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The Application of Quality Scores in Biometric Recognition

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Outline

A case for a using a vector rather than a scalar quality score for biometric data

1. How are quality scores used?
2. Issues with using a scalar value for biometric data quality
3. Implications for quality score calibration

How are quality scores used? (1)

Prediction of performance

– At acquisition, enrolment, or recognition

Level of confidence in the result

– Should quality encompass other factors affecting confidence about the data?

To improve performance if quality is poor

– Do something different if quality is poor
  - Retake image
  - Take additional image (quantity vs quality)
  - Remedial correction of specific problems (e.g. pose correction)
  - Use different algorithm

How are quality scores used? (2)

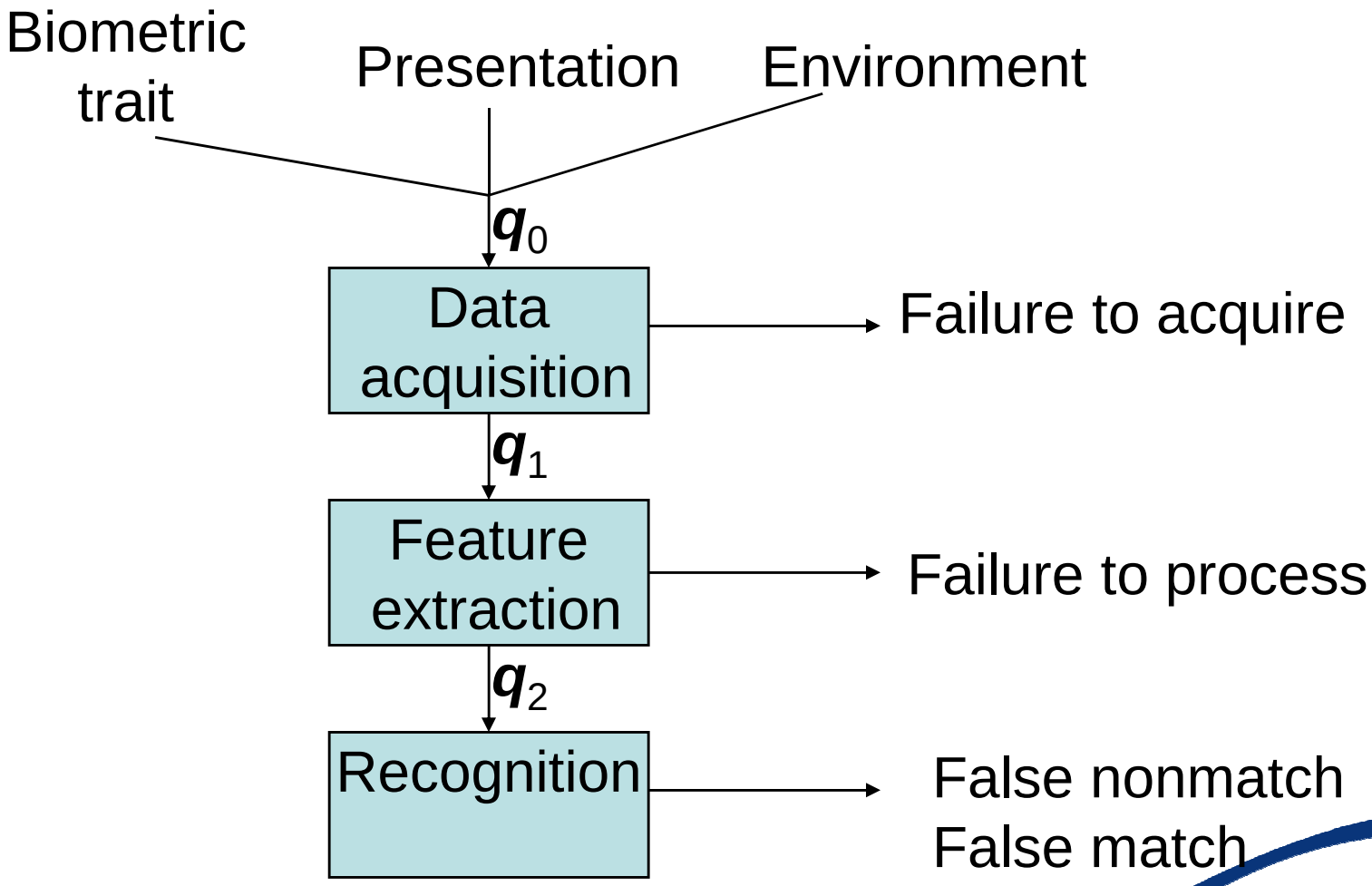
Aspects internal to algorithm

- Selection of which data to use
  - Highest quality fingerprint minutiae
  - Most feature rich portion of the image
- Quality directed fusion of multiple biometrics

Measurement of components / process

- Quality of output against quality of inputs
- Performance monitoring
- Specification of the interfaces
  - E.g. between acquisition system and matching system

Different quality at different stages of biometric recognition process



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Quality factors

Imaging properties

- Optical
  - Focus / spatial resolution / contrast / sharpness / …
- Digital
  - Format / compression / SNR / …

Presentation properties

- Occlusion / Accessories (e.g. spectacles)
- Positioning / pose angle
- Spoof attempts?

Environment properties

- Illumination / background / reflections
- Temperature / humidity

Character of biometric trait

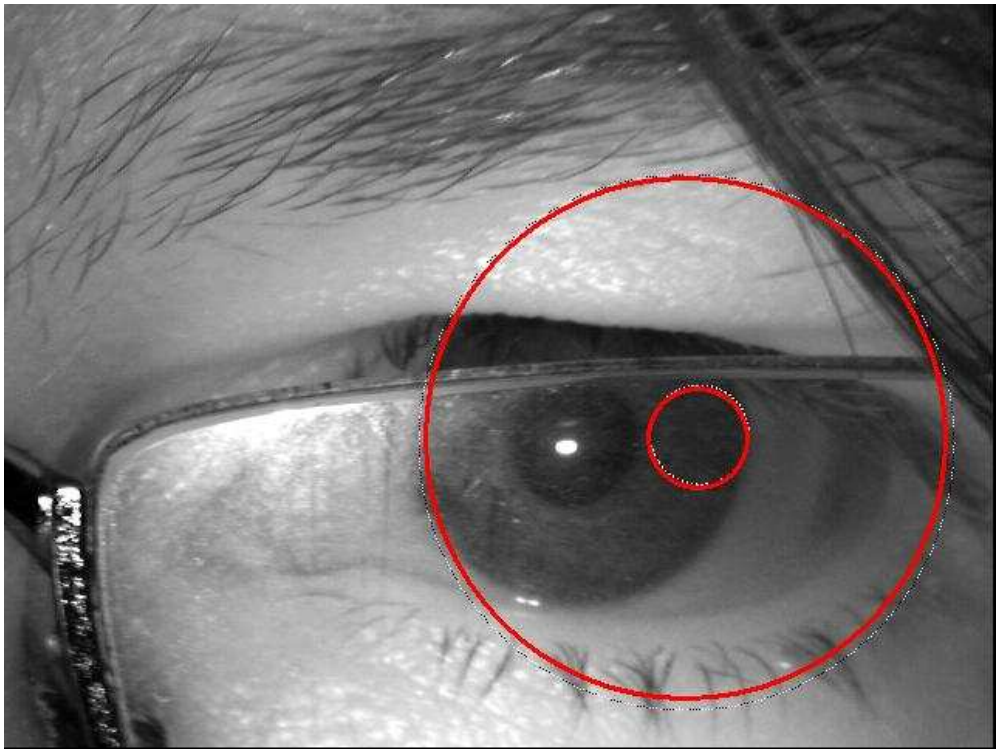
- Feature richness / e.g.number of minutiae
- Missing / Outliers affecting algorithms / e.g. mis-shapen pupil
- Difference in nature of the trait (e.g. scar tissue rather than friction ridges)
- Ageing?

NB – some properties might be measured other than by analysing image

Quality factors for segmentation differ from those for comparison

E.g. If segmentation fails then

- many of the measures contributing to quality score are incorrect
- E.g. % iris visible
  iris area
  texture energy



E.g. “faceness” measure for facial recognition

- about ease of segmentation
- rather than uniqueness of facial features

Quality scores should be "Actionable"

What is the best course of action if quality is poor?

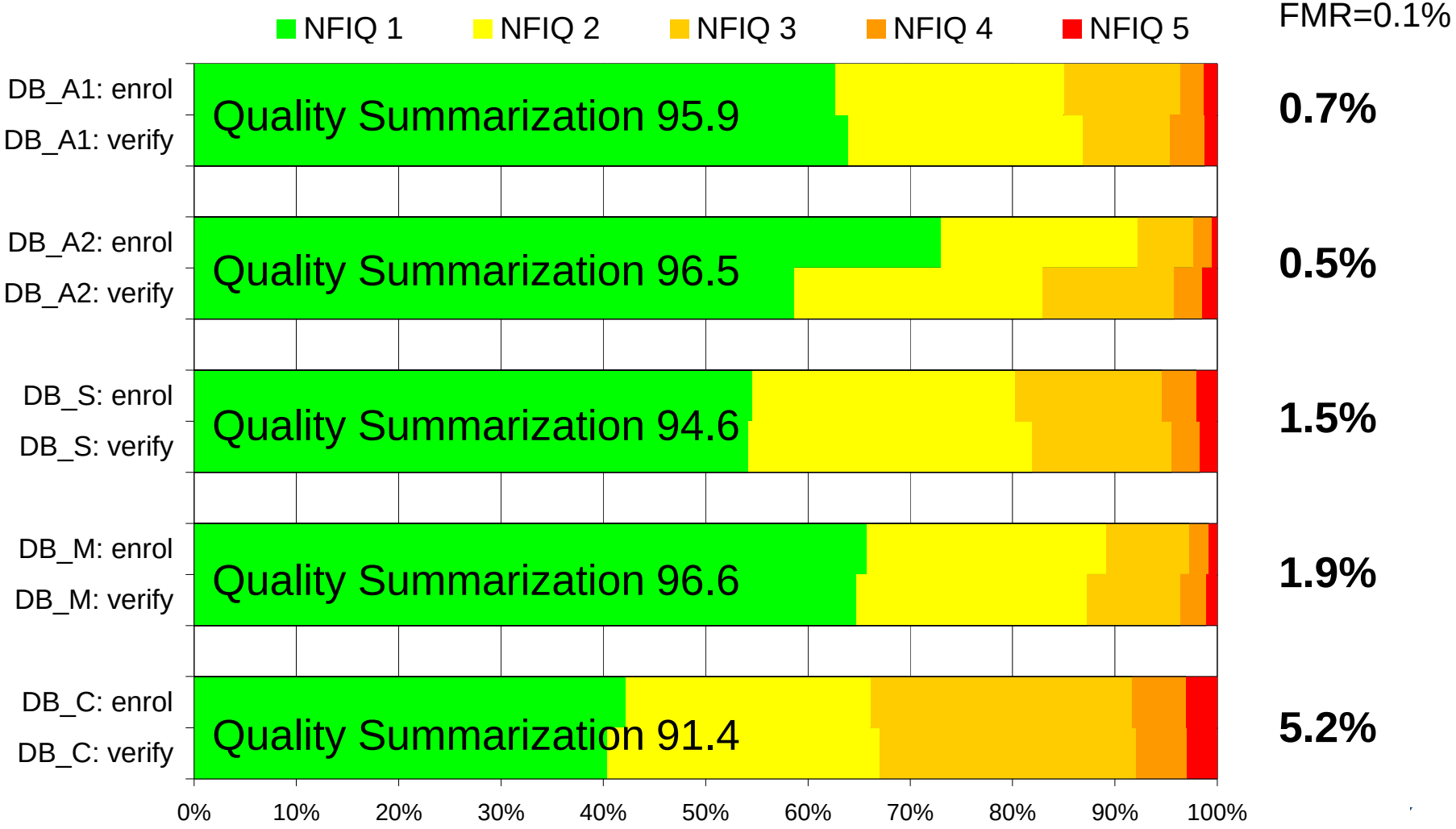
- Retake image?
- Process with a different algorithm?
- Collect additional images?

Need to know reasons for poor quality

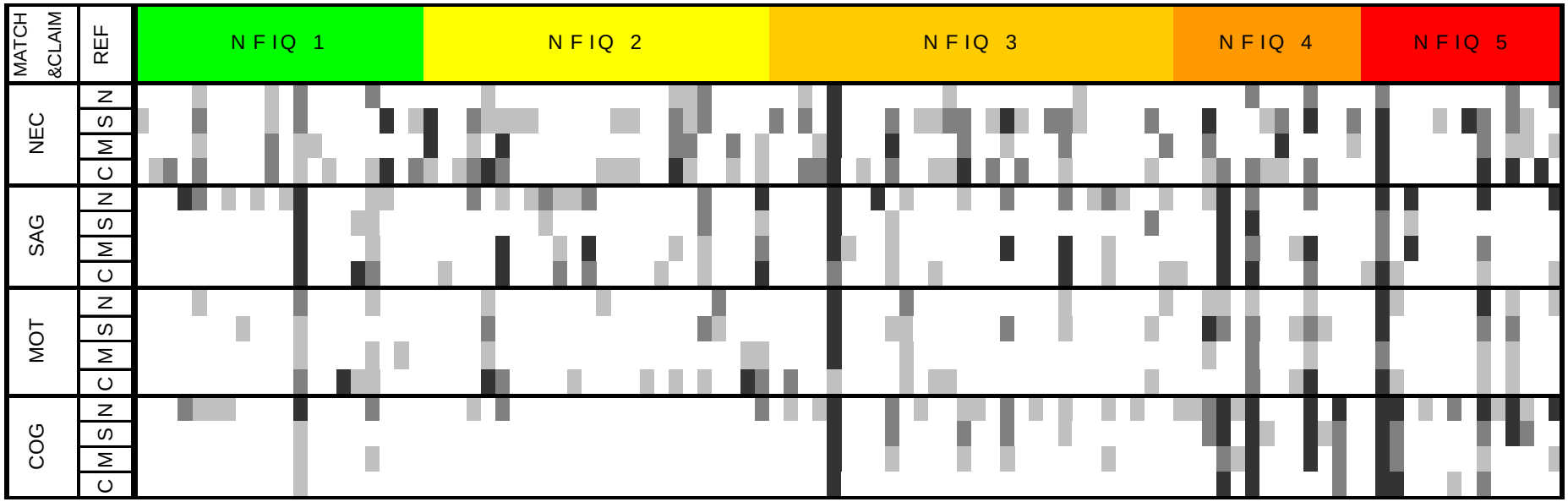
- Subject's presentation
  - (instruct and retake)
- Poor environment
  - (adjust and retake)
- Optical / digital properties of image
  - (invest in new hardware/software?)
- Character of the underlying biometric trait
  - (collect further instance / process with different algorithm)

Image-based quality scores don't fully predict performance

– Eg performance of proprietary algorithms on databases from MTIT project



Single quality score cannot be both universal & optimal for all algorithms



Example: 16 algorithm combinations from MTIT project
Distribution of false non-match cases by NFIQ scores

– False non-matches most correlated with high NFIQ for the Matcher C

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Quality scores should encourage algorithm & image improvement

Performance-based quality score:

- Good quality is that which delivers good performance on a set of algorithms
- Quality properties that don't improve performance on current algorithms have no value

But …

- Current algorithms generally tuned to give best performance on current image qualities
- Performance-based quality scores undervalue quality properties better than those off the datasets used to tune current algorithms

Proposed Approach

Use a vector of quality scores

- Each score focussed on identified quality factors
- Industry / standards bodies decide which are the key factors for any technology

Calibration of quality scores

- Two stage process
- Calibration of methods to measure the known quality factors
  - Can use reference data exhibiting the range of factors
- Calibration of a performance predictor (for matching / segmentation / (set of) algorithms
  - Reference data should be typical of applications in mind

Conclusions

- Quality scores used in a multiplicity of ways
- A scalar valued quality score is not optimal for
  - different uses
  - different algorithms
  - technical progress
- Proposal
  - Vector of quality scores
  - Separate consideration of quality factors
    - Imaging, presentation, environment, character of biometric trait
  - Calibrate production of quality vector against reference datasets
  - Calibrate performance prediction for specific application using representative data