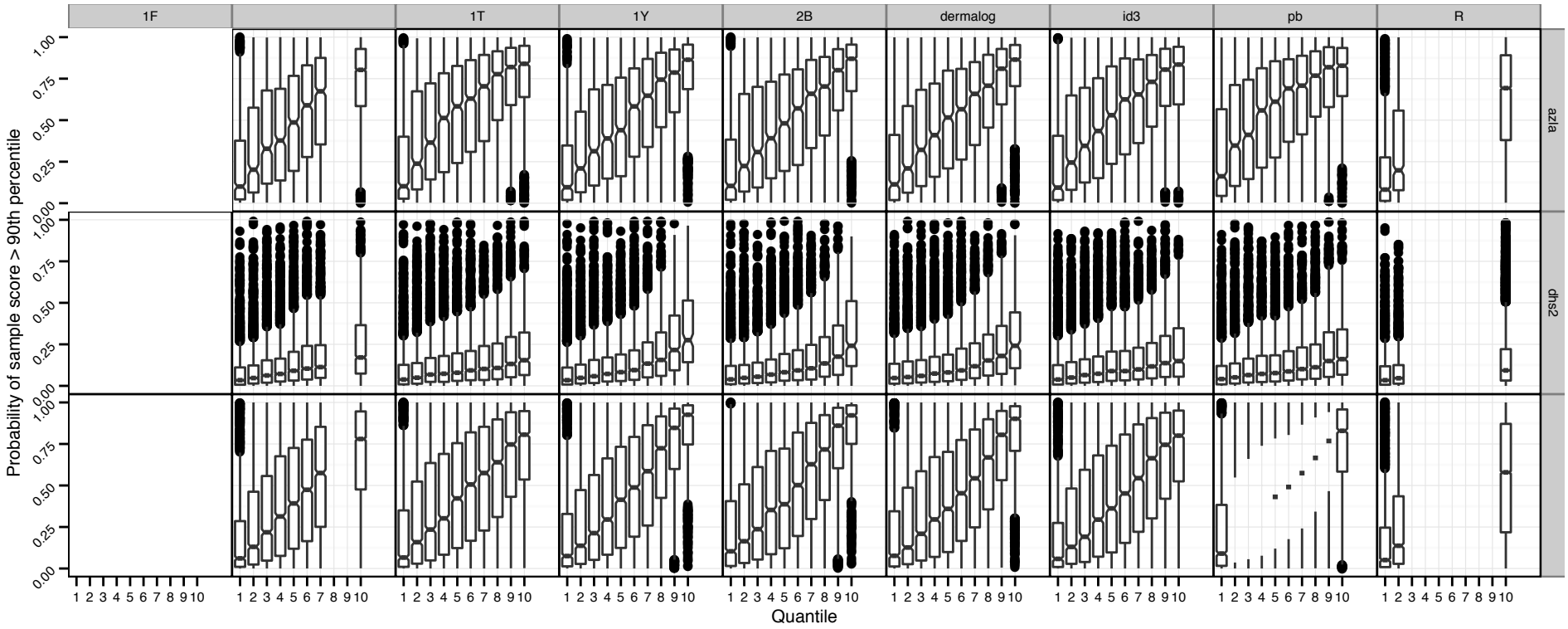
- Ensemble classifier using stochastic process
  - Use vote to determine class memberships
  - Provides class probability in predictions
- Training
  - All features
  - 4874 samples in each of the low and high performers classes
  - 1000 trees in forest
- Test
  - 287 895 comparison scores

Two class prediction

- High vs. Low performers
  - 1: High performers are images that result in high genuine scores
    - $> CDF^{-1}(0.95)$
  - 0: Low performers are images that result in false reject
    - Threshold at $FMR=0.0001$
  - Quality score is the probability that a given image belongs to class 1.
- Map quality score to recognition rate.

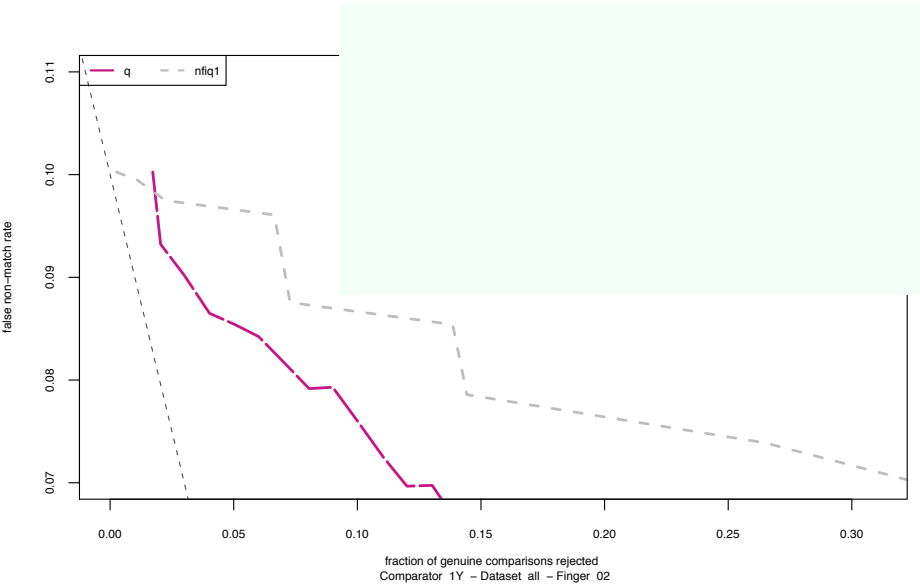
NIST

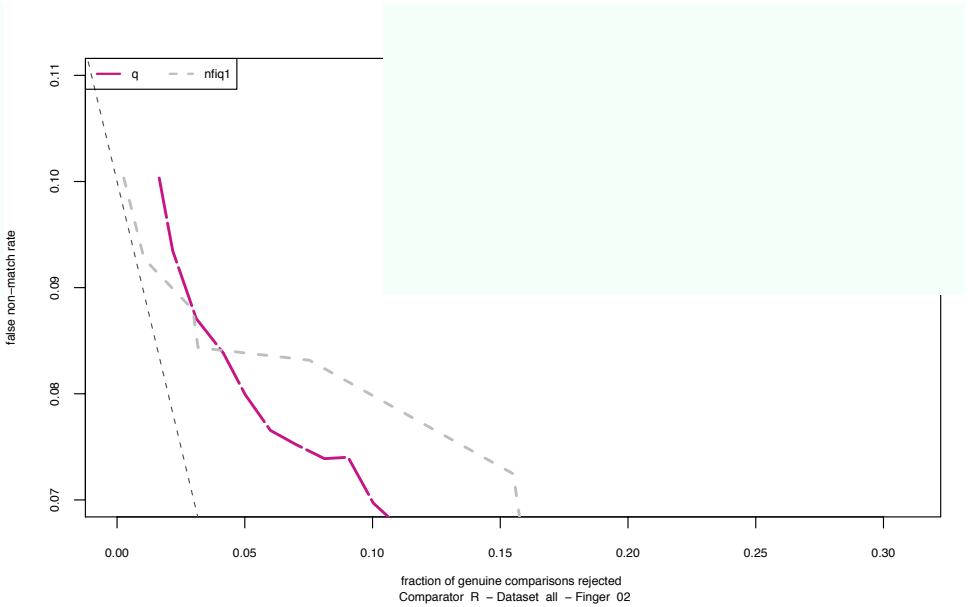
NFIQ 2.0 prototype

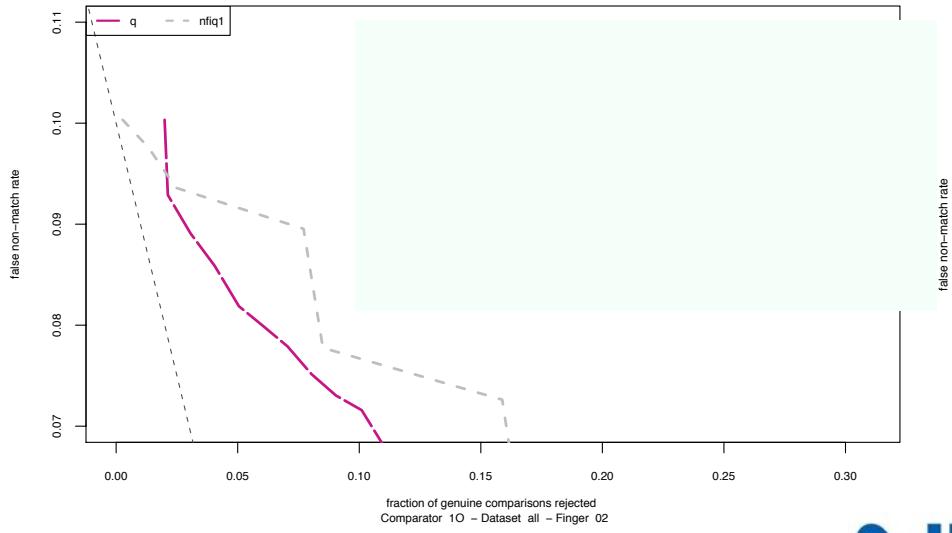


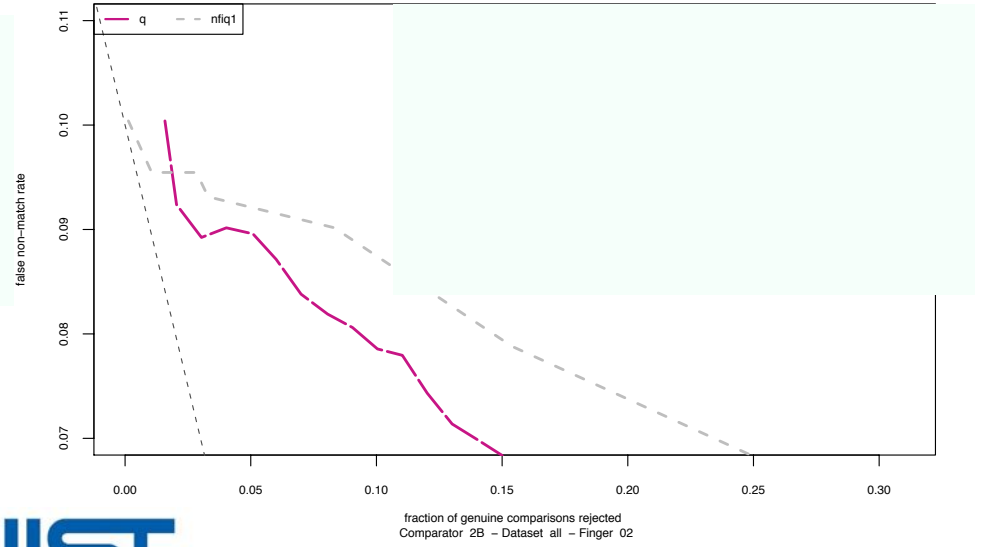
NIST

NFIQ 2.0 prototype









NIST

Actionable quality

Feed back to user/operator

- Wet / dry
  - High/low pressure
- Centeredness
  - Singularity detection
- Incompleteness
  - Singularity detection
- Ghost images

Questions?

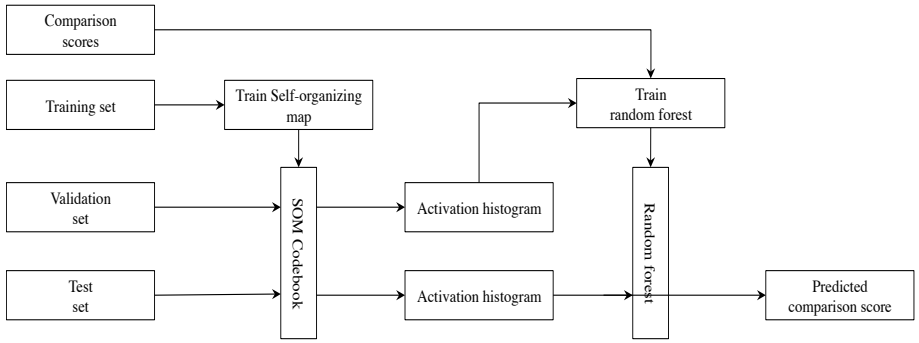
- Sensor sensitivity?
- Algorithm sensitivity?
- Already covered by features?
- Any addition or deletion?
  - Fingerness?
  - Alteredness?
  - correctness of phalanx?

NIST

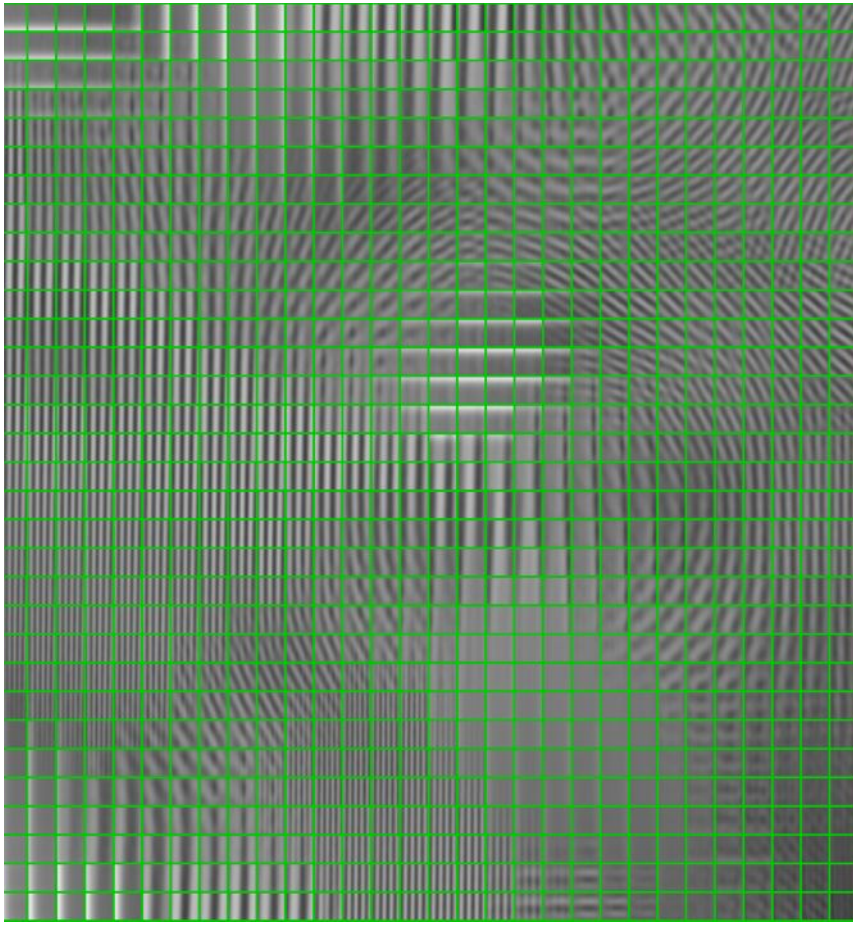
NFIQ 2.0 Lite/Mobile

Requirements

- Low computation complexity
  - processing power
  - Processing time
- Therefore, feature computation not feasible!
- Look up table?

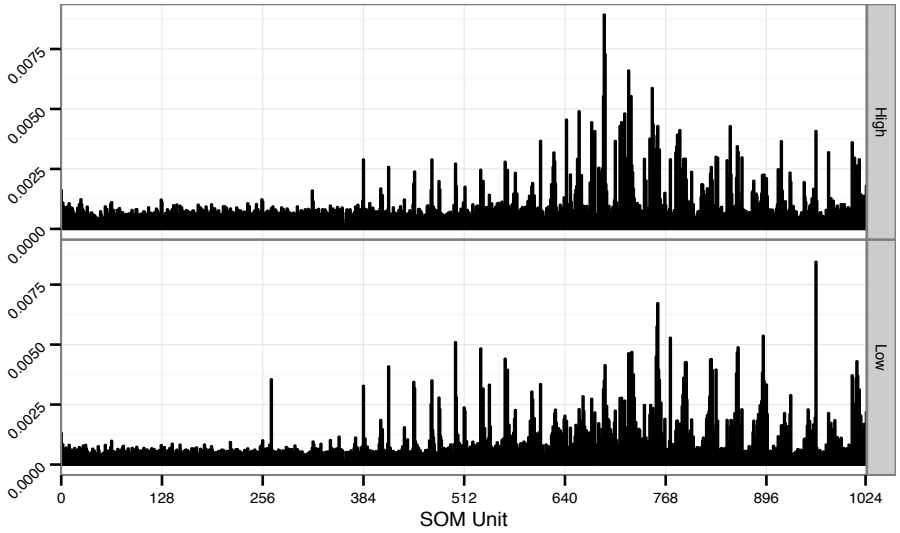


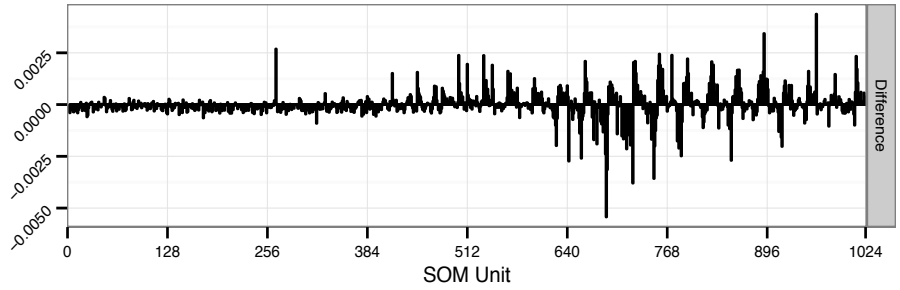
SOM code book



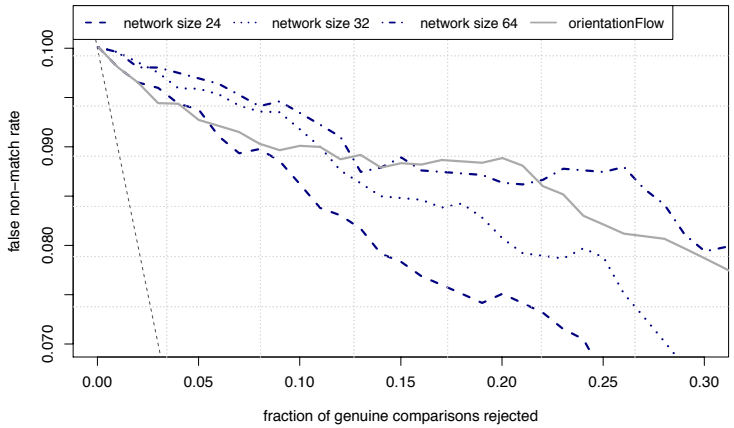
NFIQ 2.0 Lite prototype

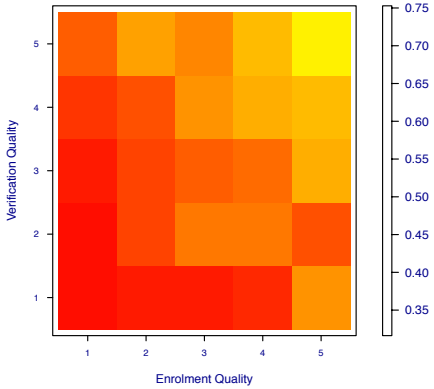
Features

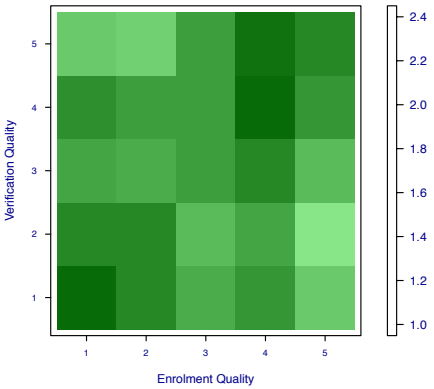




performance







NIST

NFIQ 2.0 computation time

Lite

- ~ 65 ms/image
  - PC - 2.3 GHz Intel Core i7
  - 16 GB of memory.
    network size of dim = 24
  - block size of n = 24
  - With gray scale normalization
- ~ 82 ms/image.
  - PC - 2.3 GHz Intel Core i7
  - 16 GB of memory.
  - network size of dim = 24
  - block size of n = 64
- This is prior to any code optimization

NFIQ 2.0

- ~ 19.45 msec/image
  - MacBook Air, Mid 2011
  - Processor: 1.7 GHz Intel Core i5 (dual core)
  - Memory : 4 GB 1333 MHz DDR3 (256 KB L2 cache, 3MB L3 cache)
  - Software: OS X 10.8.3 (12D78)
  - for OCL - Expect about the same for other features
- ~85 msec/image
  - Minutia based
- This is prior to any code optimization

NIST

Current Status

Completed

- Framework design
  - Modular, plug and play
- Framework implementation
- Feature selection and prototype implementation complete
  - http://biometrics.nist.gov/cs_links/quality/NFIQ_2/NFIQ-2_Quality_Feature_Defin-Ver05.pdf
- Feature evaluation complete

Underway

- Feature Implementation - MATLAB to to C/C++
  - Thanks to FBI
- Exploring machine learning
  - Random forest, SVM.
- NFIQ 2.0 Lite
  - Self organizing map
- Implementation of actionable flags for detection and mitigation of bad presentations
  - Incomplete finger (tip, etc.) + Wet / dry + Pressure
- Standardization of NFIQ 2.0 feature (ISO/IEC 29794-4)
  - Allows for plug-and-play of features for implementations that satisfy semantic conformance to the requirements of the ISO/IEC 29794-4 standard

NIST

NFIQ 2.0

Promises, promises

- Improved feature
- More level (0-100)
- Faster, lighter
- Actionable feedback
- NFIQ 2.0 mobile
- Slap
- Better performance
- Modular design
- Calibration
- Conformance testing

So far, we have achieved

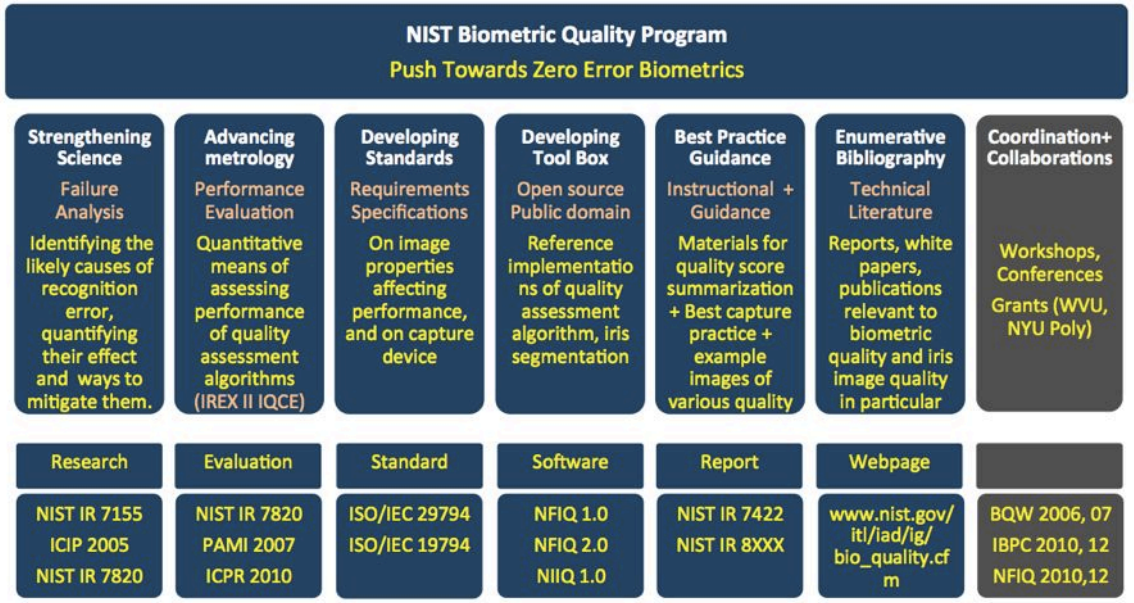
- Improved feature
- More level (0-100)
- Faster – we hope
- Actionable feedback
- Towards NFIQ Mobile
- --
- Better performance – we hope
- Plug and play

NIST

Coming up

1	Publication of NFIQ 2.0 Feature Evaluation (NIST IR)	June 2013
2	Publication of use of machine learning techniques in NFIQ 2.0 (NIST IR)	August 2013
3	Biometric quality workshop at BCC 2013 - Tampa, FL Present NFIQ 2.0 with possible demo at NIST booth	Sept 17, 1040–1200 Room 20
4	Standardization of NFIQ 2.0 features (ISO/IEC 29794-4)	2015+

NIST



Thank You.

Elham Tabassi
301 975 5292
tabassi@nist.gov