NIST ACTIVITIES: NFIQ

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NIST fingerprint image quality

–   NIST developed NFIQ in 2004
    –   Open source

–   Key innovation: quality as a rank statistic for performance

–   NFIQ is a machine learning algorithm
    –   Exploratory variables: image properties (minutiae, ridge density and clarity)
    –   Response variable: separation of genuine and impostor comparison
    –   Can only do what it is trained for!

–   Thank you for using NFIQ.
    –   And for feedbacks / lessons learned / ..

Future of NFIQ workshop

- Macrh 1, 2010

- Discussed way forward
  - Three options

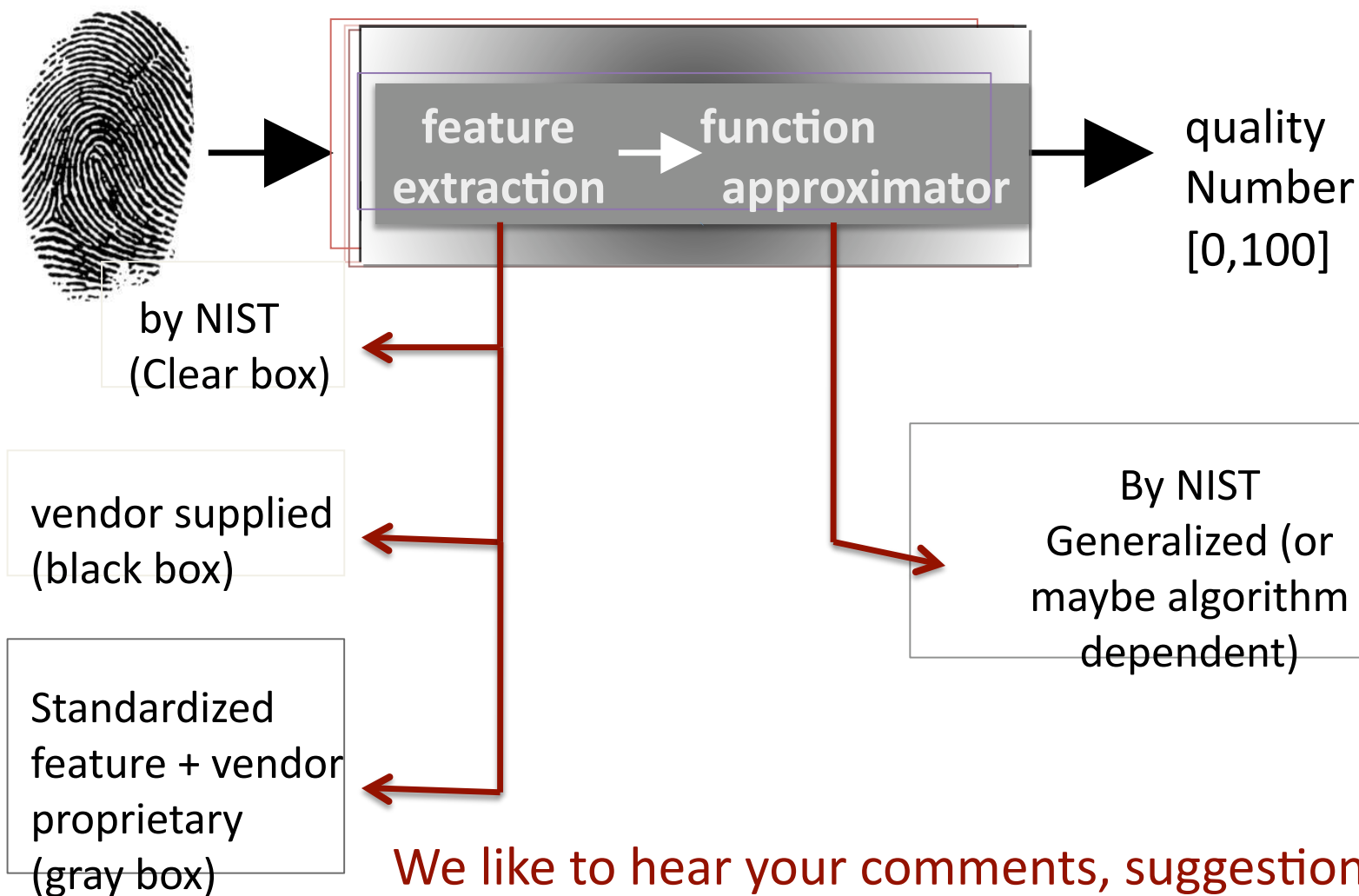- Need for calibration of quality scores

Options for NFIQ 2.0

- Do nothing!

- Incremental updates to NFIQ towards NFIQ 2.0
  - An improved NFIQ, generalized vanilla flavor
    - Improve feature extraction, training data, machine learning algorithm, better matcher, more levels
    - done by NIST – open source
  - No ability to customize it to a particular application
  - Limited collaboration with industry

- Modular NFIQ 2.0
  - Plug-and-play feature vector
    - Improves efficiency in field operations
  - NIST does the training using its large sets of data
    - Generalized or specialized to a particular comparison algorithm
    - Feedback to vendors
  - Expands the marketplace of interoperable products
    - Calibrated quality in standardized range [0,100]

We like to hear your comments, suggestions.

NFIQ 2.0: options 1 or 2

feature extraction → function approximator

quality Number [0,100]

by NIST (Clear box)

vendor supplied (black box)

Standardized feature + vendor proprietary (gray box)

By NIST Generalized (or maybe algorithm dependent)

We like to hear your comments, suggestions.

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NIST

March 4, 2010

IREX II::IQCE
IRIS QUALITY CALIBRATION + EVALUATION

IQCE is ...

- the 2nd activity under IREX

- funded by DHS S+T
  - Project "Radical improvement in iris quality assessment and maturing multimodal biometric utilization"

- an evaluation based program for development of clear, implementable, and interoperable iris quality standard ISO/IEC 29794-6.

IQCE :: objectives

- Enabling scientific progress in iris image quality assessment
  - Identifying specific iris image properties that are influential on recognition accuracy, and quantifying their effects
  - Evaluation of iris image quality assessment algorithms
    - Effectiveness + Efficiency
    - Scalar and vector quality

- Expand marketplace of interoperable products
  - Calibration of iris image quality assessment algorithms

- Support development of iris image quality standard (ISO/IEC 29794-6)
  - Strengthening the science behind the claims
  - Preventing over-prescriptive statements
 - Introducing tolerance bounds on iris image covariates

IQCE :: how
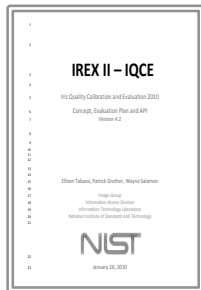
- Develop test scope, protocol, API
  - In consultation with industry and SC 37 WG 3
- Invite participation
  - Either as a provider of image quality assessment,
  - Or as a provider of generators AND matchers,
  - Or both
- Technology being supplied to NIST as SDK
  - With IQCE API
  - Rounds of testing
- Offline archived datasets at NIST
  - Uncompressed raw images
  - Dedicated data collection with specific image impairments
    - Clarkson Q-FIRE
- Devise metrics + analysis of results

IREX II – IQCE

Iris Quality Calibration and Evaluation 2010

Concept, Evaluation Plan and API
Version 4.2

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IQCE :: intended time-line

|	
October 2010	Final report
May 2010	Submission period ends
July 2010	SC 37 Working Group 3 meeting in Malaysia
February 1, 2010	Release of Clarkson Q-FIRE sample data
January 27, 2010	Submission period opened. rounds of submit -> evaluate -> report
January 18-22, 2010	SC 37 Working Group 3 meeting in Singapore
January 12, 2010	Release of final evaluation plan
November 27, 2009	Release of the 3rd draft evaluation plan, for comment.
October 22, 2009	Release of the 2nd draft evaluation plan, for comment.
October 18, 2009	Comment on the 1st draft due
October 4, 2009	Launching IQCE. Release of 1st draft of test plan + API.
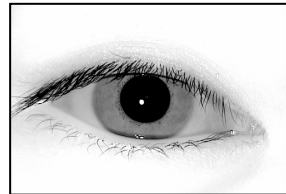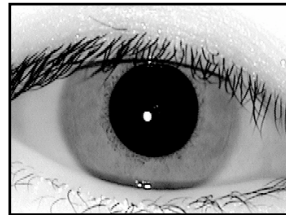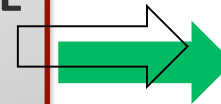
Table 4. IQAAs output format.
The range of each metric shall be [0,254], a value of 255 means that the quality metric is not computed.

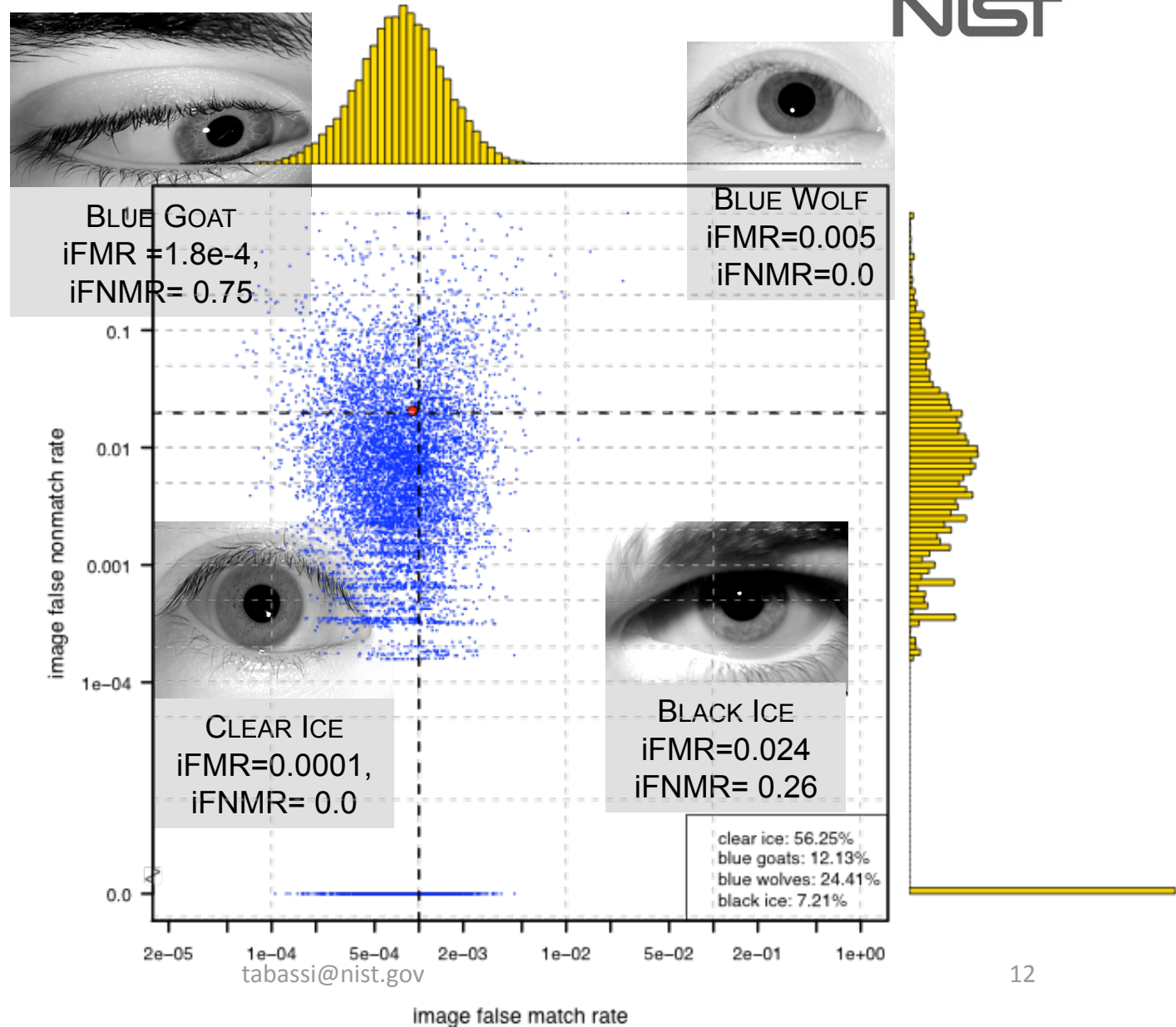| Position	Metric
1	Scalar overall quality
2	Gray level spread
3	...us in pixel)
4	Pupil iris ratio (ratio of pupil diameter over iris diameter)
5	... usable iris...
6	iris-sclera contrast
7	Iris-pupil contrast
8	...sclera boundary shape (iris shape)
9	iris pupil boundary shape (pupil shape)
10	Margin (image scale in N3331)
11	
12	Motion blur
13	Signal to noise ratio
14	Magnification
15	Head rotation
16	Gaze angle
17	Interlace
18- 32	Reserved for future standardized quality metric
33 ... 64	Vendor-defined quality measurements

1   **Scalar quality**

2 .. 17   **Defined (standard) quality metrics**

18..32   **Reserved**

33..64   **Vendor-defined quality metrics**
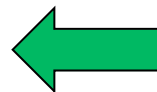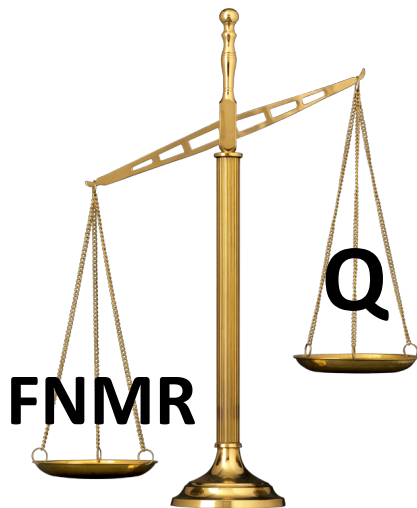
IQCE :: evaluation
Multivariate statistical analysis to investigate the causes of recognition failure

BLUE GOAT
iFMR =1.8e-4,
iFNMR= 0.75

BLUE WOLF
iFMR=0.005
iFNMR=0.0

CLEAR ICE
iFMR=0.0001,
iFNMR= 0.0

BLACK ICE
iFMR=0.024
iFNMR= 0.26

clear ice: 56.25%
blue goats: 12.13%
blue wolves: 24.41%
black ice: 7.21%

image false nonmatch rate

image false match rate

IQCE :: calibration

2. Raw quality scores are not directly interoperable and some calibration is needed.
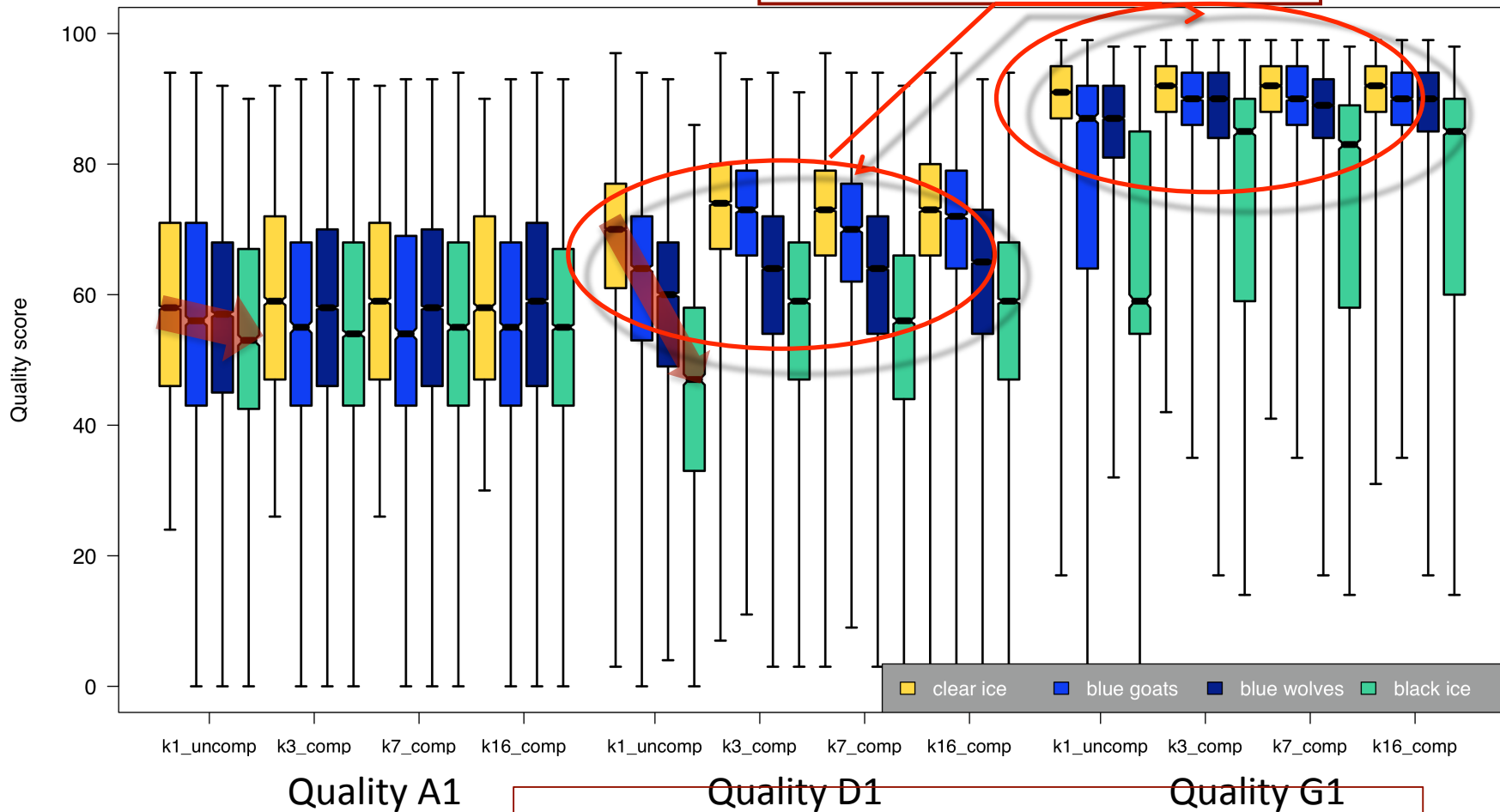
1. Highest quality with CLEAR ICE progressing down to lowest quality with BLACK ICE (IREX I report)

Legend: clear ice, blue goats, blue wolves, black ice

x-axis groups: k1_uncomp, k3_comp, k7_comp, k16_comp (Quality A1); k1_uncomp, k3_comp, k7_comp, k16_comp (Quality D1); k1_uncomp, k3_comp, k7_comp, k16_comp (Quality G1)

y-axis: Quality score (0 to 100)

IQCE :: outcome

- A refined list of iris image quality metrics with tolerance bounds
  - Quantitative support to ISO/IEC 29794-6

- Iris image quality tool box
  - Technical papers on iris image quality
    - mathematical equations on how to compute quality e.g. SNR
  - Software implementations
    - open source or proprietary compiled libraries

- Calibration curve per IQAA.

Thank You
iris.nist.gov/irexII

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