The push towards zero error biometrics

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Development of NFIQ 2.0

April 28, 2016:

- Download source code

- Documentation

- Build steps (on CentOS 6):

    tar xf NFIQ2.tar.gz

    cd NFIQ2/libOpenCV && cmake -D CMAKE_MAKE_PROGRAM=

    make ../OpenCV/make opencv_core opencv_ts opencv_imgproc
    opencv_highgui opencv_flann opencv_features2d opencv_calib3d opencv_ml
    opencv_video opencv_objdetect opencv_contrib opencv_nonfree opencv_gpu
    opencv_photo opencv_stitching opencv_videostab

    cd ../NFIQ2 && make && cd .. □

- Run:

    export LD_LIBRARY_PATH=$PWD/libOpenCV/lib

    ./NFIQ2/bin/NFIQ2

    The command line tool compute the NFIQ 2.0 quality score, and optionally
    outputs the individual quality feature values for an input fingerprint image.
    Alternatively, the tool can be used in a batch mode, allowing to compute the
    NFIQ 2.0 quality scores (and optionally the individual quality feature values)
    for a list of fingerprint images by a single invocation. □

- Compliance Test:

    cd complianceTestSet

    ./run_nfiq2_complianceTest.csh

    Compliance test is successful   if you see the below message

    Files my_nfiq_numbers.txt and compliance Test_NFIQ2_scores.csv are
    identical   □

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

It will be on github soon.

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

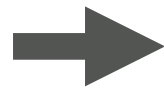Homeland Security
Science and Technology
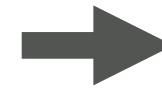
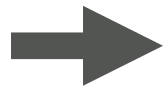Federal Office for Information Security

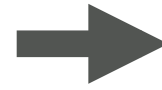Bundeskriminalamt

NIST Fingerprint Image Quality (NFIQ)
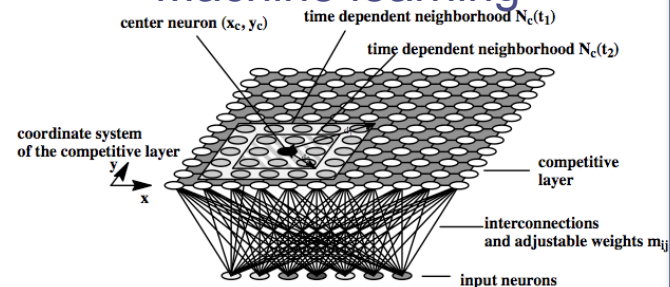
NFIQ 2.0 FEATURES

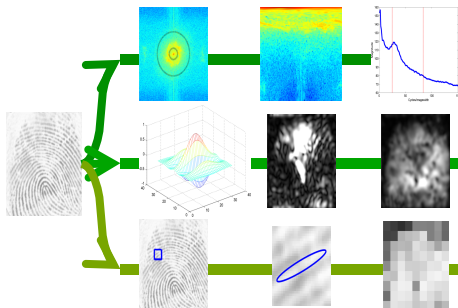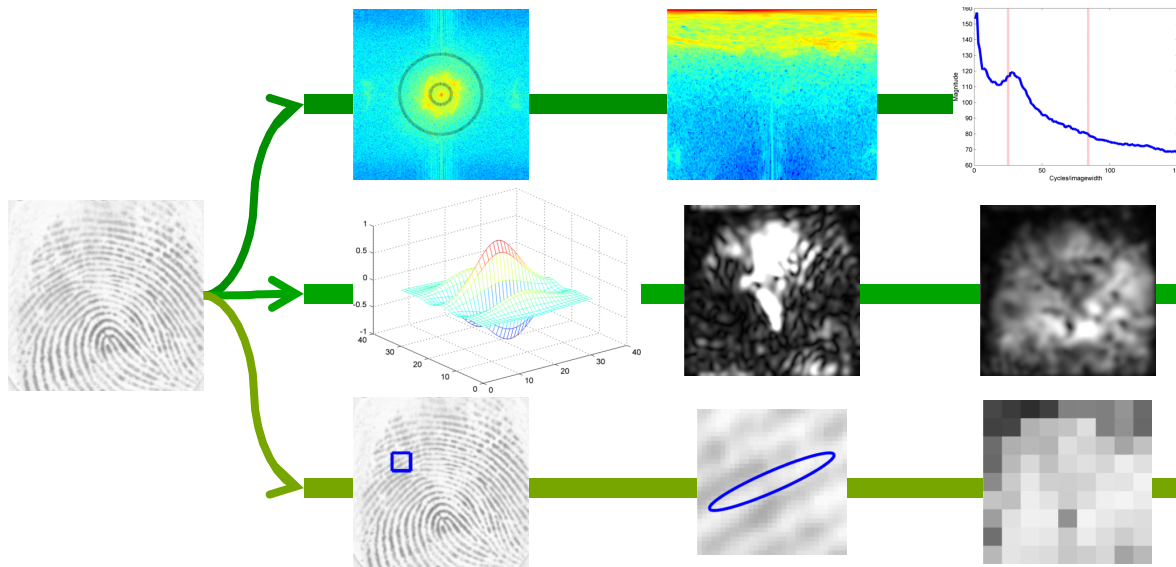NFIQ 1.0 features

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

Surveyed literature + our modifications

Open source FingerJetFx minutiae extractor

Feature selection

NFIQ 2.0 Features

NFIQ 2.0 Features

center neuron (x_c, y_c)
time dependent neighborhood $N_c(t_1)$
time dependent neighborhood $N_c(t_2)$
coordinate system of the competitive layer
competitive layer
interconnections and adjustable weights m_{ij}
input neurons
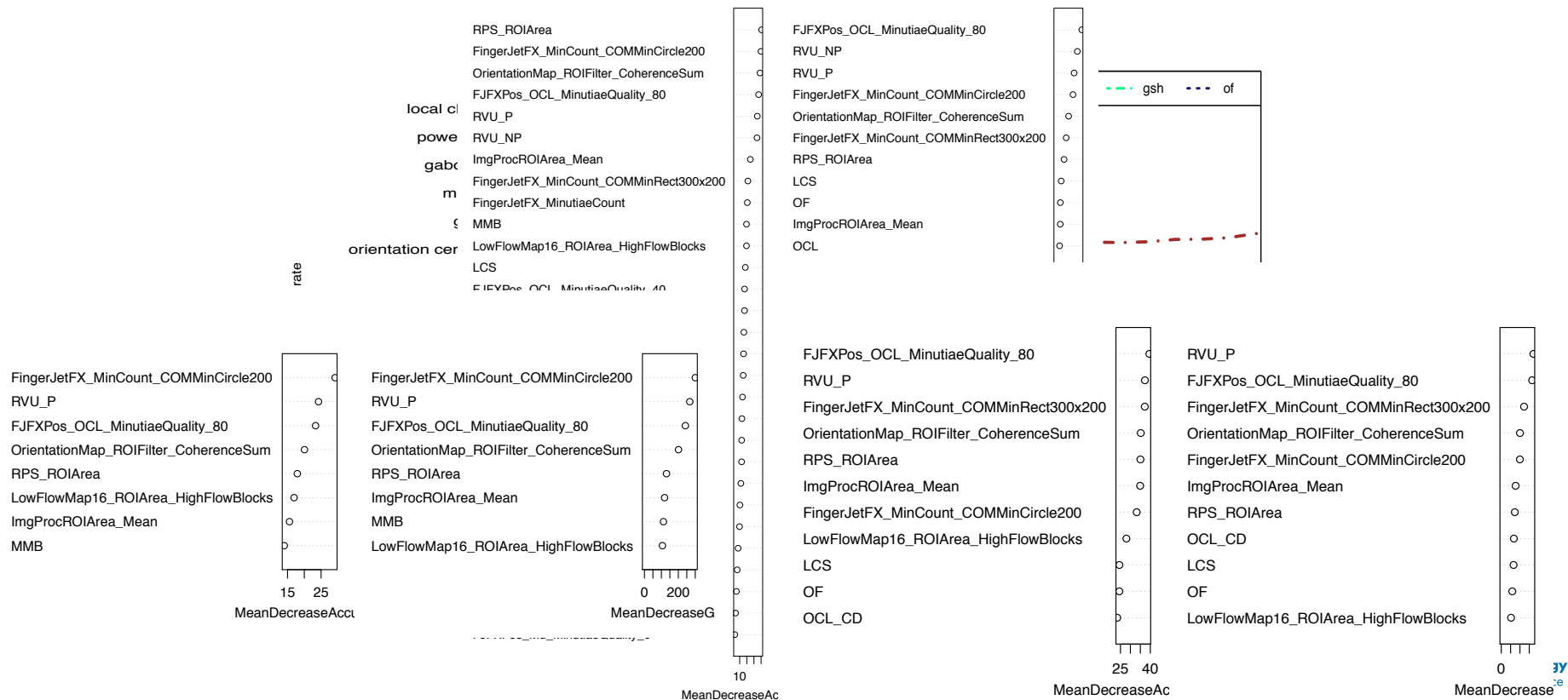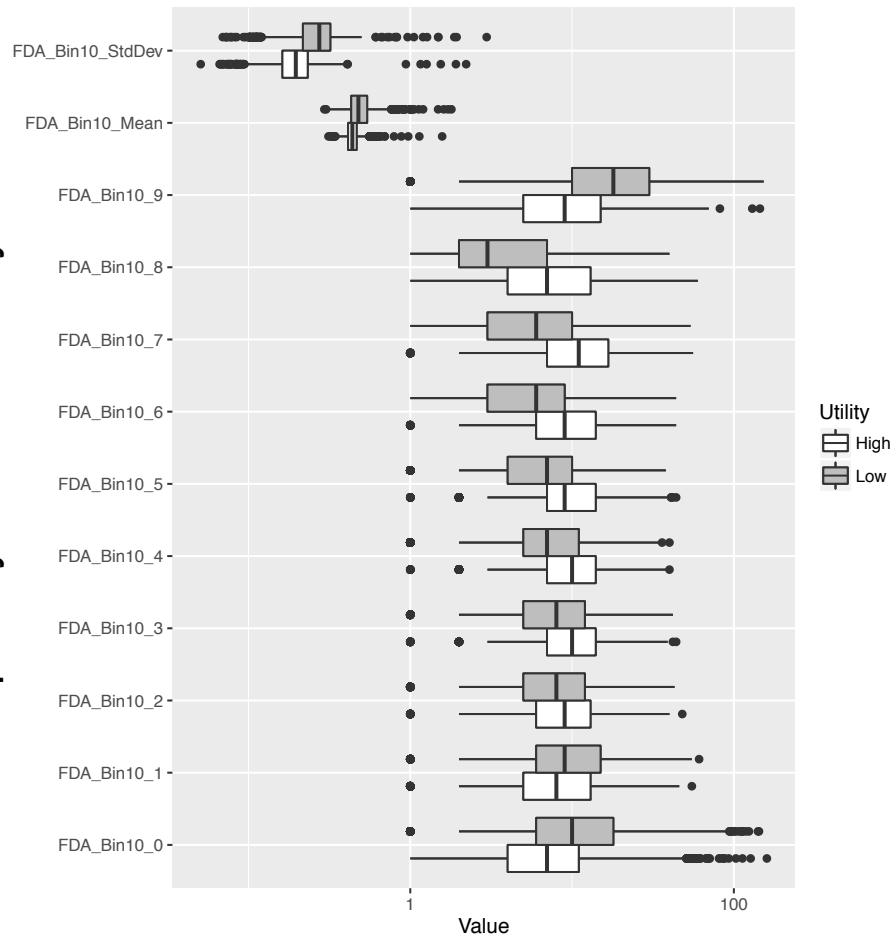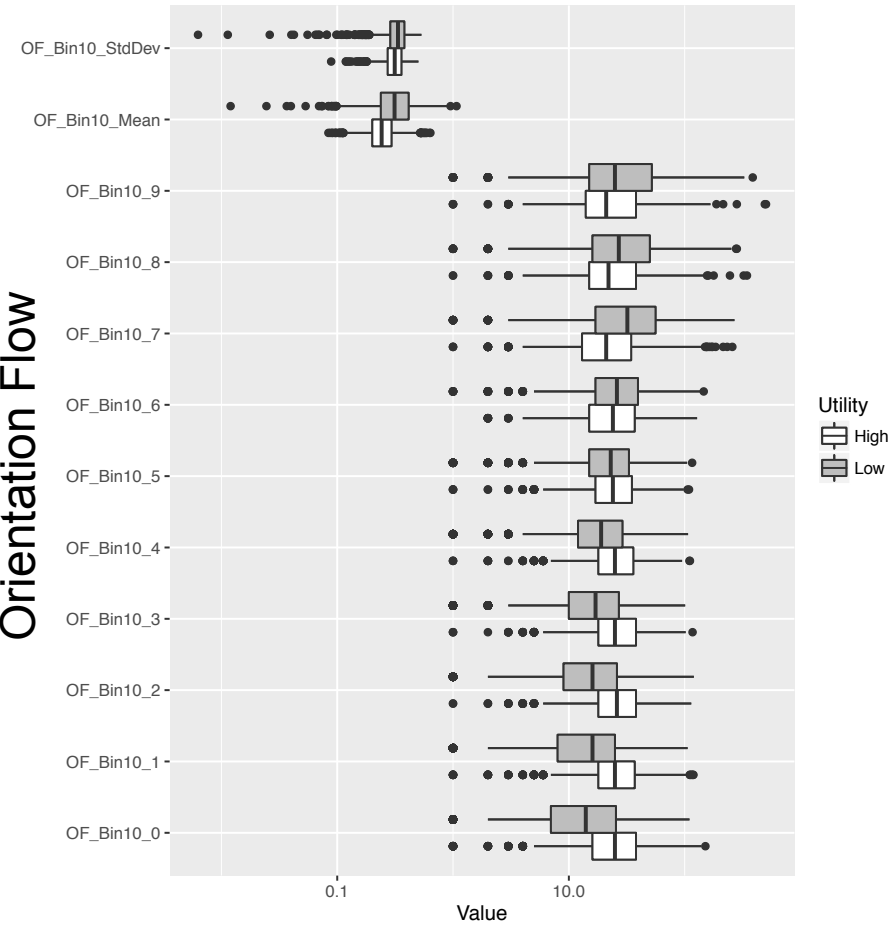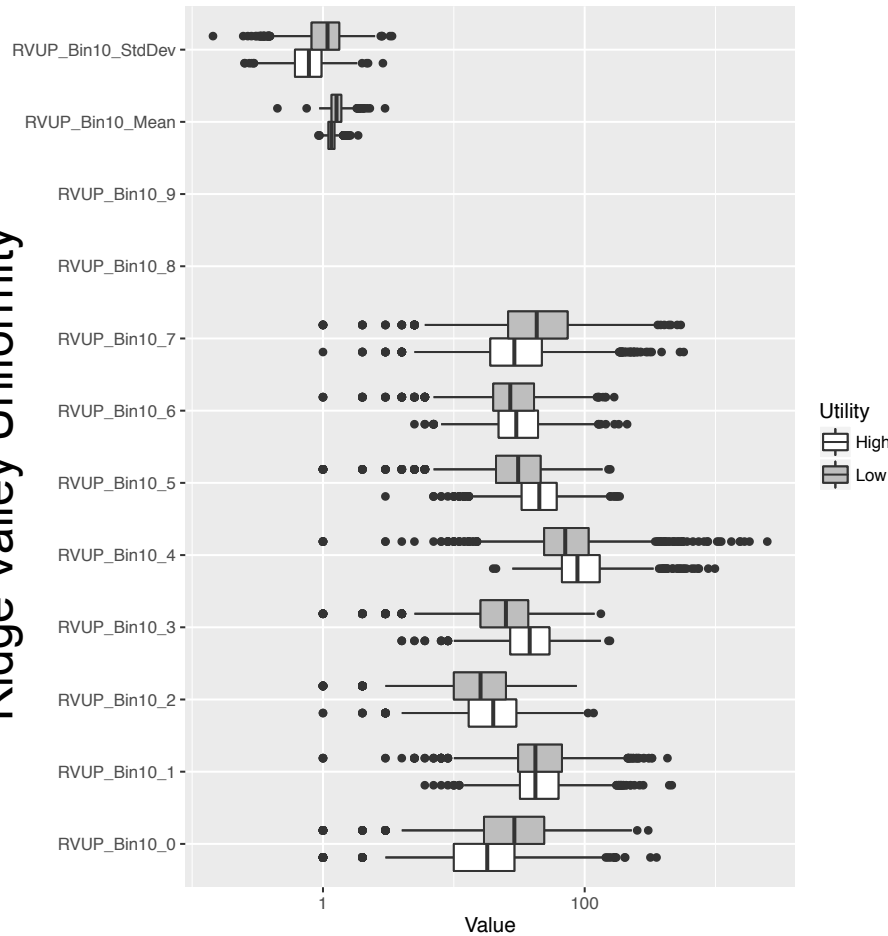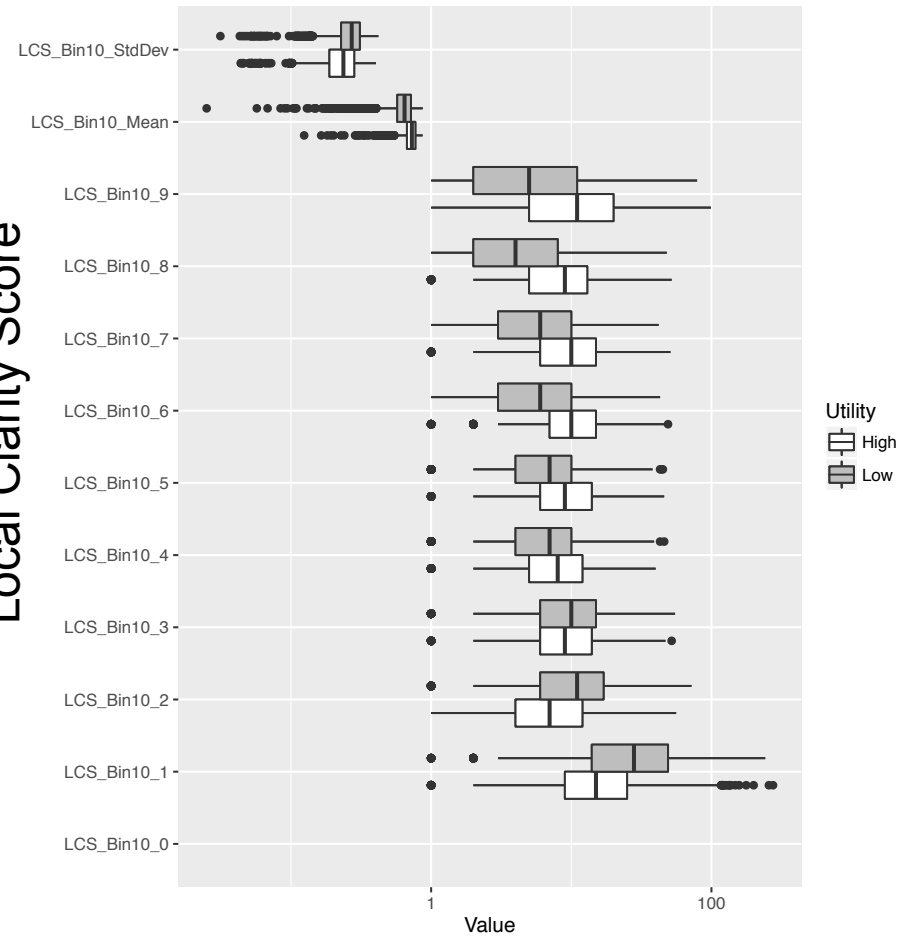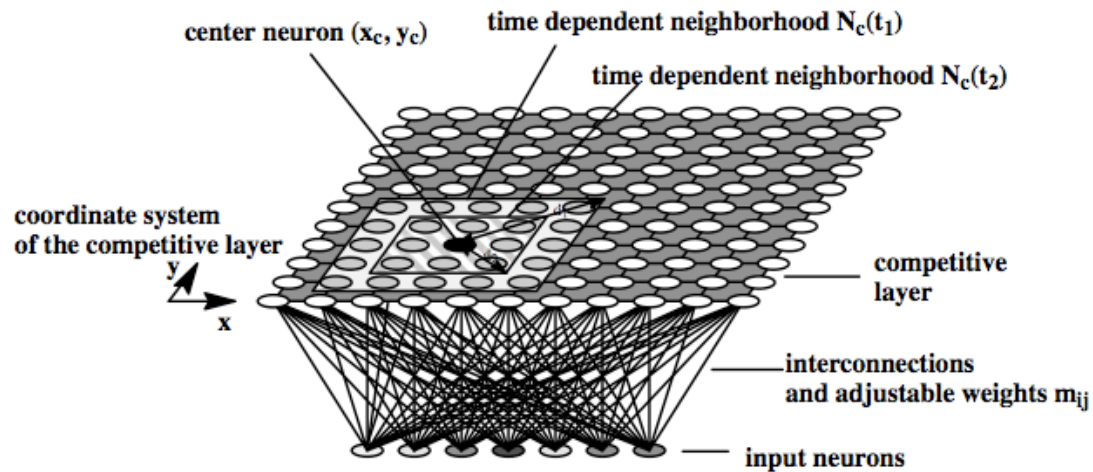
MACHINE LEARNING

We examined:
Random Forest
Support vector machine
K-nearest neighbor

Machine Learning

Random Forest

» Ensemble classifier using stochastic process
  - Uses 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 and have NFIQ1=1 with activation score > 0.7.
    • genscore > $CDF^{-1}(0.9)$ & NFIQ1.0 =1
  - 0: Low performers are images that result in false reject and have NFIQ 1.0=5 with activation score > 0.9.
    • FRR at Threshold at FMR=0.0001
  - Training data: intersection of images in Class 0 (or Class 1) across all providers
  - Quality score is the probability that a given image belongs to class 1.

» Map quality score to recognition rate.

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Training
 Features: image processing + #minutiae + minutiae quality
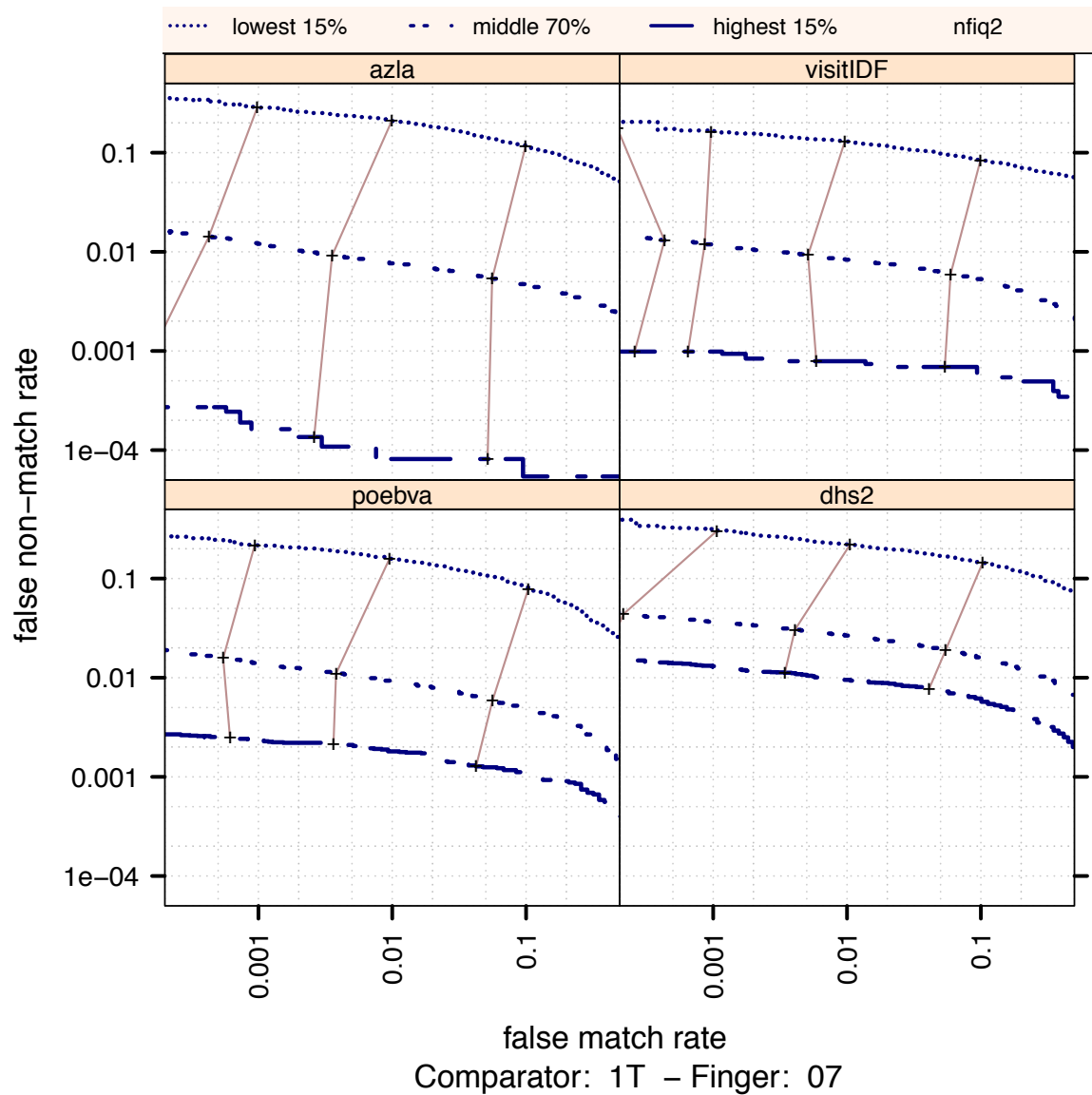 ~3500 samples in each of the low and high performers classes
 1000 trees in forest
Test
 75000 comparison scores

SO, DOES IT WORK?

NFIQ 2.0 predictive of performance

Comparator: 1T – Finger: 07

NFIQ 1.0 VS NFIQ 2.0

NFIQ 1.0 vs NFIQ 2.0
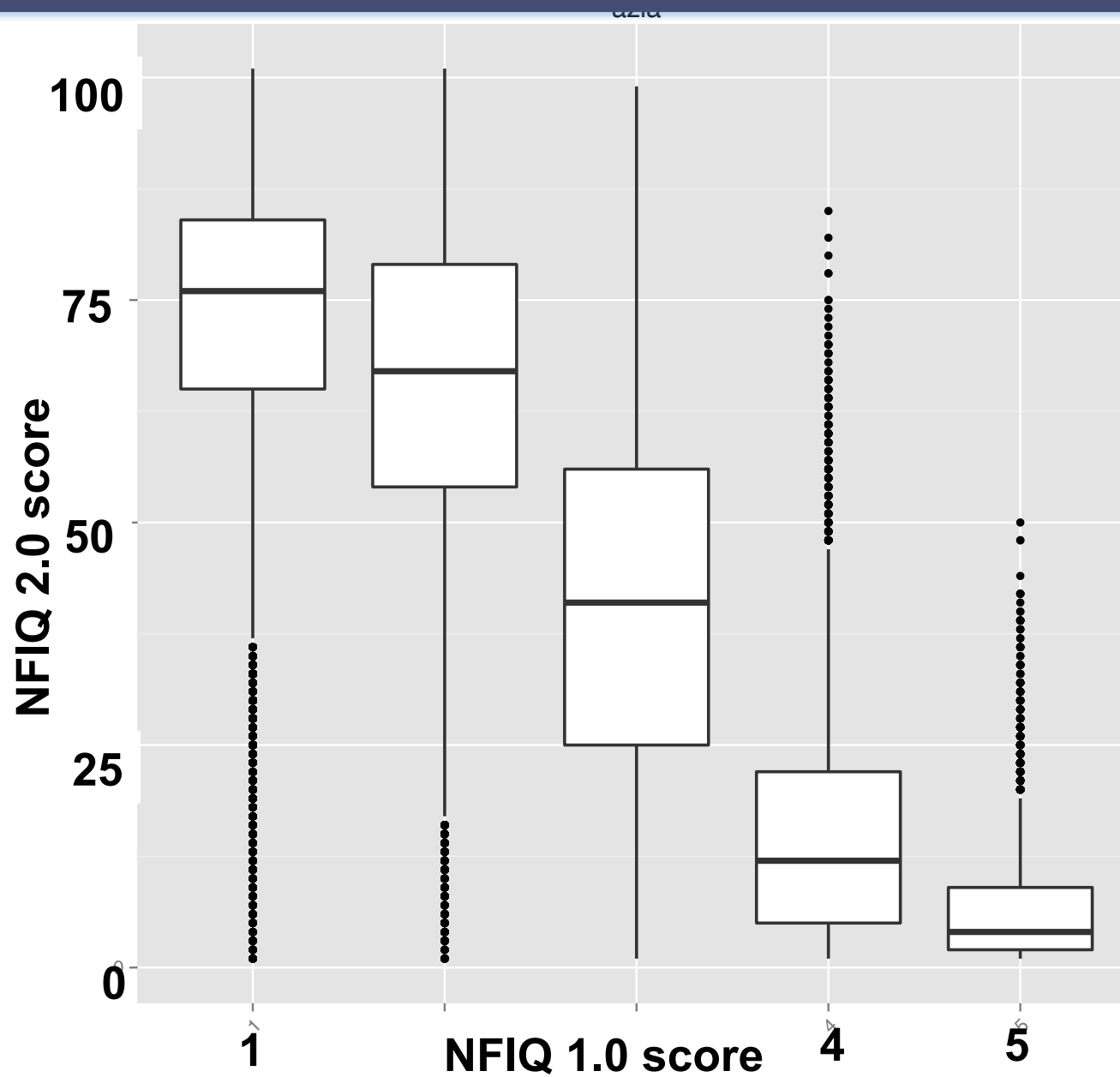
NFIQ 1.0 vs. 2.0 performance

fraction of genuine comparisons rejected
Comparator R – Dataset poebva – Finger 07
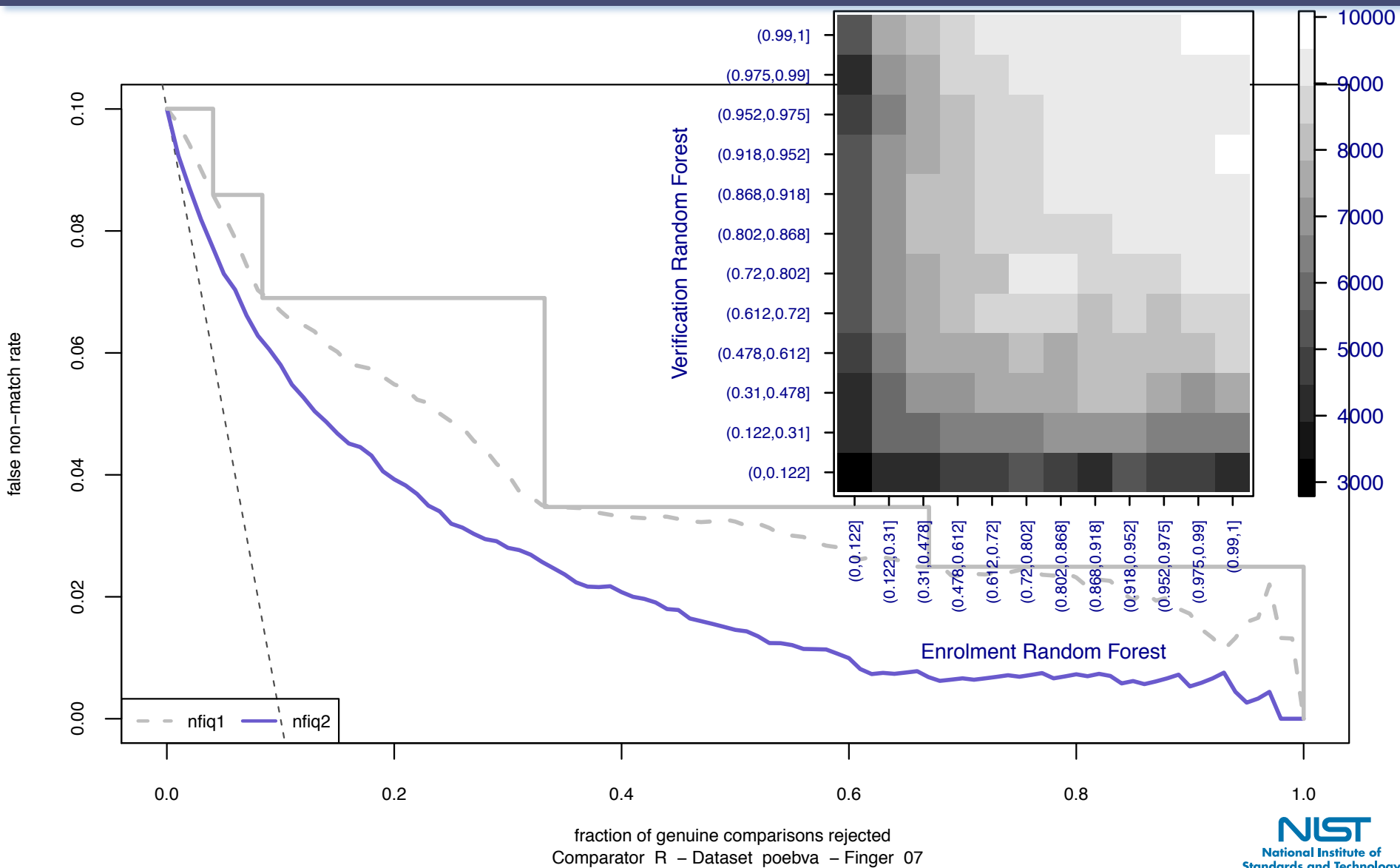
At a glance

NFIQ 1.0

» 5 levels.

   – 1(highest) to 5(lowest)

» 11 features

» Comparison scores of 3 algorithms used for training

» 3400 training images

» Neural network

» ~300 msec per image

NFIQ 2.0

» 100 levels

   – 0(lowest) to 100(highest)

» 14 (69) features

» Comparison scores of 7 algorithms used for training

» ~5000 training images

» Random forest

» ~ 120 msec per image

» Actionable quality

   – Flags for blank image, low contrast

» Design for NFIQ Mobile

Tools for easier adaption and migration

Calibration :: setting quality threshold

General: based on large scale operational data

» Calibration:
  – general calibration curves or tables for NFIQ 1.0 → NFIQ 2.0.

» Decision Table
  – For enrollment and verification quality threshold setting
  – Tabulation of estimated rejection rate and improvement in FNMR for each value of NFIQ 2.0 (i.e., [0,100]).

On-demand: based on application-specific data

» Calibration
  – We will provide software tools and technical guidance on how to compute calibration curves.

» Decision Table
  – Ditto above.

» This allows for optimal calibration and decision making considering data properties.

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THANK YOU.

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	
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	Workshops, Conferences Grants (WVU, NYU Poly)

Research	Evaluation	Standard	Software	Report	Webpage	
NIST IR 7155	NIST IR 7820	ISO/IEC 29794	NFIQ 1.0	NIST IR 7422	www.nist.gov/itl/iad/ig/bio_quality.cfm	BQW 2006, 07
ICIP 2005	PAMI 2007	ISO/IEC 19794	NFIQ 2.0	NIST IR 8XXX		IBPC 2010, 12
NIST IR 7820	ICPR 2010		NIIQ 1.0			NFIQ 2010,12

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