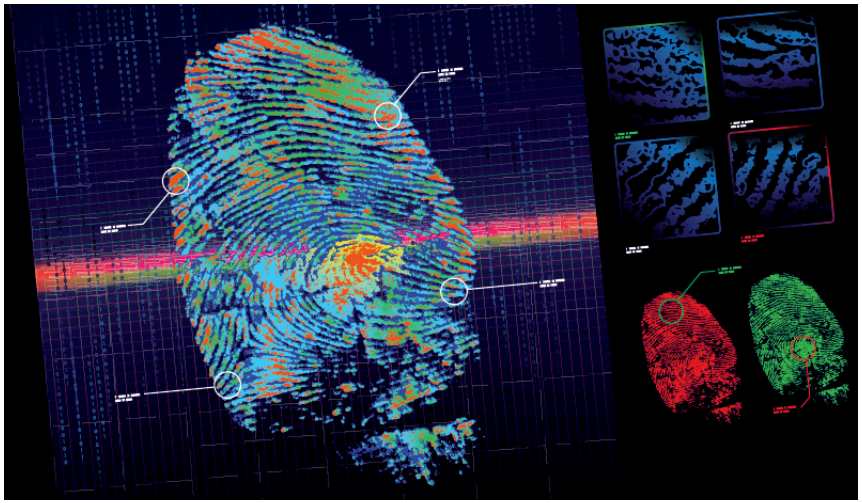

Development of NFIQ 2.0

elham.tabassi@nist.gov

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

September 17, 2013

Biometric Consortium

NIST

Outline

- History + Background
- Sponsors + Team Members
- Architecture
- Features
- Machine Learning
- NFIQ 2.0 prototype
- NFIQ 2.0 Lite (Mobile)
- Actionable quality
- Relation to ISO/IEC 29794-4
- Discussion

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, …

201 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?

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NFIQ 2.0 Community

Team Members

- NIST (US)
- BSI (Germany)
- BKA (Germany)
- Fraunhofer IGD
- MITRE (US)
- 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
Bundeskriminalamt

NIST

Team Members

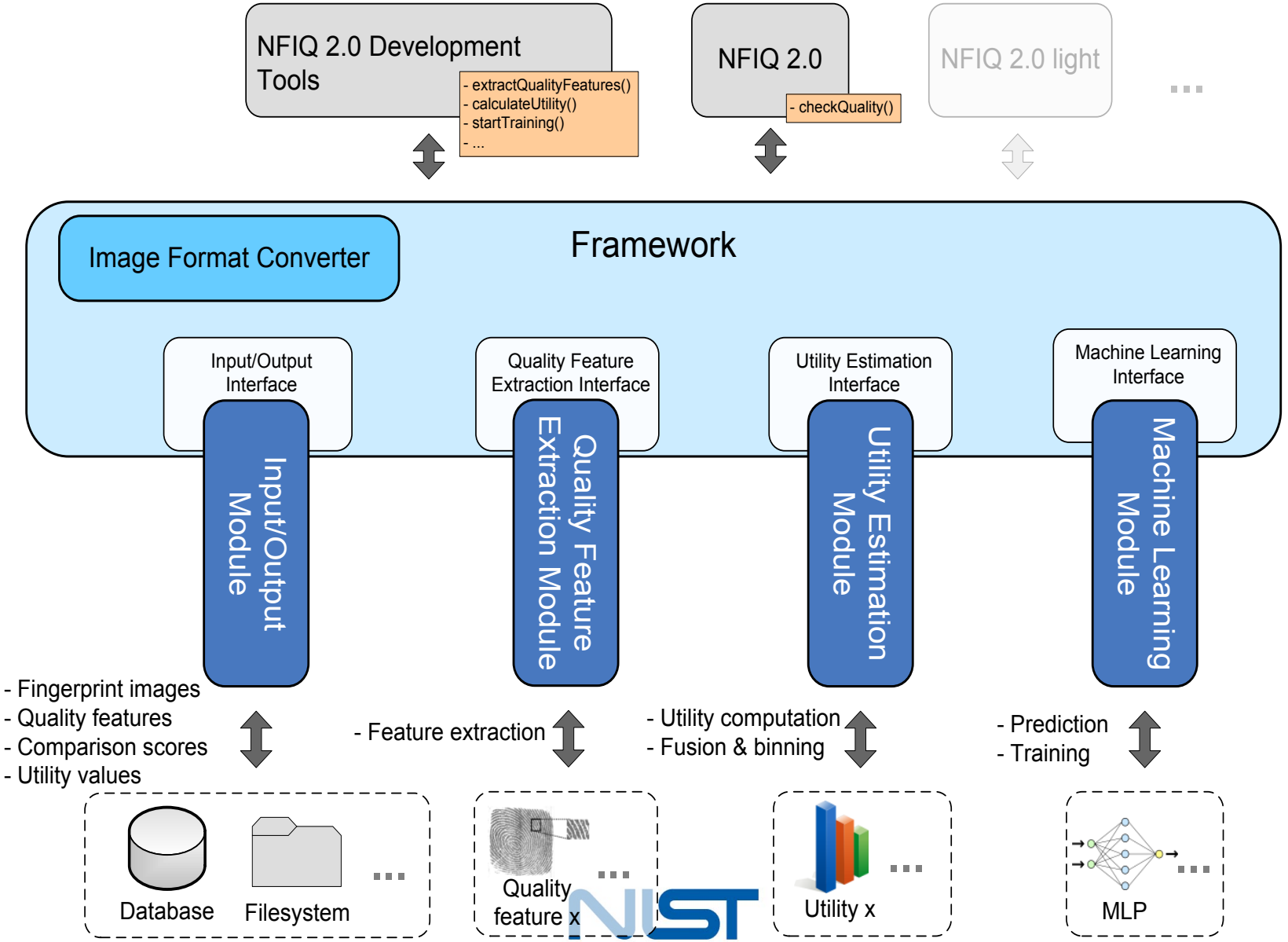
US

- Elham Tabassi (NIST)
- Patricia Flanagan (NIST)
- Greg Fiumara (NIST)
- Carol Nowacki, Carol (MITRE)
- Adam Day (MITRE)
- Marc Colosimo (MITRE)
- Martin Olsen (HDA, NIST)

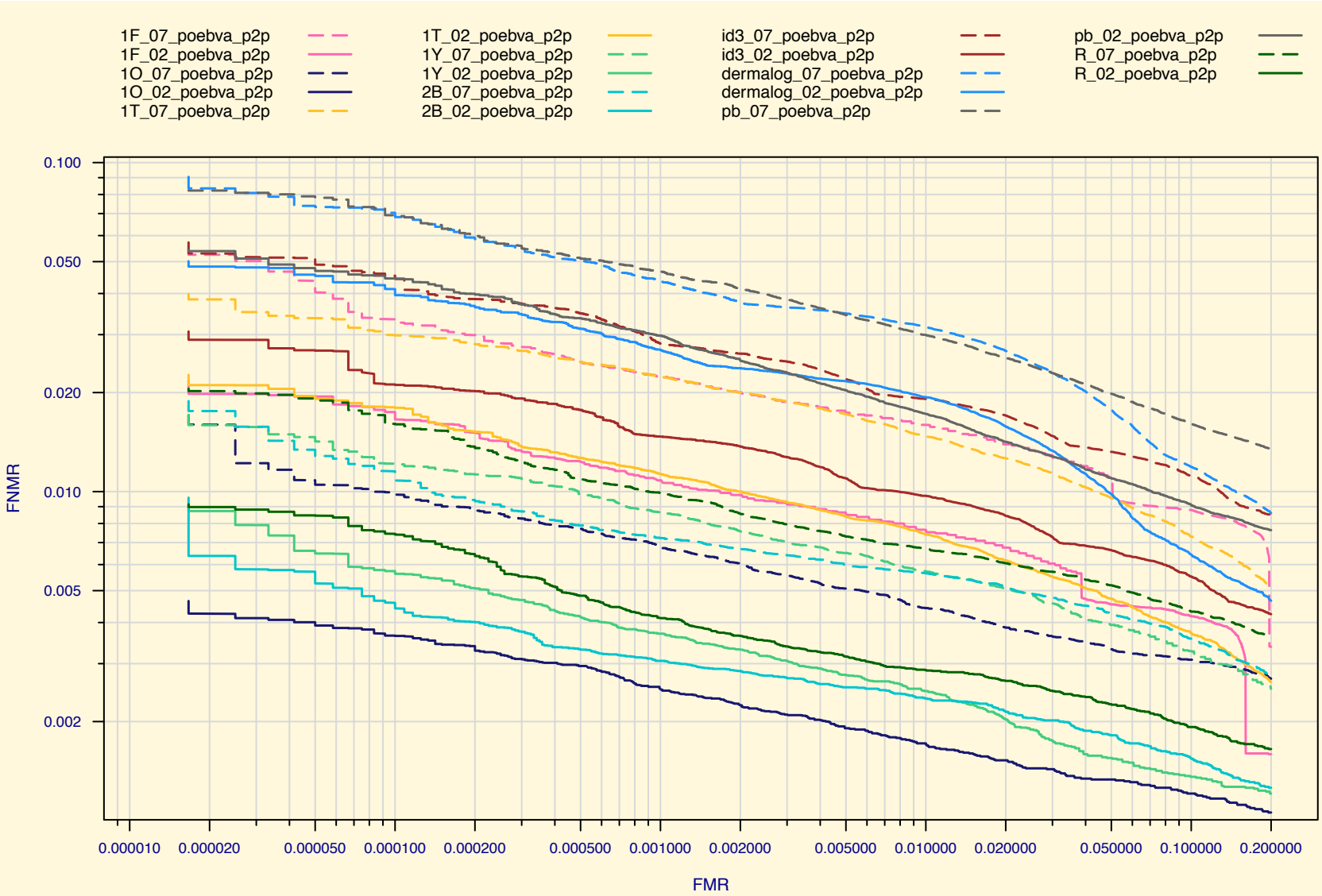
DE

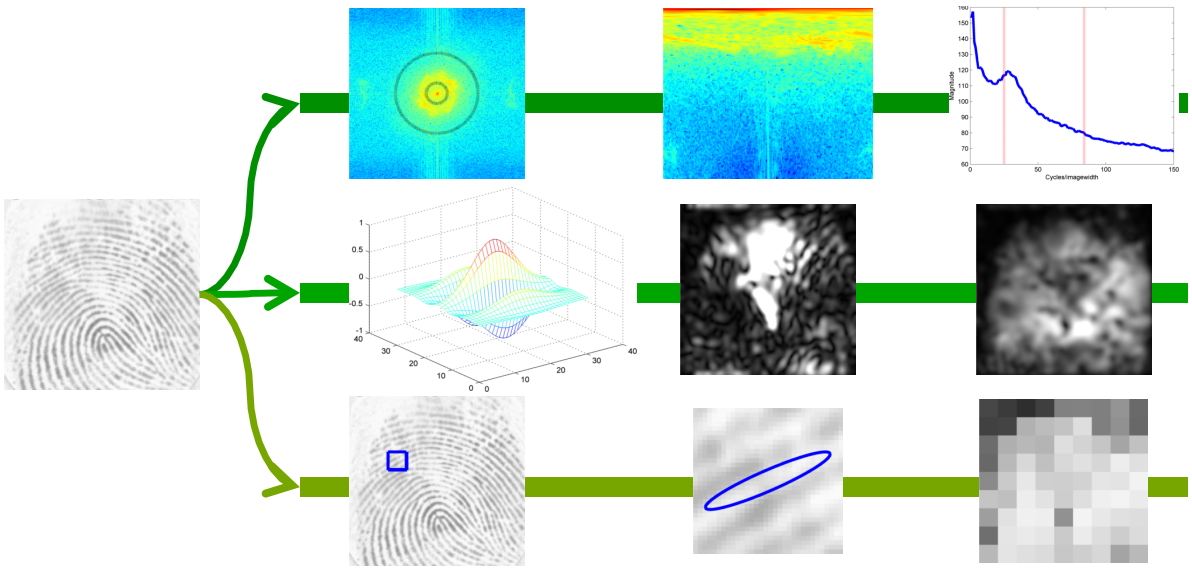
- Christoph Busch (HAD)
- Oliver Bausinger (BSI)
- Johannes Merkle (SEC)
- Michael Schwaiger (SEC)
- Christopher Schiel (BKA)
- Timo Ruhland (BKA)
- Alexander Nouak (IGD)
- Olaf Henniger (IGD)

NFIQ 2.0 Framework



NFIQ 2.0 comparison score provider





NFIQ 2.0 Features

NFIQ 1.0 features

Recommended Features in ISO/IEC 29794-4:2009 + our modifications

Surveyed literature + out modifications

Open source FingerjetFx minutia extractor

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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.

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~100 features …

Feature ID in Framework	Comments
NFIQ1_Feature_1	Original NFIQ1 Feature 1
NFIQ1_Feature_2	Original NFIQ1 Feature 2
NFIQ1_Feature_3	Original NFIQ1 Feature 3
NFIQ1_Feature_4	Original NFIQ1 Feature 4
NFIQ1_Feature_5	Original NFIQ1 Feature 5
NFIQ1_Feature_6	Original NFIQ1 Feature 6
NFIQ1_Feature_7	Original NFIQ1 Feature 7
NFIQ1_Feature_8	Original NFIQ1 Feature 8
NFIQ1_Feature_9	Original NFIQ1 Feature 9
NFIQ1_Feature_10	Original NFIQ1 Feature 10
NFIQ1_Feature_11	Original NFIQ1 Feature 11
NFIQ1_Time_All	Speed computation of NFIQ1 features in ms
FingerJetFX_MinutiaeCount	Number of detected minutiae (no limitation as in original FJFX source code)
FingerJetFX_MinutiaeQuality_0	Percentage of minutiae that have minutiae quality of 0 (= not calculated)
FingerJetFX_MinutiaeQuality_1	Percentage of minutiae that have minutiae quality between 1 and 10
FingerJetFX_MinutiaeQuality_2	Percentage of minutiae that have minutiae quality between 11 and 20
FingerJetFX_MinutiaeQuality_3	Percentage of minutiae that have minutiae quality between 21 and 30
FingerJetFX_MinutiaeQuality_4	Percentage of minutiae that have minutiae quality between 31 and 40
FingerJetFX_MinutiaeQuality_5	Percentage of minutiae that have minutiae quality between 41 and 50
FingerJetFX_MinutiaeQuality_6	Percentage of minutiae that have minutiae quality between 51 and 60
FingerJetFX_MinutiaeQuality_7	Percentage of minutiae that have minutiae quality between 61 and 70
FingerJetFX_MinutiaeQuality_8	Percentage of minutiae that have minutiae quality between 71and 80
FingerJetFX_MinutiaeQuality_9	Percentage of minutiae that have minutiae quality between 81 and 90
FingerJetFX_MinutiaeQuality_10	Percentage of minutiae that have minutiae quality between 91 and 100
FingerJetFX_AverageMinutiaeQuality	Arithemtic mean (average) of FJFX quality value of all minutiae
FingerJetFX_ROIBlockArea	Percentage of blocks that have at least one minutia in it (block size 32x32 pixels)
FingerJetFX_ROIBlockAbs	Absolute number of blocks that have at least one minutia in it (block size 32x32 pixels)
FingerJetFX_MinCount_COMMinRect200x200	Number of minutiae detected in rectangle of 200x200 pixels around centre of mass (based on minutiae locations)
FingerJetFX_MinCount_COMMinRect300x200	Number of minutiae detected in rectangle of 300x200 pixels around centre of mass (based on minutiae locations)
FingerJetFX_MinCount_COMMinCircle200	Number of minutiae detected in a circle of diameter 200 pixels around centre of mass (base on minutiae locations)
FingerJetFX_MinCount_COMMinCircle250	Number of minutiae detected in a circle of diameter 250 pixels around centre of mass (base on minutiae locations)
FingerJetFX_MinCount_COMGrayRect200x200	Number of minutiae detected in rectangle of 200x200 pixels around centre of mass (based on grayvalues)
FingerJetFX_MinCount_COMGrayRect300x200	Number of minutiae detected in rectangle of 300x200 pixels around centre of mass (based on grayvalues)
FingerJetFX_MinCount_COMGrayCircle200	Number of minutiae detected in a circle of diameter 200 pixels around centre of mass (base on grayvalues)
FingerJetFX_MinCount_COMGrayCircle250	Number of minutiae detected in a circle of diameter 250 pixels around centre of mass (base on grayvalues)
FingerJetFX_Time_All	Speed computation of FJFX feature extraction (of all features within this module, including COM and ROI based features) in ms
FingerJetFX_Time	Speed computation of FJFX minutiae extraction and ISO container parsing
Mu	Mu (= mean of all pixel values)
MMB	Mu Mu Block (MMB) (= mean of all blockwise mean intensity values)
Sigma	Sigma (= standard deviation of pixel values)
Mu_Time	Speed computation of Mu feature
MMB_Time	Speed computation of MMB feature
Sigma_Time	Speed computation of Sigma feature
ImgProcROIBlockArea	Percentage of ROI blocks in relation to all blocks of image (block size 32x32 pixels)
ImgProcROIBlockAbs	Absolute number of ROI blocks in image (block size 32x32 pixels)
ImgProcROIPixelArea	Percentage of ROI pixels in relation to total number of pixels of image
ImgProcROIPixelAbs	Absolute number of ROI pixels in image
ImgProcROIArea_Mean	Mean value (= Mu) of ROI blocks only
ImgProcROIArea_StdDev	Standard deviation (= sigma) of ROI blocks only
ImgProcROIArea_OCL	Orientation Certainty Level (OCL) feature value of ROI blocks only
ImgProcROIArea_Time	Speed computation of ImgProcROI features
ImgProcROIArea_OCL_Time	Speed computation of ImgProcROIArea_OCL feature
FJFXPos_Mu_AverageMinutiaeQuality	Average minutiae quality based on mean and stddev of pixel grayvalues (=Mu) of a 32x32 pixels block around minutiae location
FJFXPos_Mu_MinutiaeQuality_0	Percentage of Mu values (as defined above) that have value <= -0.5
FJFXPos_Mu_MinutiaeQuality_1	Percentage of Mu values (as defined above) that have value > -0.5 and <= 0
FJFXPos_Mu_MinutiaeQuality_2	Percentage of Mu values (as defined above) that have value > 0 and <= 0.5
FJFXPos_Mu_MinutiaeQuality_3	Percentage of Mu values (as defined above) that have value > 0.5
FJFXPos_COMMin_MMB_224	MMB value of square (size 224x224 pixels, block size 32x32 pixels) around centre of mass (based on minutiae locations)
FJFXPos_OCL_AverageMinutiaeQuality	Average of minutiae quality that was computed based on the OCL value around each minutiae location
FJFXPos_OCL_MinutiaeQuality_0	Percentage of minutiae quality values (based on OCL value around each minutiae location) between 0 and 20
FJFXPos_OCL_MinutiaeQuality_20	Percentage of minutiae quality values (based on OCL value around each minutiae location) between 20 and 40
FJFXPos_OCL_MinutiaeQuality_40	Percentage of minutiae quality values (based on OCL value around each minutiae location) between 40 and 60
FJFXPos_OCL_MinutiaeQuality_60	Percentage of minutiae quality values (based on OCL value around each minutiae location) between 60 and 80
FJFXPos_OCL_MinutiaeQuality_80	Percentage of minutiae quality values (based on OCL value around each minutiae location) between 80 and 100
FJFXPos_OCL_4Blocks_AverageMinQuality	Average of minutiae quality that was computed based on the mean of all OCL values around each minutiae location (4 blocks around
FJFXPos_Coherence_AvgMinQuality	Average of minutiae quality that was computed based on the coherence value of the orientation map field of the block in which the mir
FJFXPos_CMEnh_InhQual_AvgMinQual	Average of minutiae quality that was computed based on the inhomogenety quality value of the enhanced contrast map
FJFXPos_MinutiaeFusion_1	Average of fused minutiae quality that was computed based on OCL, Mu, coherence values and enhanced constrast map values
FJFXPos_AvgMinReliability_QMEnh	Average of minutiae quality that was computed on the reliability value retrieved from the enhanced quality map
FJFXPos_AvgMinReliability_QMAdv	Average of minutiae quality that was computed on the reliability value retrieved from the advanced quality map
FJFXPos_MinutiaeFusion_2	Average of fused minutiae quality that was computed based on OCL, Mu, coherence values, enhanced quality map zones and enhanc
FJFXPos_QualityMapEnh_AvgMinQual	Average of minutiae quality that was computed based on the quality zones determined by the enhanced quality map
FJFXPos_LCS_AverageMinutiaeQuality	Average of minutiae quality that was computed based on block-wise LCS
FJFXPos_RVU_AverageMinutiaeQuality	Average of minutiae quality that was computed based on block-wise RVU
FJFXPos_LowFlow_AverageMinutiaeQuality	Average of minutiae quality that was computed based on block-wise values returned by the low flow map
FJFXPos_Time_All	Speed computation of minutiae quality computation values
OCL	Orientation Certainty Level (OCL) of whole image
OCL_Time	Speed computation of OCL computation
QualityMap_HighContrastBlocks	Number of blocks that have high contrast according to NFIQ1 low contrast map (re-implemented using OpenCV)
QualityMap_Time	Speed computation of quality map computation (low contrast map, enhanced orientation map, high curve map)
OrientationMap_Time	Speed computation of orientation map (without ROI filtering)
OrientationMap_ROIFilter_Time	Speed computation of orientation map determination with ROI filtering
QualityMapEnh_Time	Speed computation of enhanced quality map computation (enhanced low contrast map, enhanced orientation map, low flow map, high
QualityMapAdv_Time	Speed computation of advanced quality map computation (enhanced low contrast map, enhanced orientation map, high curve map)
LowFlowMap_Time	Speed computation of low flow map
OrientationMap_ROIFilter_CoherenceSum	Sum of all blockwise coherence values based on orientation map computation (block size 16) with applied ROI filter of ImgProcROI m
OrientationMap_ROIFilter_CoherenceRel	Relative number of all blockwise coherence values based on orientation map computation (block size 16) with applied ROI filter of Img
OrientationMap_CoherenceSum	Sum of all blockwise coherence values based on orientation map computation (block size 16) of the whole image
OrientationMap_CoherenceRel	Relative number of all blockwise coherence values based on orientation map computation (block size 16) of the whole image
QualityMap_Foreground	Number of foreground blocks based on the quality map computation (similar but not identical to NFIQ1 quality map with block size 8)
QualityMap_RelCount_1	Relative number of quality map blocks that have an assigned value of 1 (similar but not identical to NFIQ1 quality map with block size
QualityMap_RelCount_2	Relative number of quality map blocks that have an assigned value of 2 (similar but not identical to NFIQ1 quality map with block size
QualityMap_RelCount_3	Relative number of quality map blocks that have an assigned value of 3 (similar but not identical to NFIQ1 quality map with block size
QualityMap_RelCount_4	Relative number of quality map blocks that have an assigned value of 4 (similar but not identical to NFIQ1 quality map with block size
ContrastMapEnh_HighContrastBlocks	Number of high contrast blocks according to the computation results of the enhanced contrast map
ContrastMapEnh_AvgInhomogenety	Average of block-wise inhomogenety values returned by enhanced contrast map
ContrastMapEnh_AvgSmoothness	Average of block-wise smoothness values returned by enhanced contrast map
ContrastMapEnh_AvgUniformity	Average of block-wise uniformity values returned by enhanced contrast map
ContrastMapEnh_AvgQuality	Average of block-wise quality values based on the returned inhomogenety, uniformity and smoothness values of the enhanced contra
ContrastMapEnh_Time	Speed computation of enhanced contrast map computation
QualityMapEnh_HighFlowBlocks	Number of high flow blocks determined by the enhanced quality map (low flow map)
QualityMapEnh_LowFlowBlocks	Number of low flow blocks determined by the enhanced quality map (low flow map)
QualityMapEnh_Foreground	Number of foreground blocks based on the quality map computation (similar but not identical to NFIQ1 quality map with block size 8)
QualityMapEnh_RelCount_1	Relative number of enhanced quality map blocks that have an assigned value of 1 (similar but not identical to NFIQ1 quality map with
QualityMapEnh_RelCount_2	Relative number of enhanced quality map blocks that have an assigned value of 2 (similar but not identical to NFIQ1 quality map with
QualityMapEnh_RelCount_3	Relative number of enhanced quality map blocks that have an assigned value of 3 (similar but not identical to NFIQ1 quality map with
QualityMapEnh_RelCount_4	Relative number of enhanced quality map blocks that have an assigned value of 4 (similar but not identical to NFIQ1 quality map with
QualityMapAdv_Foreground	Number of foreground blocks based on the quality map computation (similar but not identical to NFIQ1 quality map with block size 8)
QualityMapAdv_RelCount_1	Relative number of advanced quality map blocks that have an assigned value of 1 (similar but not identical to NFIQ1 quality map with
QualityMapAdv_RelCount_2	Relative number of advanced quality map blocks that have an assigned value of 2 (similar but not identical to NFIQ1 quality map with
QualityMapAdv_RelCount_3	Relative number of advanced quality map blocks that have an assigned value of 3 (similar but not identical to NFIQ1 quality map with
QualityMapAdv_RelCount_4	Relative number of advanced quality map blocks that have an assigned value of 4 (similar but not identical to NFIQ1 quality map with
LowFlowMap24_HighFlowBlocks	Number of high flow blocks determined by the low flow map (block size 24 x 24)
LowFlowMap24_Time	Speed computation of low flow map with block size 24 x 24
LowFlowMap32_HighFlowBlocks	Number of high flow blocks determined by the low flow map (block size 32 x 32)
LowFlowMap32_Time	Speed computation of low flow map with block size 32 x 32
Gab	Gabor feature
GSh	Gabor Shen feature
LCS	Local Clarity Score (LCS) feature
OCL_S	Orientation Certainty Level (OCL) feature based on Sobel filters
OCL_CD	Orientation Certainty Level (OCL) feature based on centered differences
RVU_P	Ridge Valley Uniformity (RVU) feature with padding (block size 32)
RVU_NP	Ridge Valley Uniformity (RVU) feature without padding (block size 32)
OF	Orientation Flow (OF) feature
RPS	Radial Power Spectrum (RPS) feature
FDA	Frequency Domain Analysis (FDA) feature

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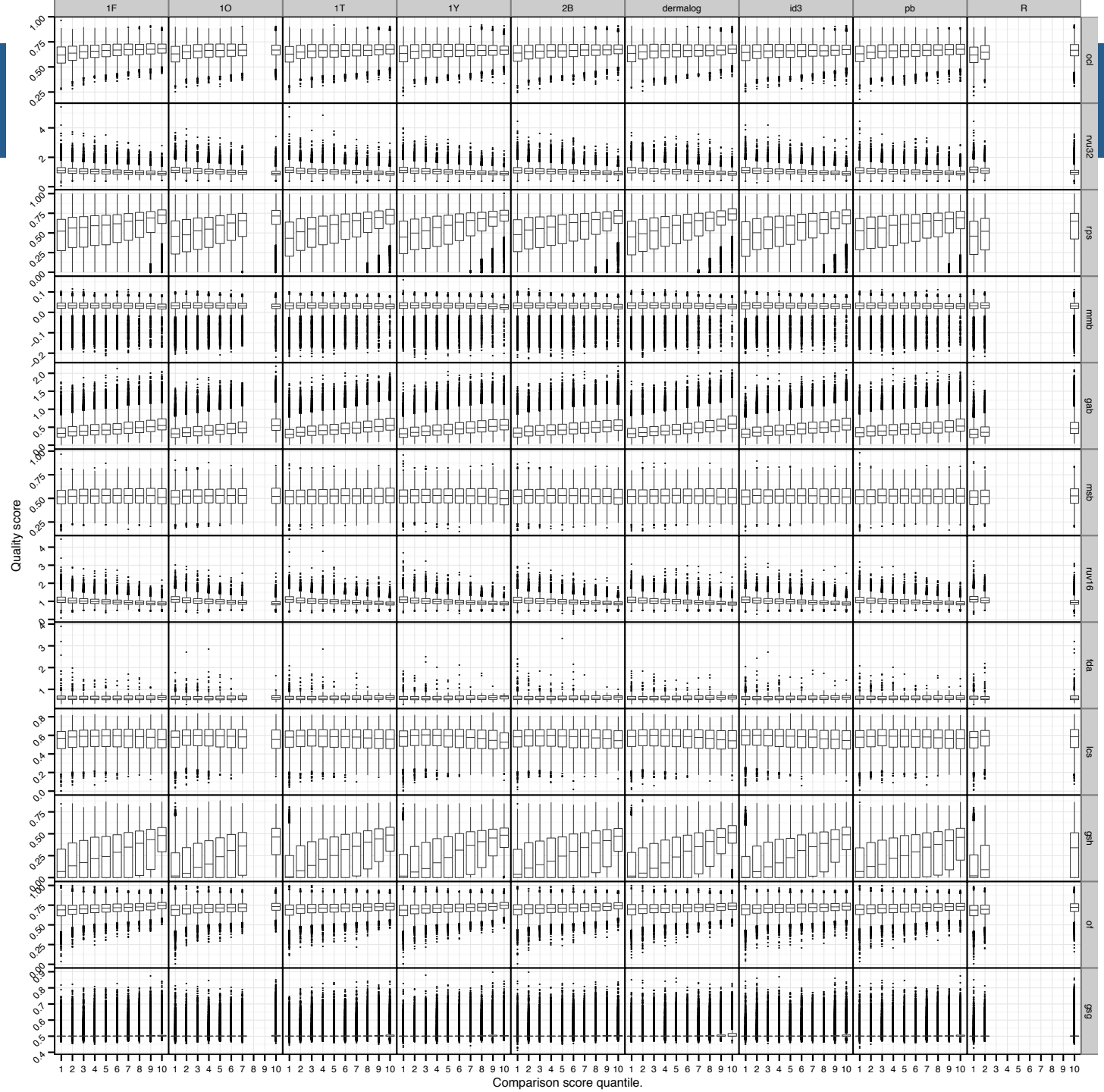
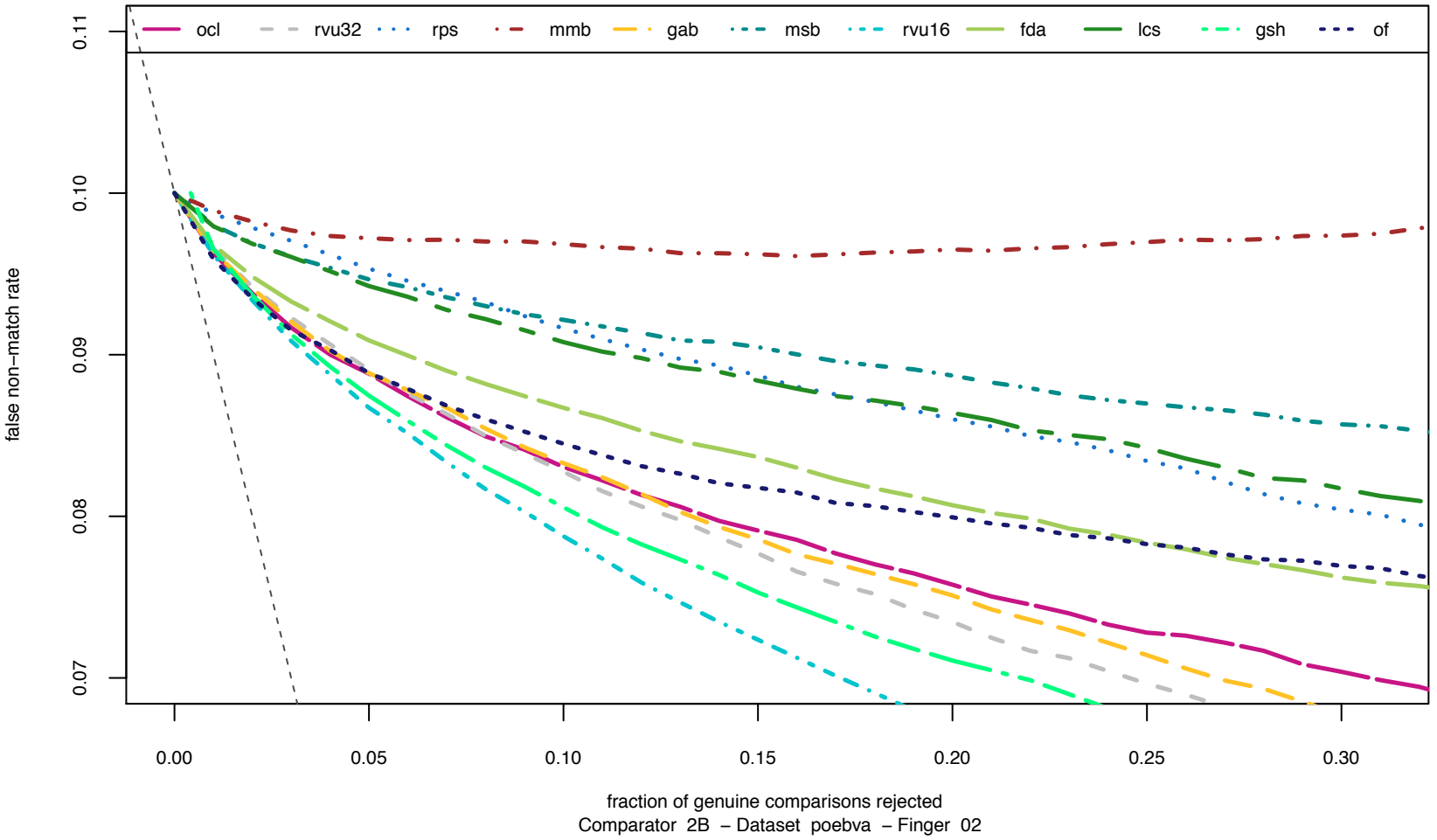
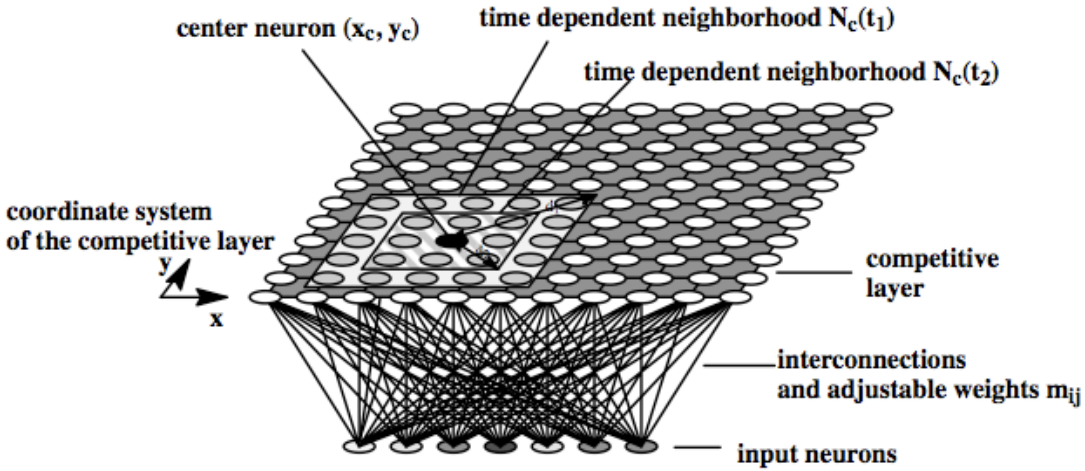

1F
1O
1T
1Y
2B
dermalog
id3
pb
R
ocl
nvu32
rps
mmb
gab
msb
nuv16
fda
lcs
gsh
of
gsg
Quality score
Comparison score quantile.

NFIQ 2.0 :: performance per features





MACHINE LEARNING

We examined:

Random forest

Support vector machine

K-nearest neighbor

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Machine Learning

Random Forest

- Ensemble classifier using stochastic process
  - Use vote to determine class memberships
  - Provides class probability in predictions
  - Analysis of features importance and their ranking
    - We used this to do our final feature selection

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.

Training

- Features: image processing + #minutiae + minutiae quality
- ~5000 samples in each of the low and high performers classes
- 1000 trees in forest

Test

- 30000 comparison scores

So, Does It Work?

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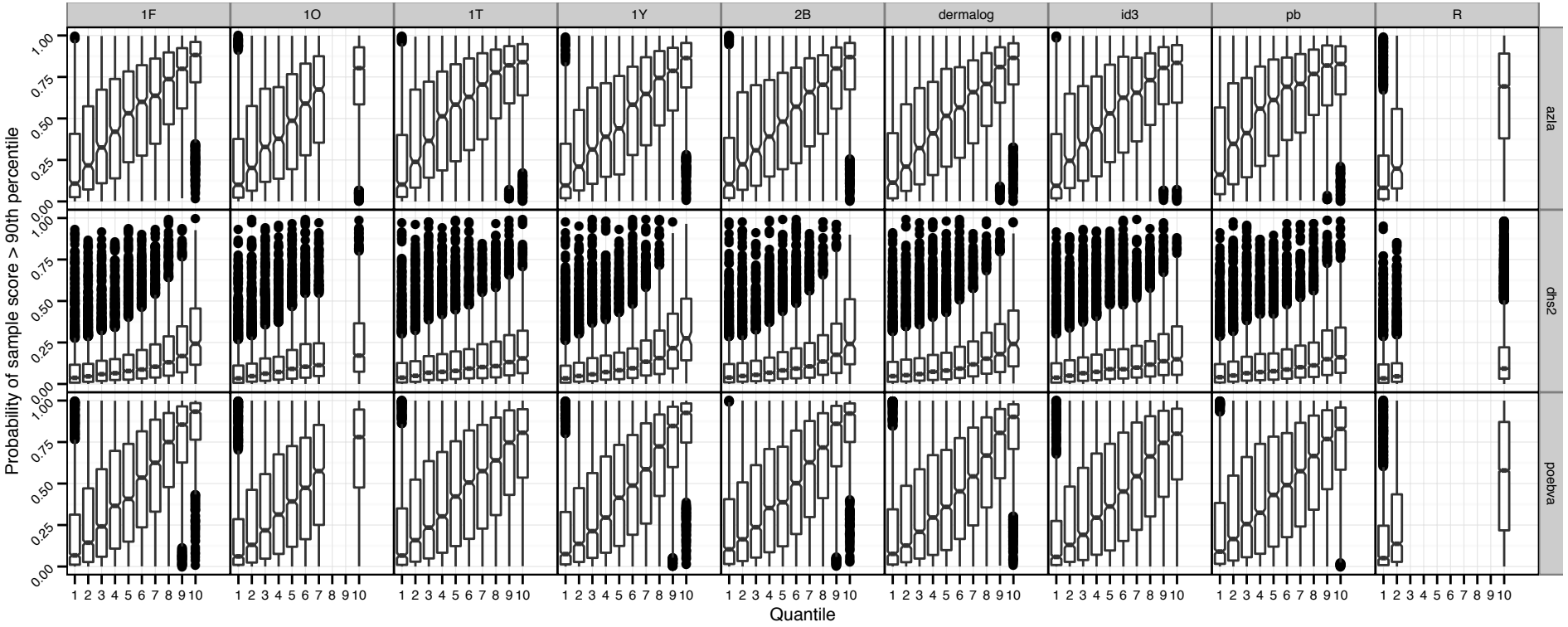
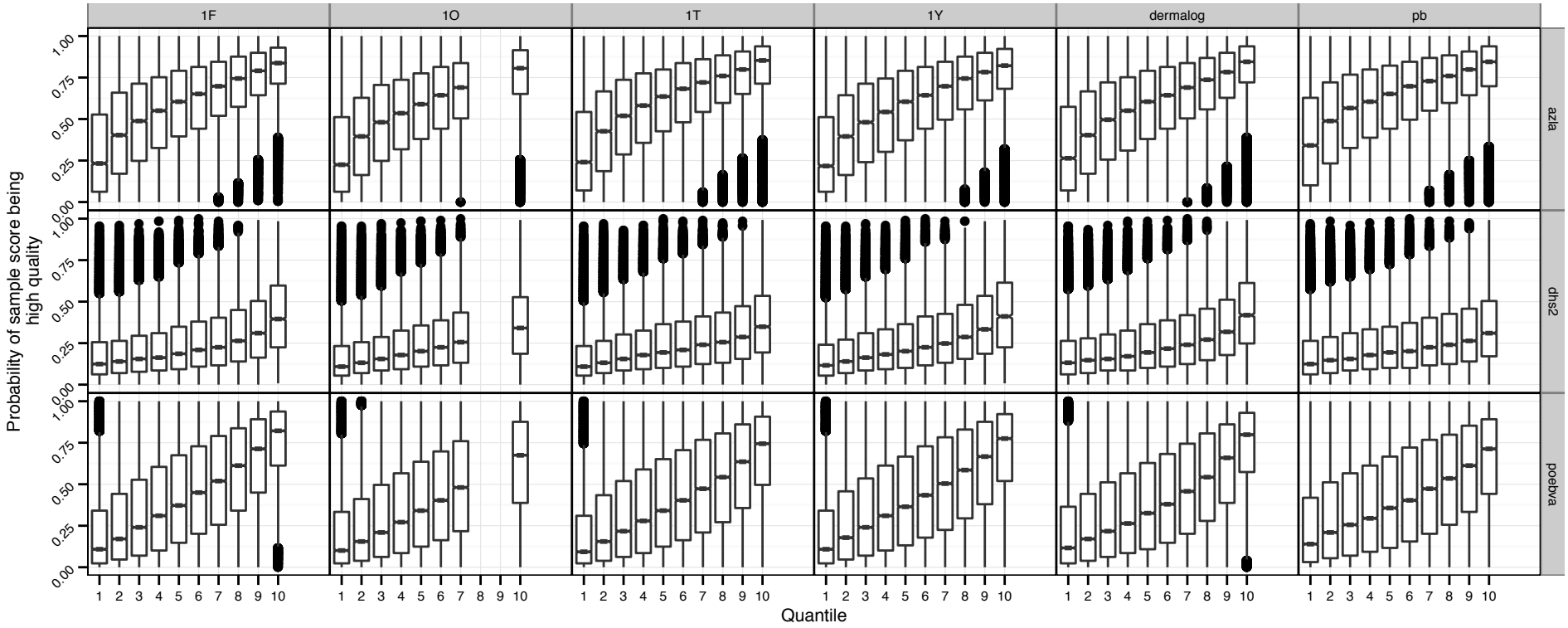
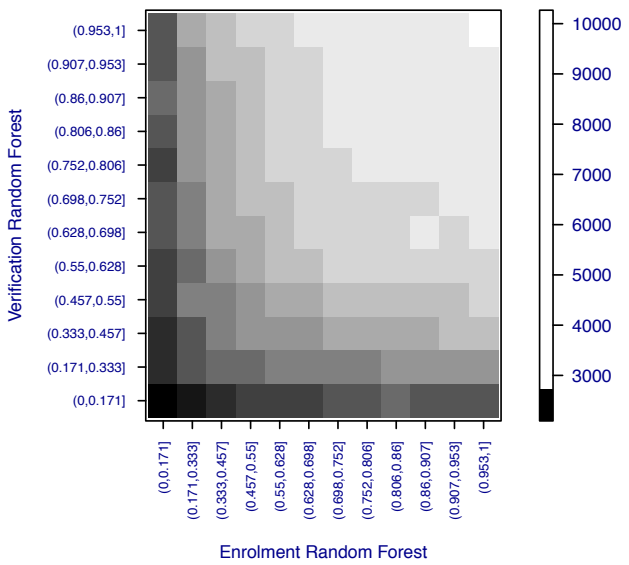
NFIQ 2.0 test –all features

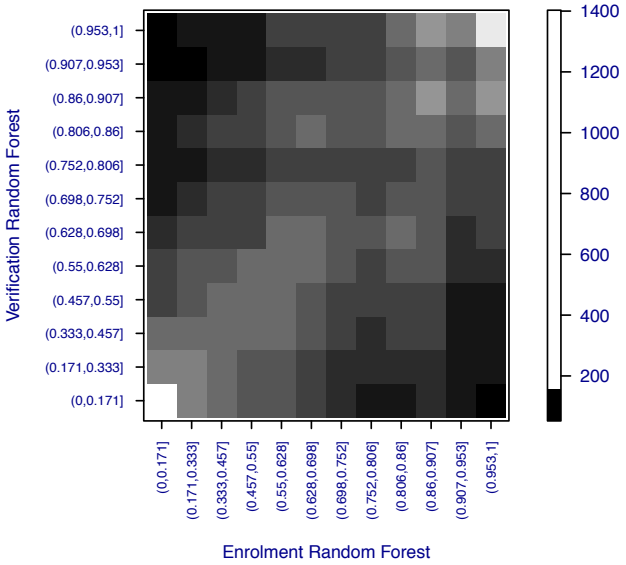


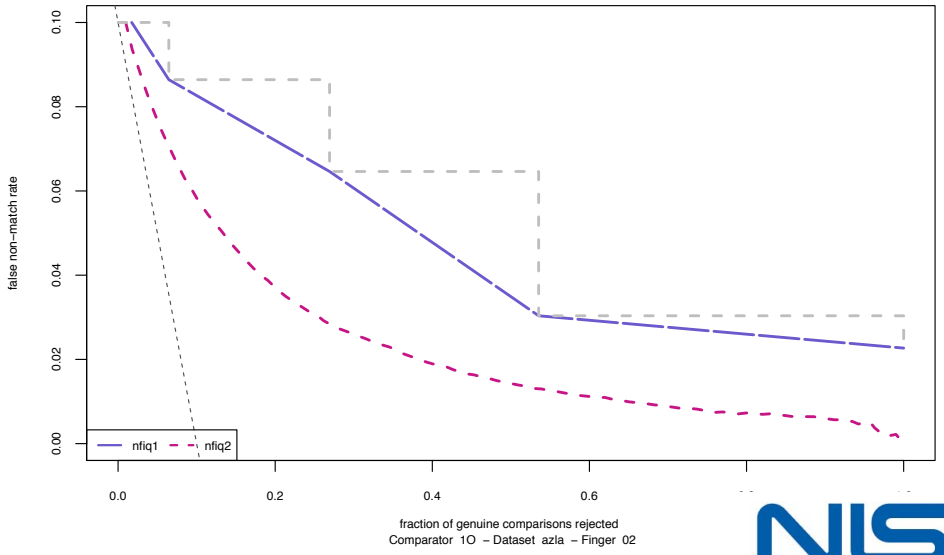
NFIQ 2.0 prototype
(current selecetion of features)



NFIQ 2.0 prototype performance







Features:

Gabor
Gabor Shen
Local Clarity Score (LCS)
Orientation Certainty Level (OCL)
Ridge Valley Uniformity (RVU) w/o padding
Ridge Valley Uniformity with padding
Orientation Flow (OF)
Radial Power Spectrum (RPS)
Minutia count
Minutiae quality based on Mu
Minutia quality based on OCL
ROI (foreground size)

ACTIONABLE QUALITY

Actionable quality

Feed back to user/operator

- Wet / dry
  - High/low pressure
    - MS Thesis (M. Dusio, C. Busch)
- Centeredness
  - Singularity detection
- Incompleteness
  - Entropy of orientation flow
- Ghost images

Questions?

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

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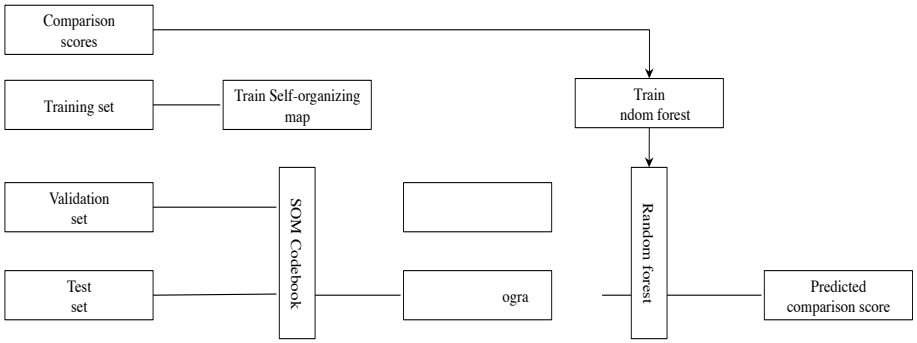
NFIQ 2.0 LITE (MOBILE)

NFIQ 2.0 Lite/Mobile

Requirements

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

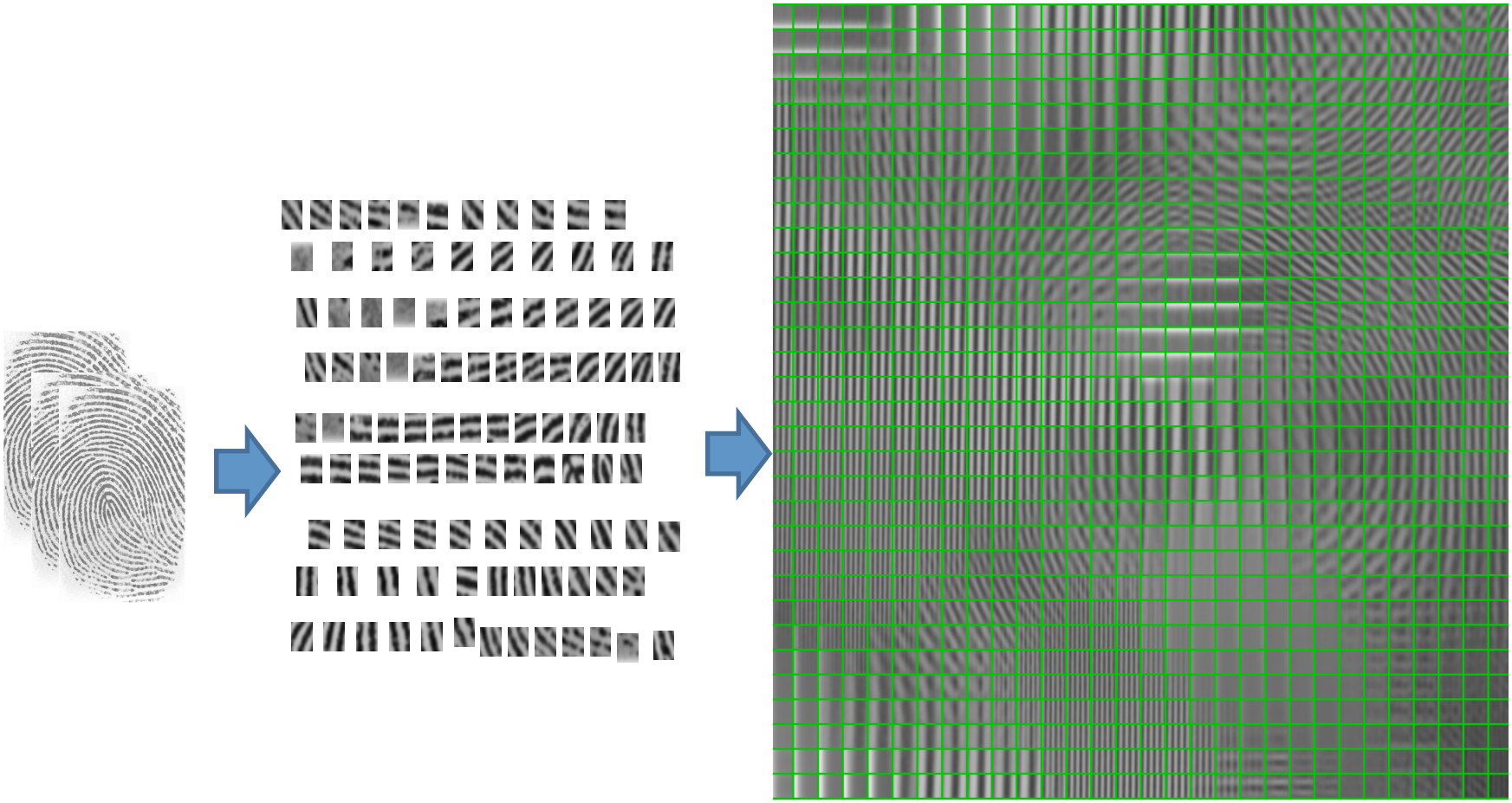


SOM

- Unsupervised clustering (unlabelled training data)
- Training phase
  - Iteratively present training vectors to build clusters (codebook vectors)
- Prediction phase
  - Input vector is assigned a class based on distance to learned clusters
- Topology preserving - similar classes will have similar spatial locations in the map

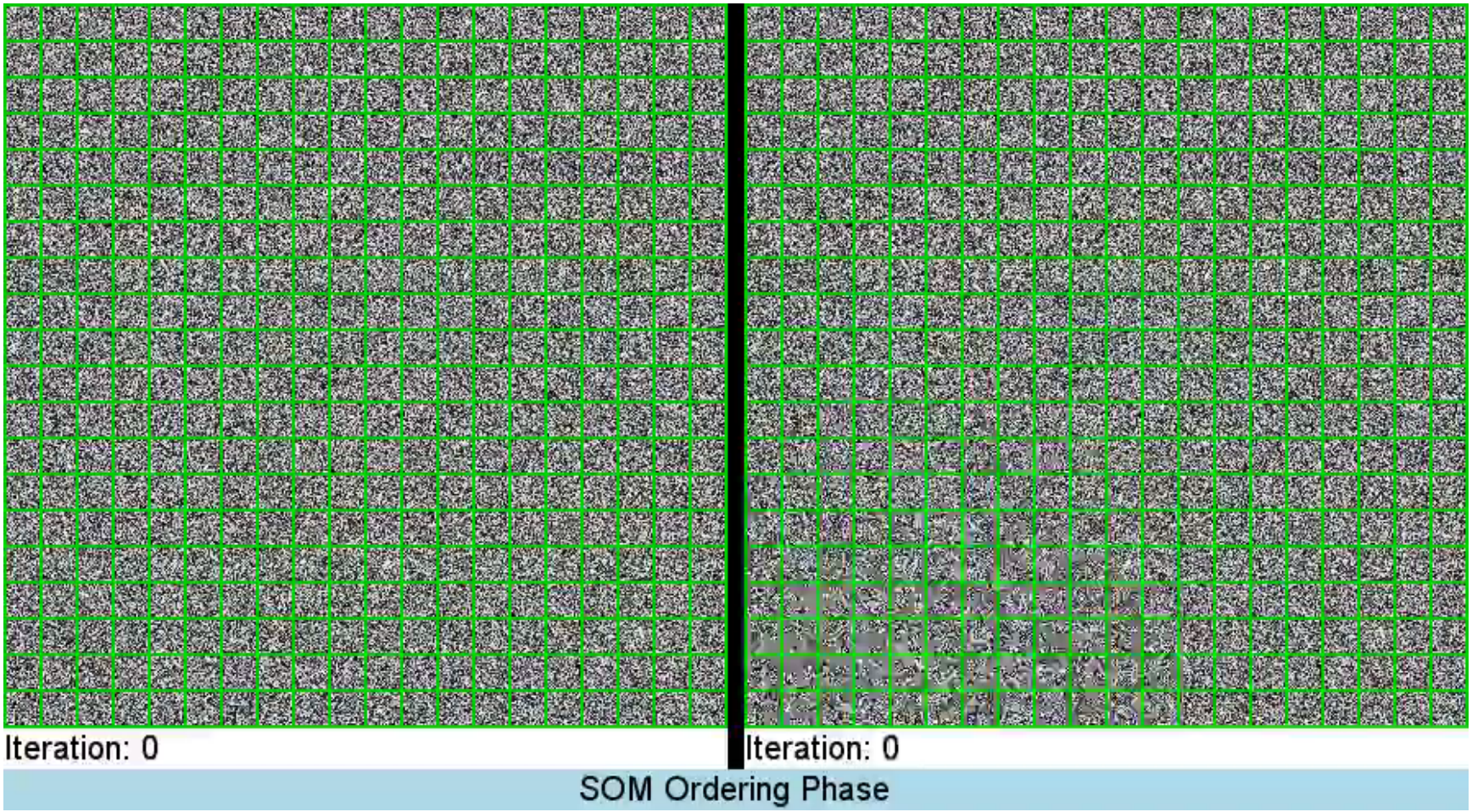
Self organizing maps

M. Olsen, E. Tabassi, A. Makarov, C. Busch: „Self-Organizing Maps for Fingerprint Image Quality Assessment“, in Proceedings of the 26th Conference on Computer Vision and Pattern Recognition (CVPR 2013), June 23-28, Portland, Oregon, (2013)



SOM code book

SOM unsupervised training

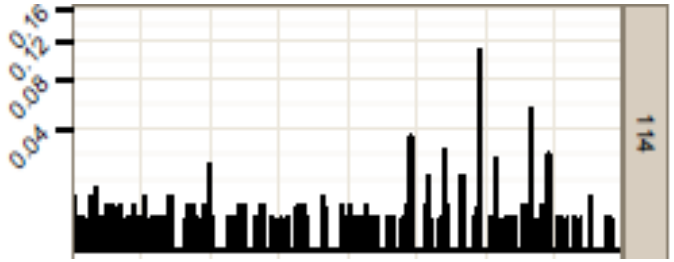


Self organizing maps for NFIQ2.0 Lite-1

Divide fingerprint image into blocks and look up nearest cluster to get a label

A A A A A
A B C D A
A E C D A
A E C C A

Finger image is transformed into cluster histogram

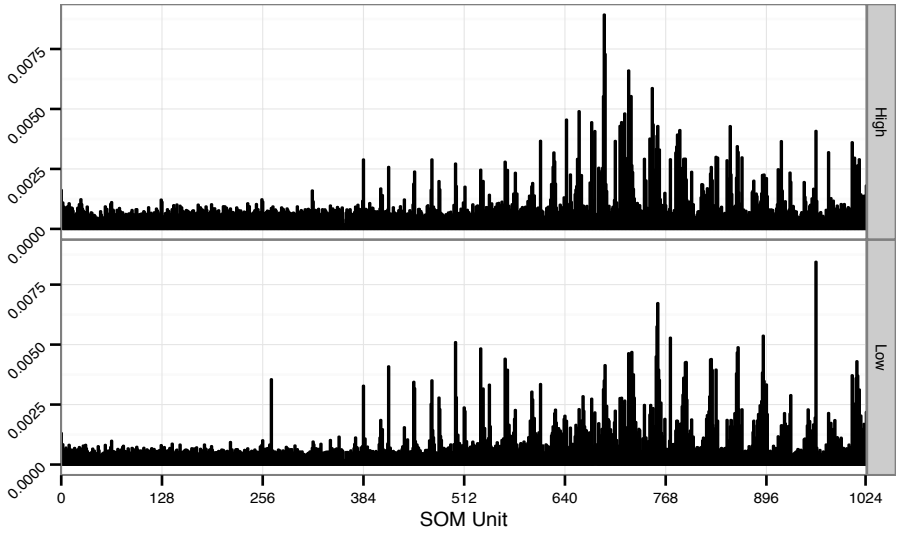


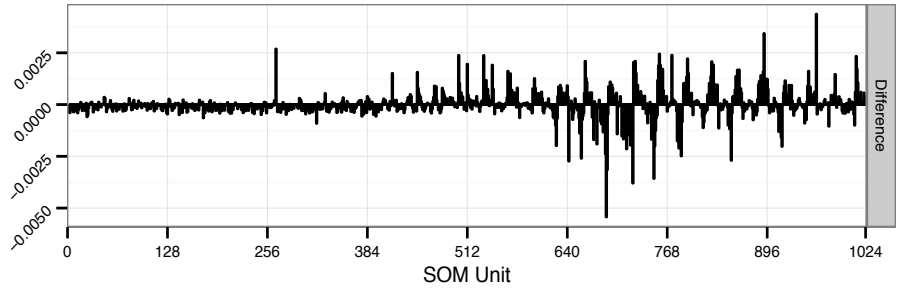
Random Forest

Quality Score

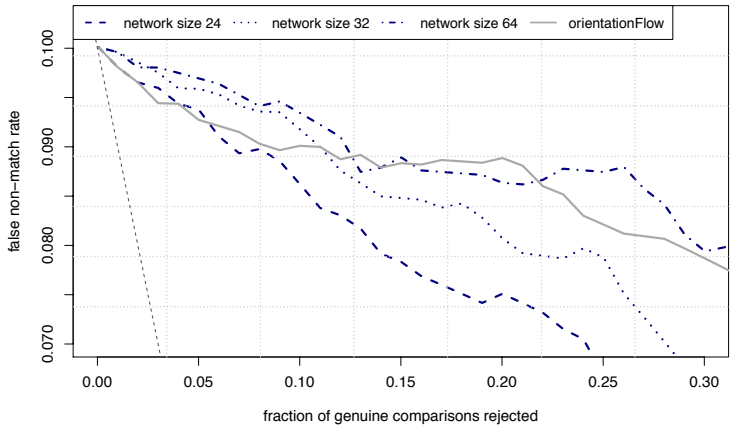
NFIQ 2.0 Lite prototype

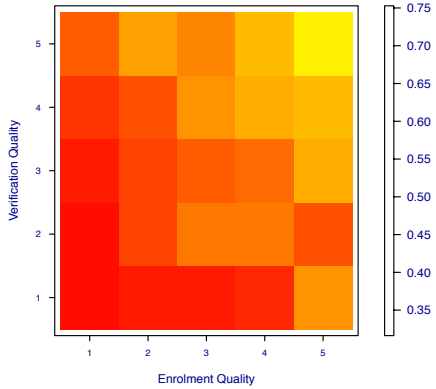
Features

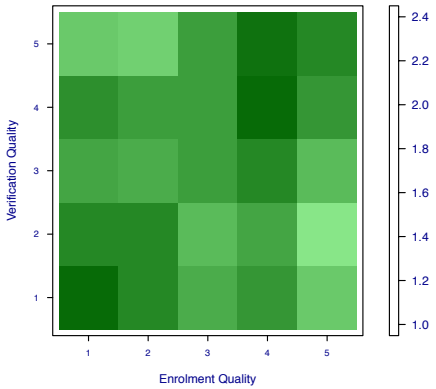




performance







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

- *Feature* computation time
  - ~ 19.45 msec/image for OCL - Expect about the same for other features
    - 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)
  - ~85 msec/image for Minutia based features
- This is prior to any code optimization

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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.
- Feature Implementation - MATLAB to to C/C++
  - Thanks to FBI + MITRE
- Exploring machine learning
  - Random forest, SVM.
- Feature selection (almost – contingent on their computation time).
- Implementation of actionable flags for detection and mitigation of bad presentations
  - Incomplete finger (tip, etc.) + Wet / dry + Pressure

Underway

- Finalizing training
  - After this workshop
- NFIQ 2.0 Lite
  - Self organizing map
- Evaluation of Implementation of actionable flags for detection and mitigation of bad presentations
  - Incomplete finger (tip, etc.) + Wet / dry + Pressure
  - But, tricky – since we do not have groundtruth for this.
- Mapping of NFIQ 2.0 → NFIQ 1.0

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

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Standardization - then

ISO/IEC IS 29794-1:2009

- Information technology - Biometrics sample quality Part 1: Framework
- Definitions
  - quality: "the degree to which a biometric sample fulfils specified requirements for a targeted application"
  - quality score: "a quantitative expression of quality"
  - utility: "the observed performance of a biometric sample or set of samples in one or more biometric systems"
- Quality score from 0 to 100

5-byte Quality Block

description		size	valid values	notes
Number of Quality Blocks		1 byte	[0,255]	This field is followed by the number of 5-byte Quality Blocks reflected by its value (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). A value of zero (0) means that no attempt was made to assign a quality score. In this case, no Quality Blocks are present.
Quality Block	Quality Score	1 byte	[0,100] 255	0: lowest 100: highest 255: failed attempt to assign a quality score
	Quality Algorithm Vendor ID	2 bytes	[1,65535]	Quality Algorithm Vendor ID shall be registered with IBIA as a CBEFF biometric organization. Refer to CBEFF vendor ID registry procedures in ISO/IEC 19785-2.
	Quality Algorithm ID	2 bytes	[1,65535]	Quality Algorithm ID may be optionally registered with IBIA as a CBEFF Product Code. Refer to CBEFF product registry

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Standardization - now

ISO/IEC 29794-1:201X

- Information technology - Biometrics sample quality Part 1: Framework
- Definitions
  - Same as before, but allow for a vector of quality components
  - Goal: Actionable quality
- Each element of quality vector has a score from 0 to 100.

Vector of quality components

Table 2 – Data fields

		Description	Size	Valid values	Notes
		Number of Quality Blocks (N)	1 byte	0 to 255	This field is followed by the number of 5-byte Quality Blocks reflected by its value. A value of zero (0) means that no attempt was made to assign a quality score. In this case, no Quality Blocks are present.
Quality Block 1	Byte 1	Quality Indicator	1 byte	0 to 100 250 255	0 to 100: the encode value is the overall quality score of the representation. It should express the predicted recognition performance of a representation with higher values indicating better quality. 250 (FA_{Hex}): a vector of quality metrics is encoded in bytes 6-N. 255 (FF_{Hex}), an attempt to calculate a quality score has failed
	Bytes 2-3	Quality Algorithm Vendor ID	2 bytes	1 to 65535	Quality Algorithm Vendor ID shall be registered with IBIA as a CBEFF biometric organization. Refer to CBEFF vendor ID registry procedures in ISO/IEC 19785-2.
	Bytes 4,5	Quality Algorithm ID	2 bytes	1 to 65535	Quality Algorithm ID may be optionally registered with IBIA as a CBEFF Product Code. Refer to CBEFF product registry procedures in ISO/IEC 19785-2.
Bytes 6 – 5 x (Number of quality blocks) exist only if quality indicator (Byte 1) is 250 (FA_{Hex}).					
Quality Blocks 2-N	6	Overall quality score	1 byte	0 to 100	A quality score should express the predicted comparison performance of a representation. A quality score shall be encoded in one byte as an unsigned integer. Allowed values are 0 to 100 with higher values indicating better quality
	7	Number of quality vector elements	1 byte	Defined in each Part of this Standard	If the number of quality vector elements mod 5 is not equal to three then padding bytes should be added such that the length of the block is a multiple of five. This will ensure backward compatibility with the implementations conformant with ISO/IEC 29794-1:2009 and ISO/IEC 19794-x:2011. For example, if the number of quality vector elements is 14, 4 padding bytes shall be added so that the length of the image quality record is 25 = 4(padding) + 14(number of quality vector elements) + 7(as shown in rows 1-7).
	8	Quality metrics			As defined in modality specific parts of this International Standard.

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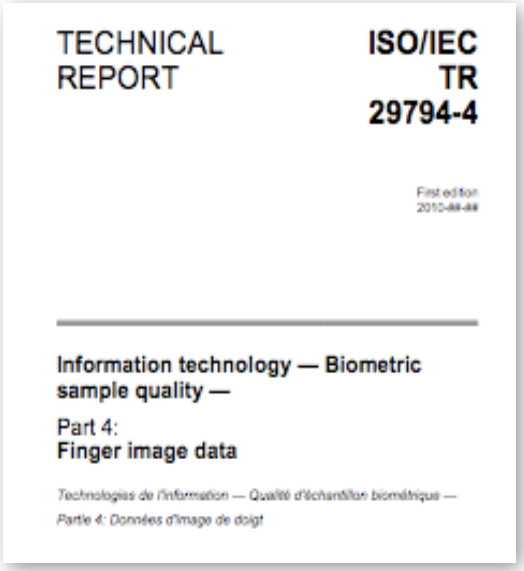
Support standardization of finger image quality

ISO/IEC 29694-4

- Provide quantitative support to development of Information technology – Biometric sample quality – Part 4: Finger image
  - Currently at 2nd working draft
- Contribute feature computation method + codes
  - Allows for plug-and-play of features for implementations that satisfy semantic conformance to the requirements of the ISO/IEC 29794-4 standard


TECHNICAL REPORT

ISO/IEC TR 29794-4

First edition 2010-##-##

Information technology — Biometric sample quality —

Part 4: Finger image data

Technologies de l'information — Qualité d'échantillon biométrique — Partie 4: Données d'image de doigt

NIST Biometric Quality Program

Push Towards Zero Error Biometrics

Strengthening Science	Advancing metrology	Developing Standards	Developing Tool Box	Best Practice Guidance	Enumerative Bibliography	Coordination+ Collaborations
Failure Analysis	Performance Evaluation	Requirements Specifications	Open source Public domain	Instructional + Guidance	Technical Literature	Workshops, Conferences
Identifying the likely causes of recognition error, quantifying their effect and ways to mitigate them.	Quantitative means of assessing performance of quality assessment algorithms (IREX II IQCE)	On image properties affecting performance, and on capture device	Reference implementations of quality assessment algorithm, iris segmentation	Materials for quality score summarization + Best capture practice + example images of various quality	Reports, white papers, publications relevant to biometric quality and iris image quality in particular	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 NIIQ 1.0	NIST IR 7422 NIST IR 8XXX	www.nist.gov/itl/iad/ig/bio_quality.cfm	BQW 2006, 07 IBPC 2010, 12 NFIQ 2010,12

Thank You.

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Panel Discussion

- Greg Cannon (CrossMatch)
- John Dowden (NEC)
- Anne Wang (3M Cogent)
- Timo Ruhland (BKA)
- Jean Christophe FONDEUR (MORPHO)
  - the main advantage of NFIQ –by far- is that it is universal and common to all, so I clearly recommend that we keep this universality for NFIQ 2 and hence have no option in the definition. NFIQ score on a given image should remain an absolute and universal value.

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