

# Development of NFIQ 2.0

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[http://www.nist.gov/itl/iad/ig/development\\_nfiq\\_2.cfm](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](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



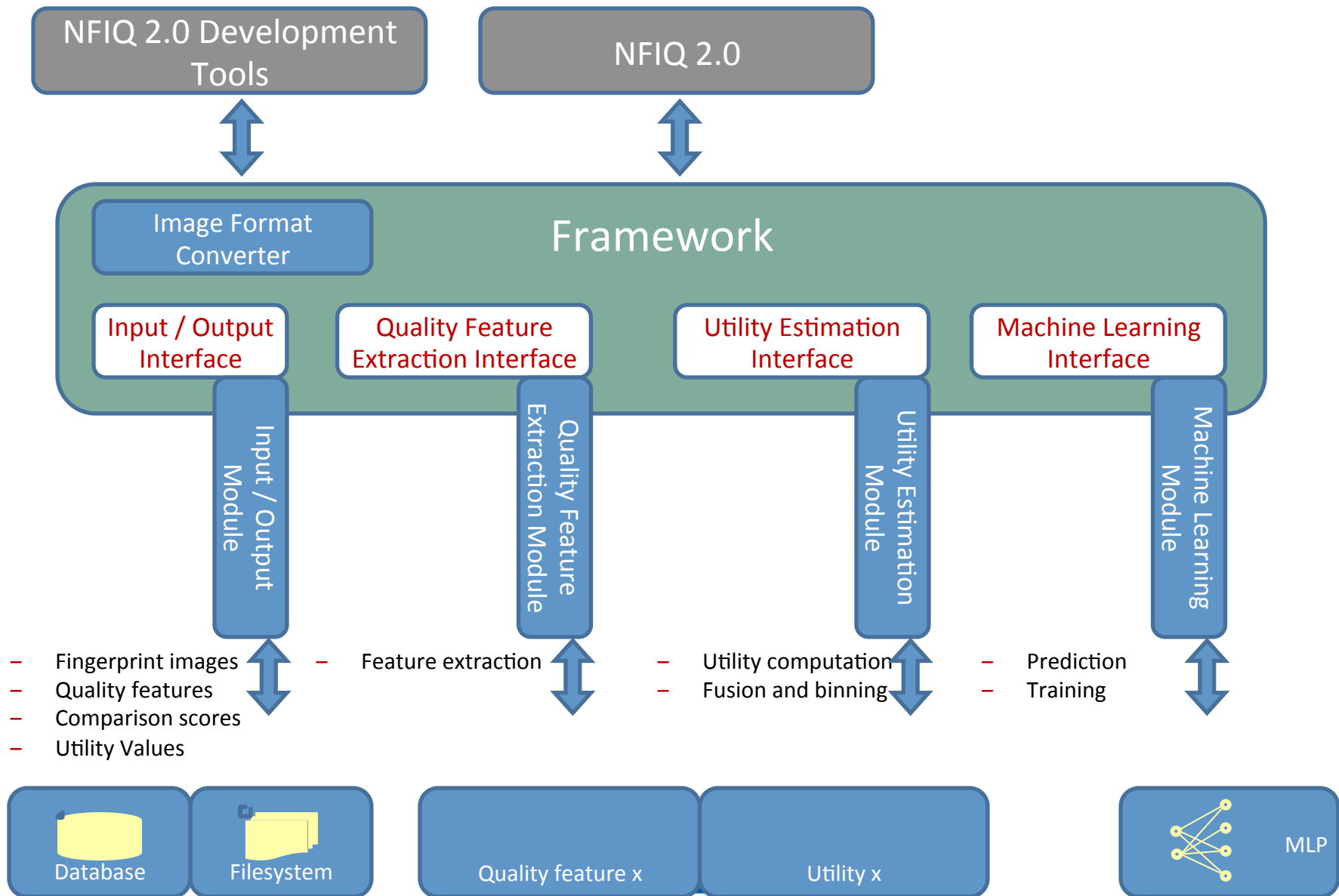
**Homeland  
Security**

Science and Technology



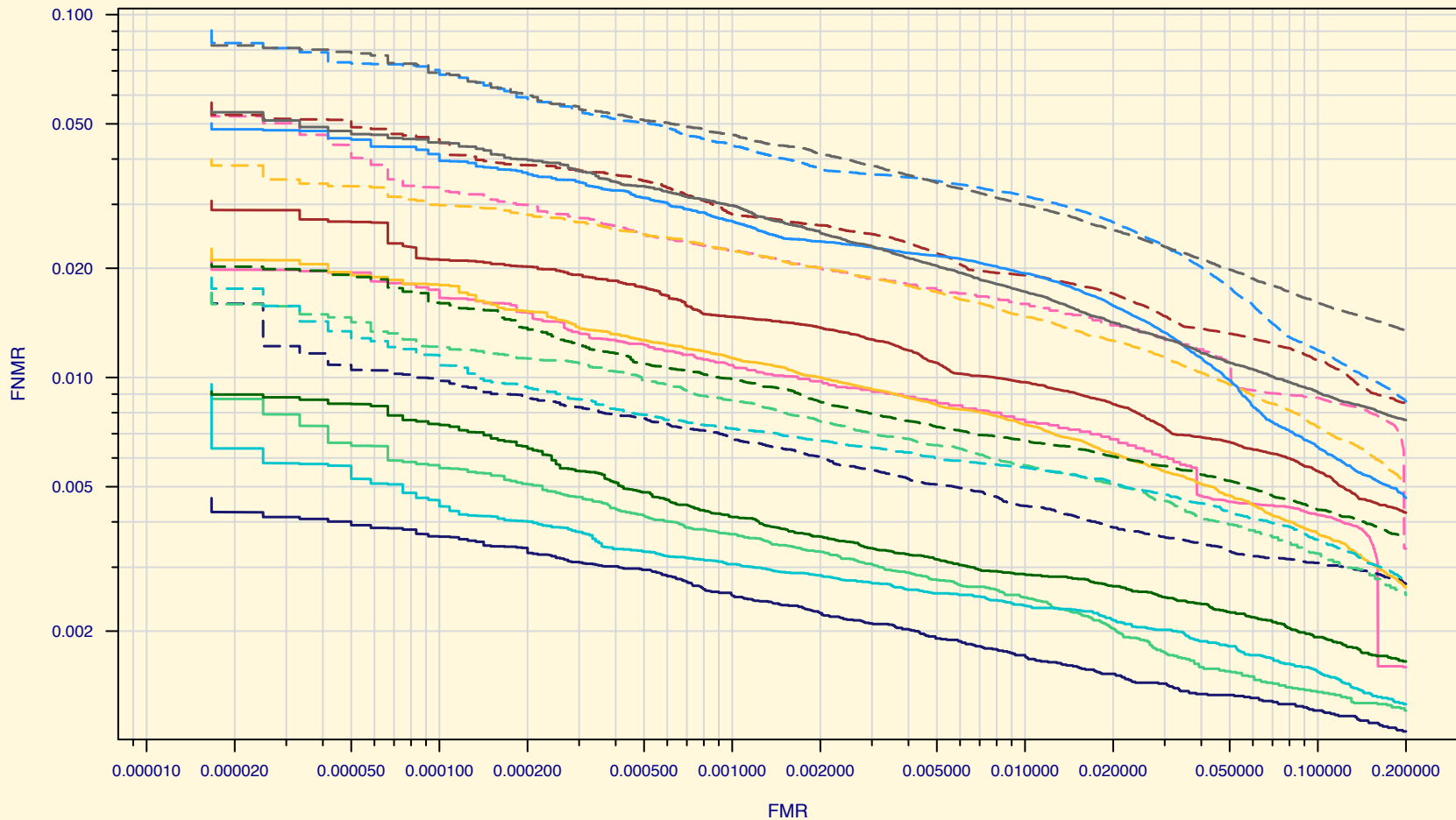
Federal Office  
for Information Security

# Architecture of NFIQ 2.0 Framework



# NFIQ 2.0 comparison score provider

1F_07_poebva_p2p	1T_02_poebva_p2p	id3_07_poebva_p2p	pb_02_poebva_p2p
1F_02_poebva_p2p	1Y_07_poebva_p2p	id3_02_poebva_p2p	R_07_poebva_p2p
1O_07_poebva_p2p	1Y_02_poebva_p2p	dermalog_07_poebva_p2p	R_02_poebva_p2p
1O_02_poebva_p2p	2B_07_poebva_p2p	dermalog_02_poebva_p2p	
1T_07_poebva_p2p	2B_02_poebva_p2p	pb_07_poebva_p2p	



# NFIQ 2.0 features

## Image/signal processing

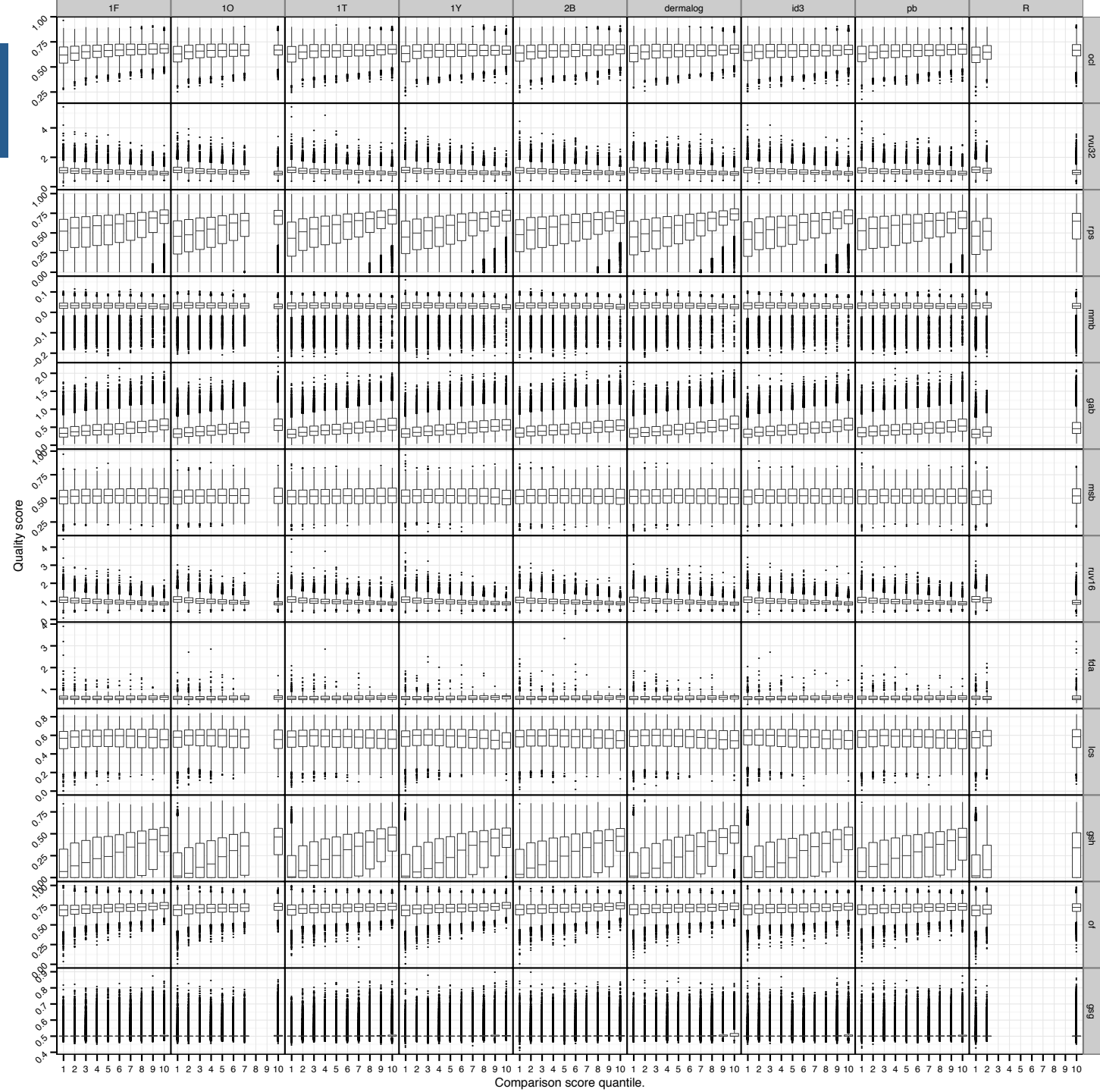
- » Local clarity score
- » Ridge valley uniformity
- » Orientation certainty level
- » Orientation flow
- » Frequency domain analysis
- » Radial power spectrum
- » Gabor filters (several variants)

## Minutiae based

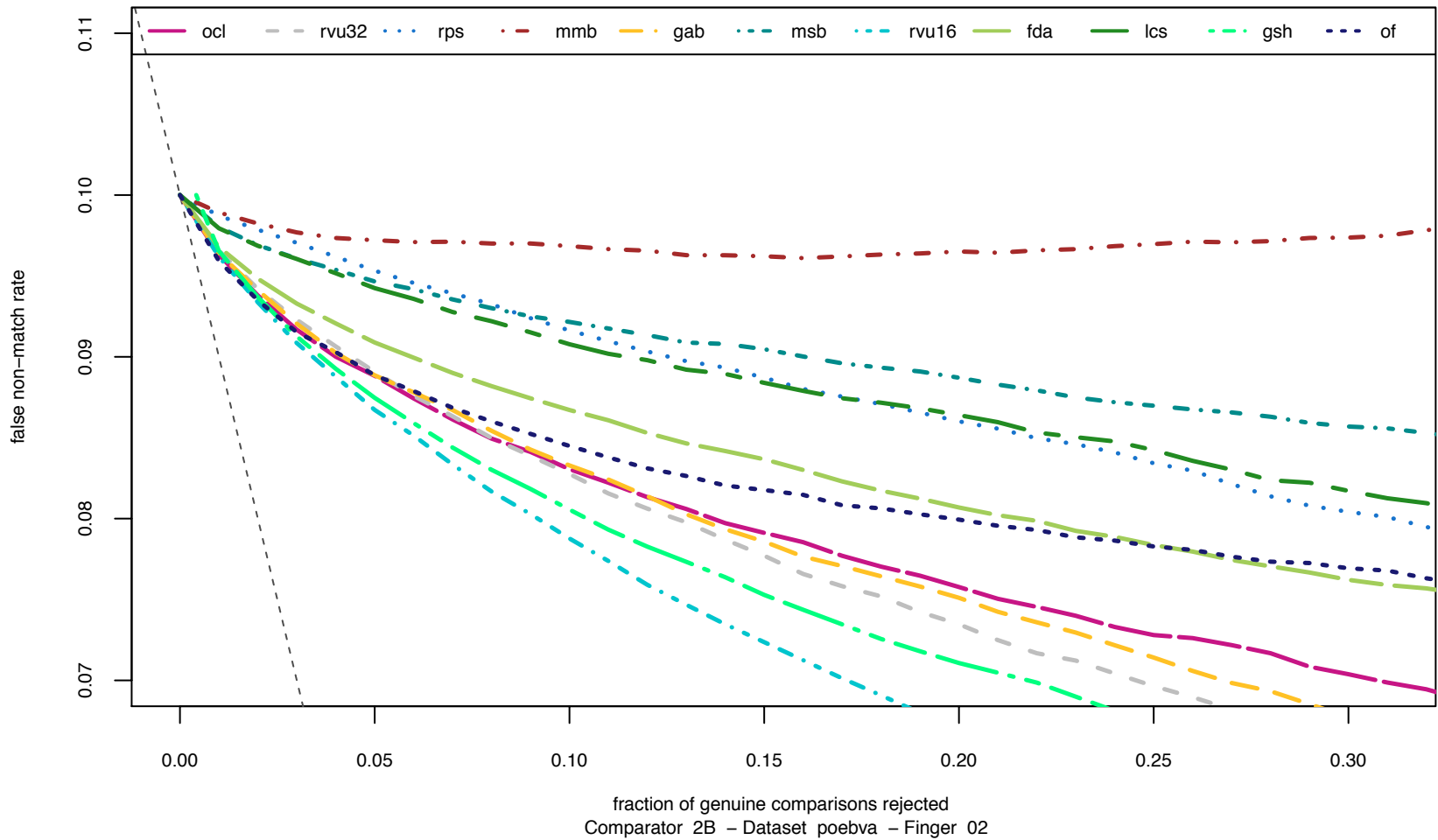
- » FingerjetFx
  - Open source implementation from digitalPersona
  - [Digitalpersona.com/fingerjetfx](https://digitalpersona.com/fingerjetfx)
- » Total count of minutia
- » Count of minutia in region of interest
  - Various selection of ROI

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.



# NFIQ 2.0 features - 3





# Machine Learning

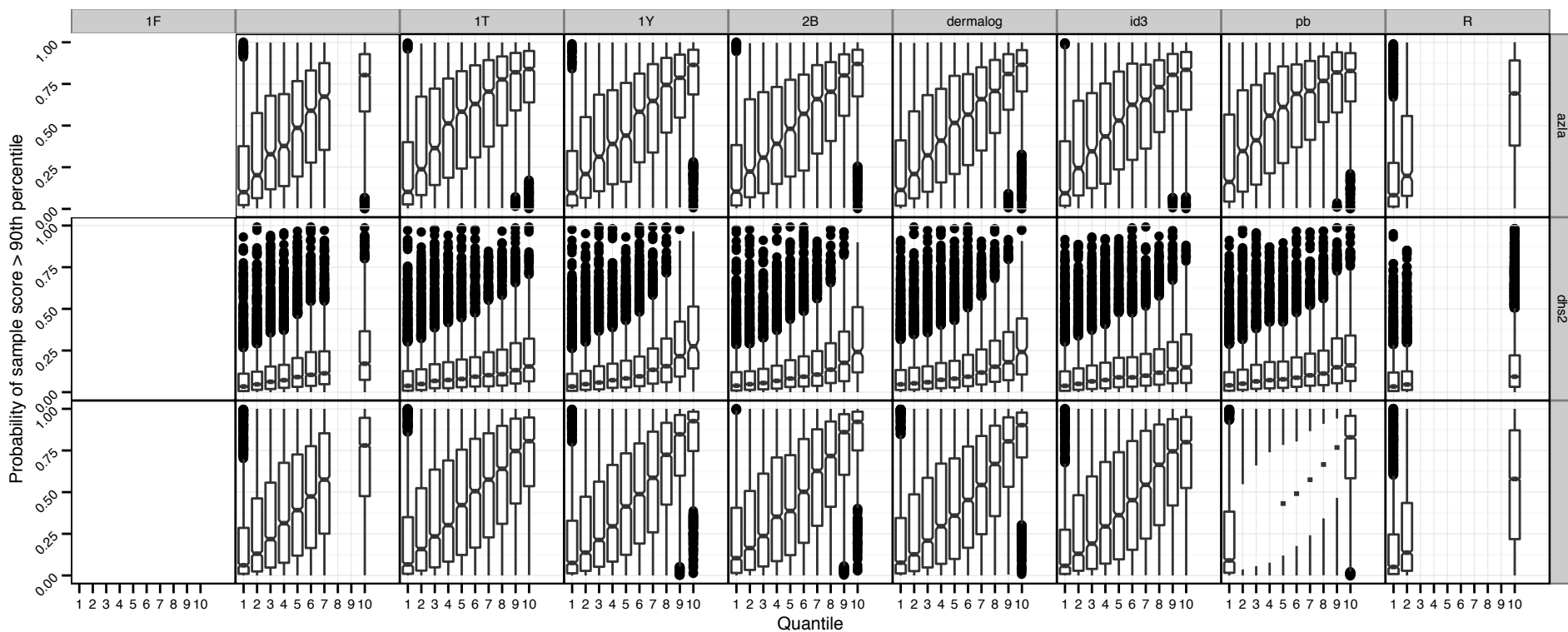
## Random Forest

- » 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

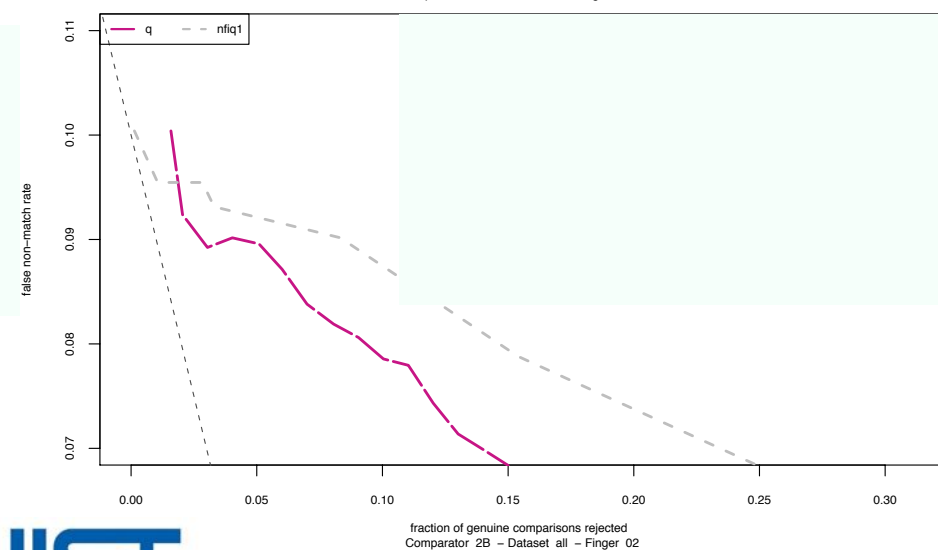
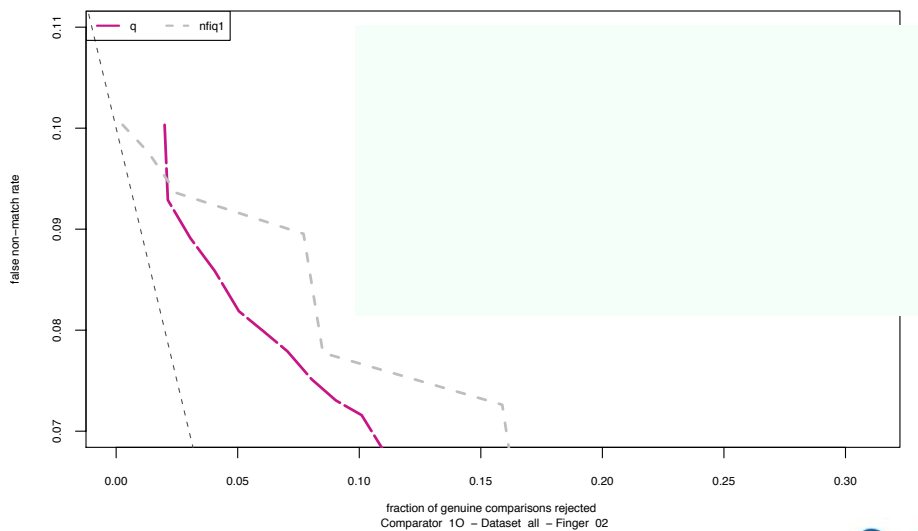
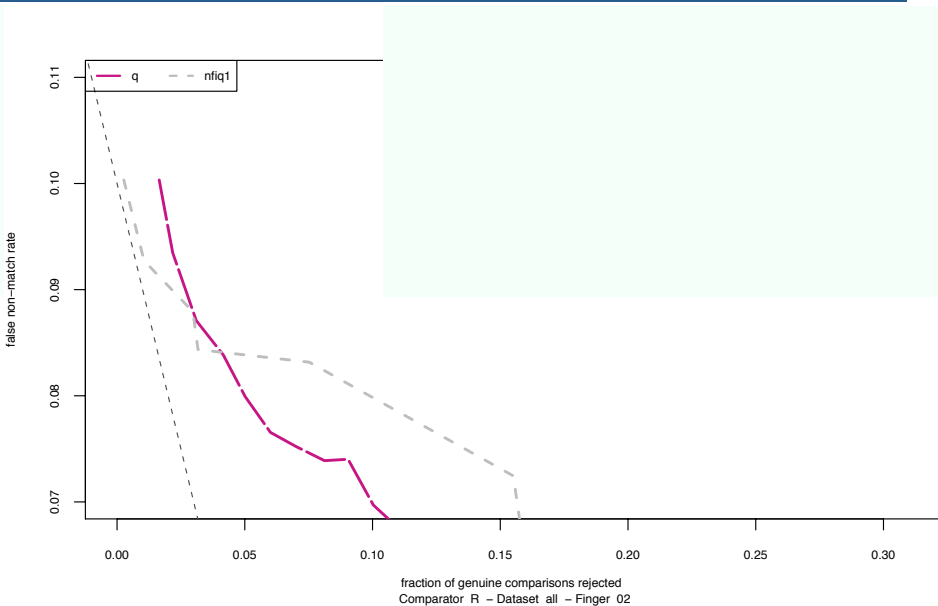
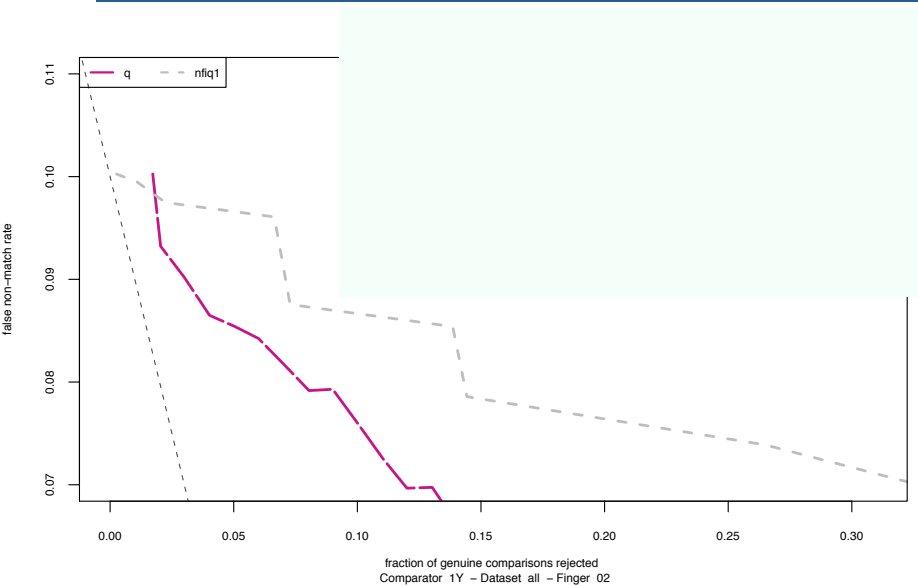
## Two class prediction

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

# NFIQ 2.0 prototype



# NFIQ 2.0 prototype



# Actionable quality

## Feed back to user/operator

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



## Questions?

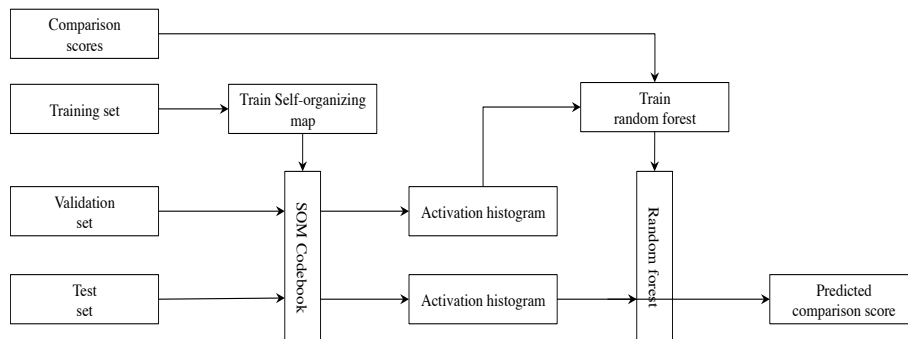
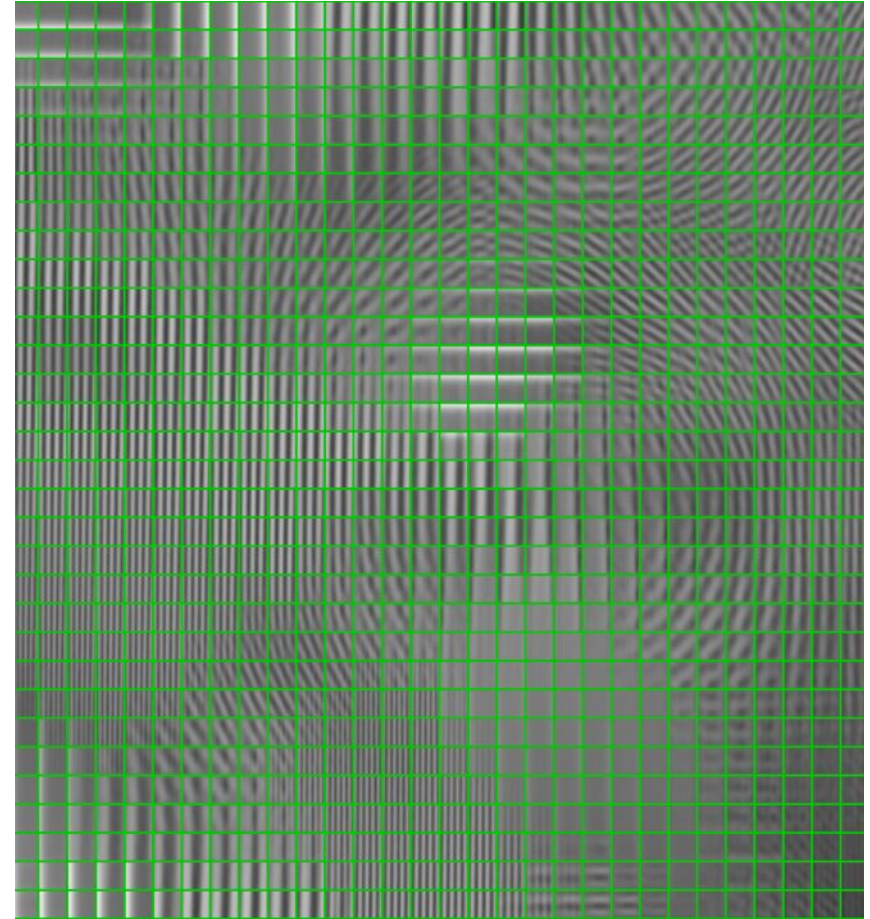
- » Sensor sensitivity?
- » Algorithm sensitivity?
- » Already covered by features?
- » Any addition or deletion?
  - Fingerness?
  - Alteredness?
  - correctness of phalanx?

# NFIQ 2.0 Lite/Mobile

## Requirements

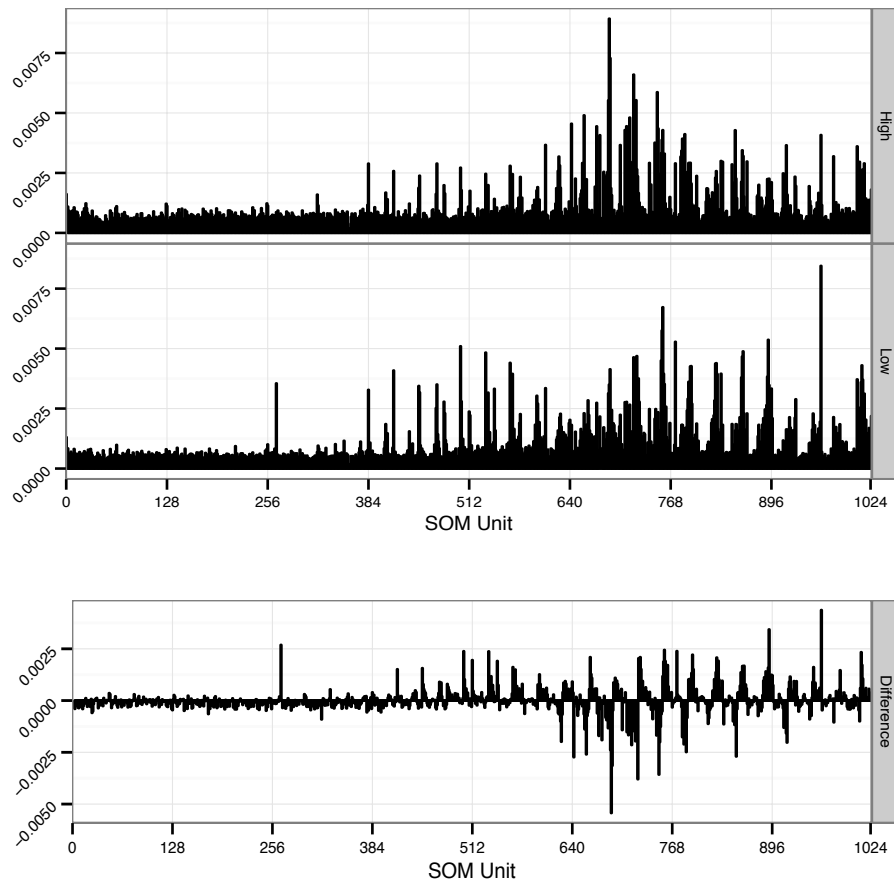
- » Low computation complexity
  - processing power
  - Processing time
- » Therefore, feature computation not feasible!
- » Look up table?

## SOM code book

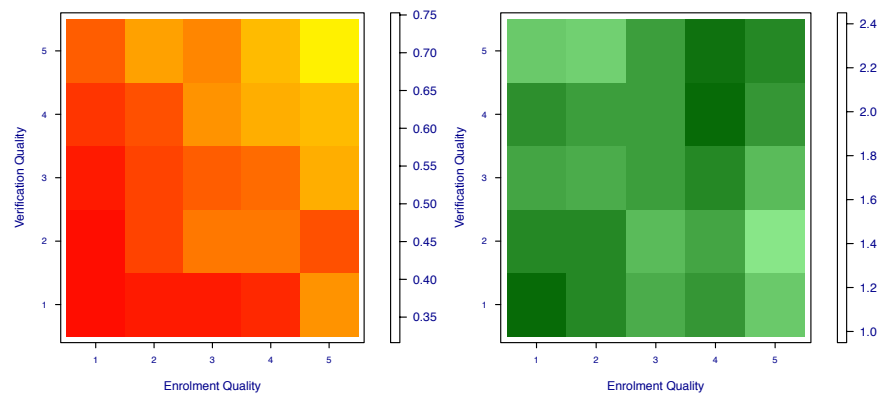
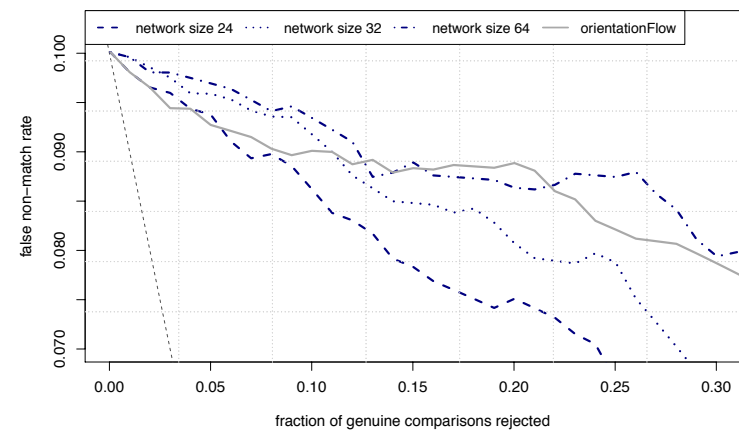


# NFIQ 2.0 Lite prototype

## Features



## performance



# 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

# 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](http://biometrics.nist.gov/cs_links/quality/NFIQ_2/NFIQ-2_Quality_Feature_Defin-Ver05.pdf)
- » Feature evaluation complete

## Underway

- » Feature Implementation - MATLAB 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



# 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

# 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 Biometric Quality Program**  
 Push Towards Zero Error Biometrics

<b>Strengthening Science</b> Failure Analysis Identifying the likely causes of recognition error, quantifying their effect and ways to mitigate them.	<b>Advancing metrology</b> Performance Evaluation Quantitative means of assessing performance of quality assessment algorithms (IREX II IQCE)	<b>Developing Standards</b> Requirements Specifications On image properties affecting performance, and on capture device	<b>Developing Tool Box</b> Open source Public domain Reference implementations of quality assessment algorithm, iris segmentation	<b>Best Practice Guidance</b> Instructional + Guidance Materials for quality score summarization + Best capture practice + example images of various quality	<b>Enumerative Bibliography</b> Technical Literature Reports, white papers, publications relevant to biometric quality and iris image quality in particular	<b>Coordination+ Collaborations</b> Workshops, Conferences Grants (WVU, NYU Poly)
Research	Evaluation	Standard	Software	Report	Webpage	
NIST IR 7155 ICIP 2005 NIST IR 7820	NIST IR 7820 PAMI 2007 ICPR 2010	ISO/IEC 29794 ISO/IEC 19794	NFIQ 1.0 NFIQ 2.0 NIQ 1.0	NIST IR 7422 NIST IR 8XXX	<a href="http://www.nist.gov/itl/iad/ig/bio_quality.cfm">www.nist.gov/itl/iad/ig/bio_quality.cfm</a>	BQW 2006, 07 IBPC 2010, 12 NFIQ 2010,12

**Thank You.**

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