

# Zen and the Art of Facial Image Quality

**Terry P. Riopka**



# Overview

What is Quality? – Definition(s), Utility and Relevance to Biometrics

What is Image Quality?

Biometric Matching: Face vs. Fingerprints

Measuring “Facial” Image Quality

Recommendations

# What is Quality?

**Merriam-Webster:** a degree or grade of excellence or worth

**Philip Crosby:** conformance to requirements

**ISO 9000:** degree to which a set of inherent characteristics fulfills requirements

# What is Quality?

**Merriam-Webster:** a degree or grade of **excellence** or **worth**

**Philip Crosby:** conformance to **requirements**

**ISO 9000:** degree to which a set of inherent characteristics fulfills **requirements**

- ultimately undefinable - value judgement that emerges from the relationship between observer and the object being observed
- *can be* definable in the proper context

# What is Image Quality?

Humans evolved to make use of image data for daily living

- as a stimulus for behavioral responses
- as input data for generating conceptual representations

→ our perception of the world is less complete and continuous than we think and our awareness based on more *a priori* information than is obvious to us

Subjectivity of term “quality” is problematic for image analysis

- ambiguous performance criteria are the gremlins of image analysis
- usually manifest themselves in unpredictable or unintended behavior

Meaning of the term ultimately depends on the application – how is it used and for what purpose?

- motivation for NFIQ – reasonable...for fingerprints

# Biometric Matching: Face vs. Fingerprints

## Step 1: Image Acquisition



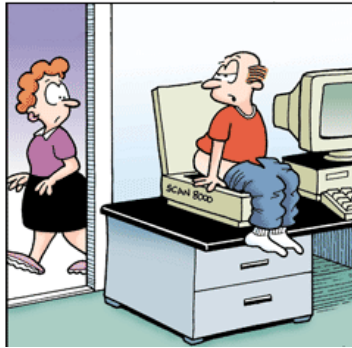
- definition of “face” has been extended (inadvertently) to include many different instantiations of human face appearances
- perception is that quality analysis, face recognition should be possible to some degree



- a quality metric for “facial” images (above) might be expected and desired, but not for a comparable variation in finger images – we don’t even try to classify these types of finger images

# Biometric Matching: Face vs. Fingerprints

- by definition, a fingerprint is an impression made by direct contact of the finger with a solid surface



- ~~unknown scale~~
- ~~unknown illumination~~
- ~~unknown focus~~
- ~~unknown age~~
- noise
- ~~resolution~~
- unknown pose
- unknown deformation
- occlusion

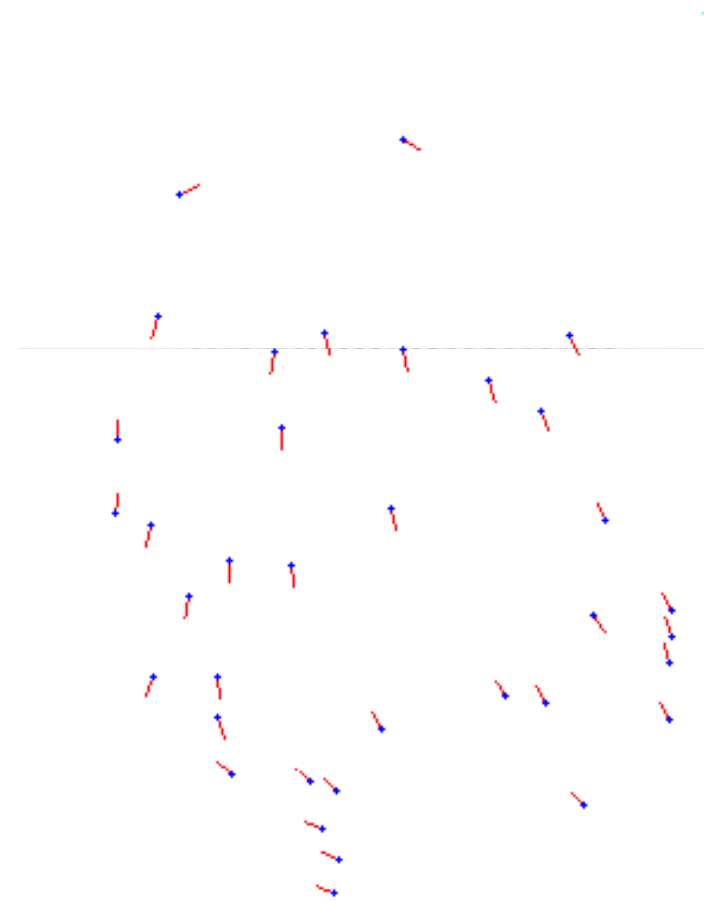


- context of fingerprint quality much more constrained
- multiple, relatively robust, relatively stable features for matching – very unlike face images

# Biometric Matching: Fingerprints

## Step 2: Feature Extraction/Template Generation

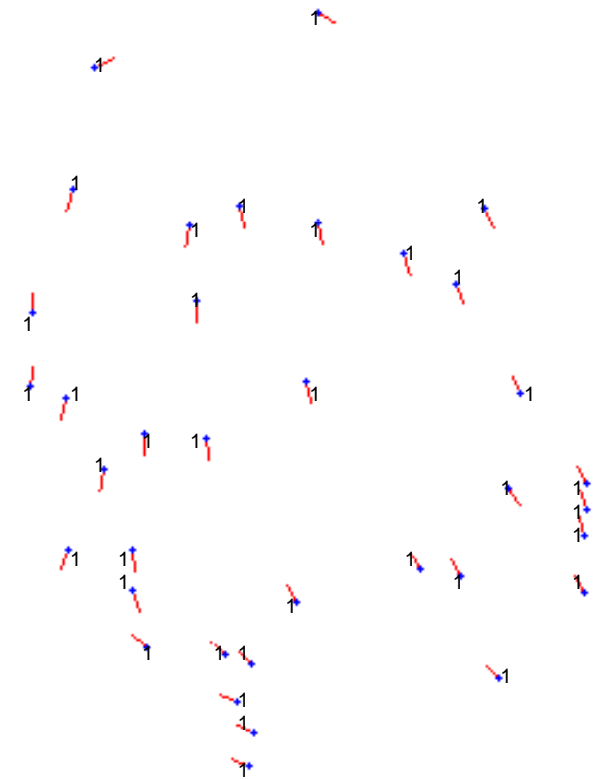
- minutiae extraction
- template generation





# Biometric Matching: Fingerprints

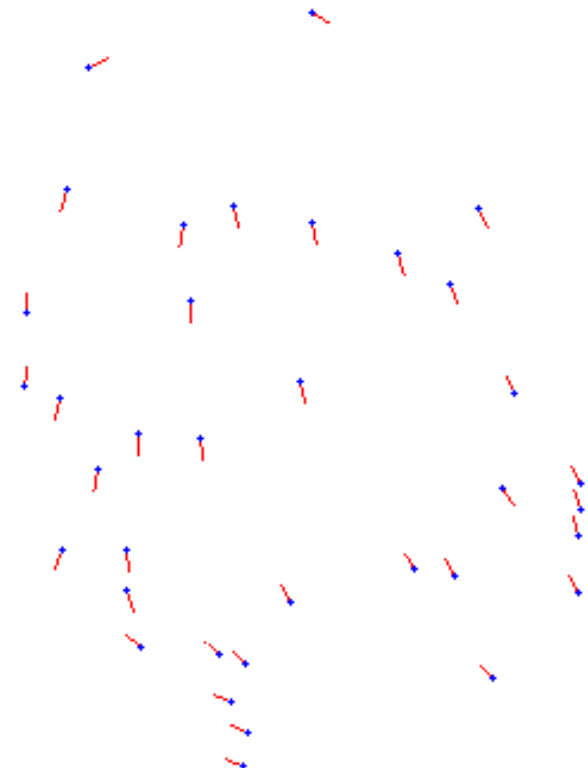
**Step 2:** Feature Extraction/Template Generation



# Biometric Matching: Fingerprints

## Step 2: Feature Extraction/Template Generation

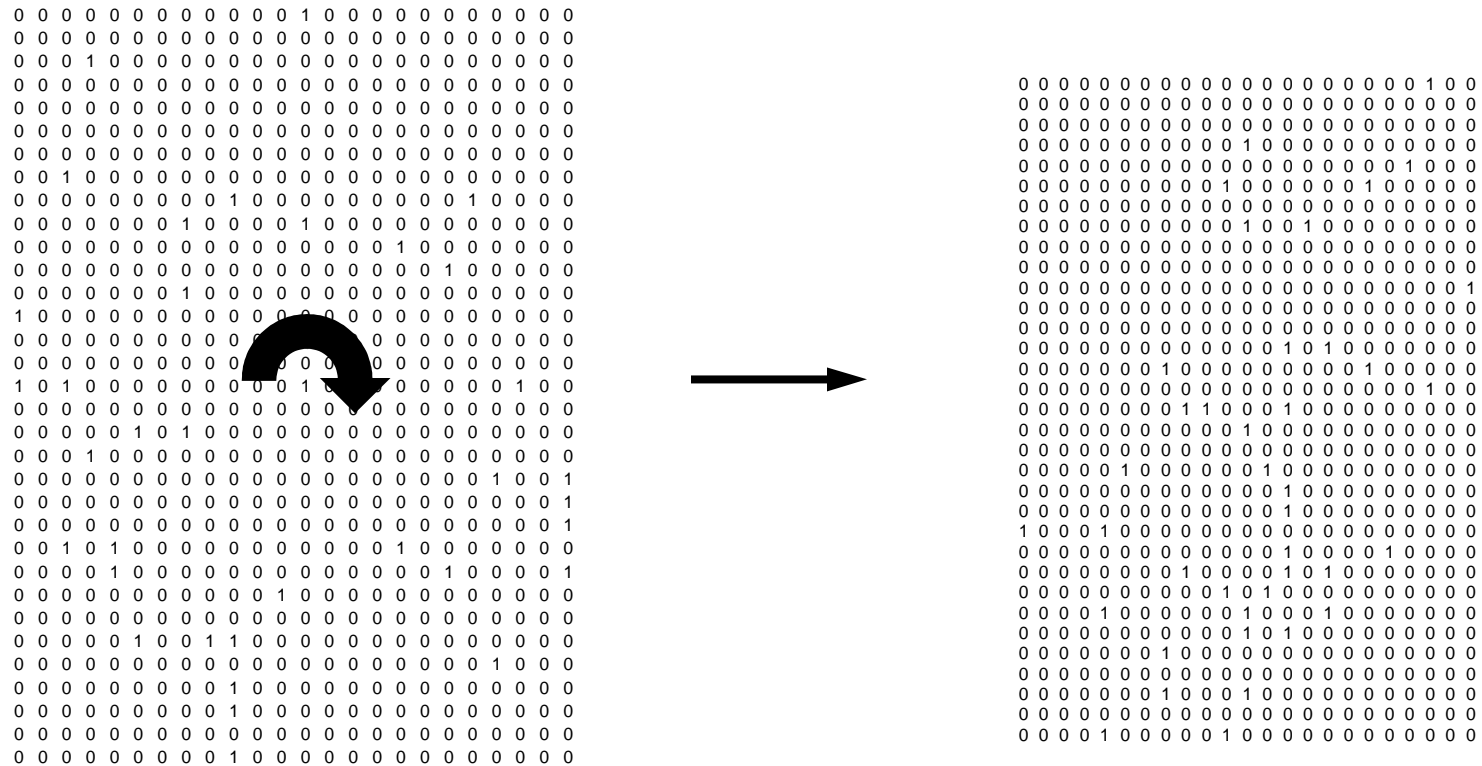
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0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```



# Biometric Matching: Fingerprints

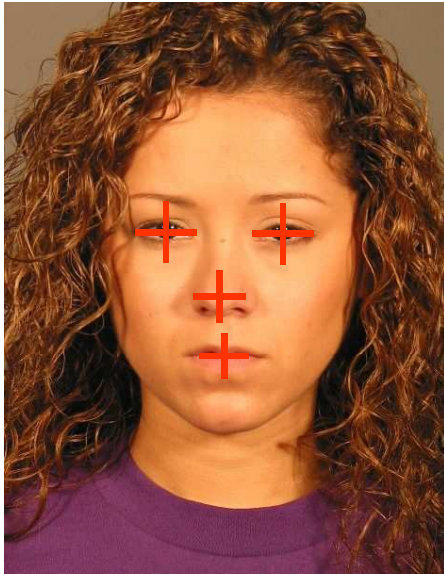
## Step 2: Feature Extraction/Template Generation

- rotate and apply “convolution” kernel to unknown images
- magnitude of maximum response determines match



# Biometric Matching: Face

Fingerprints: multiple, relatively robust, relatively stable features for matching



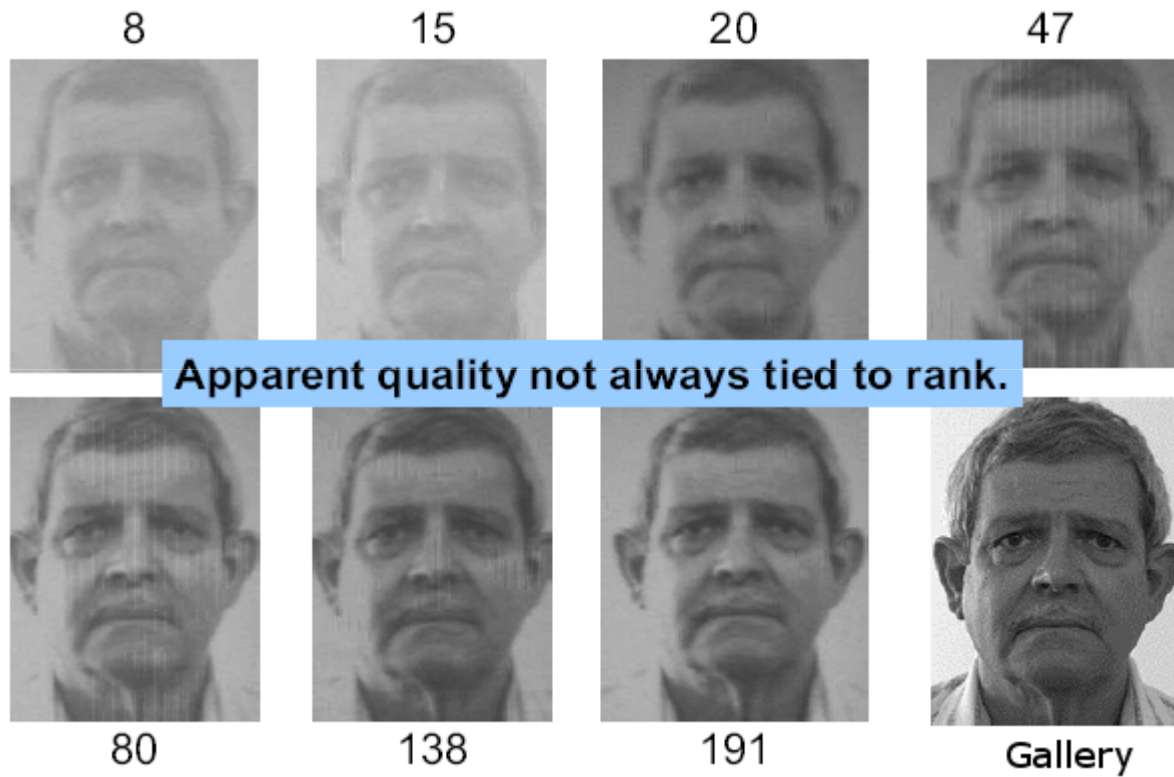
Face:

- no agreed-upon common feature set for “face” images
- maximum of 3 or 4 consistently reproducible features
- eye location is often critical – perturbation studies with various face recognition algorithms have shown a high sensitivity to eye location (Riopka & Boulton, ACM Bioometrics Workshop 2003) – c.f. minutiae

Image Quality: needs to be indicative of how consistent and complete feature extraction is *likely to be* for a given image and identity

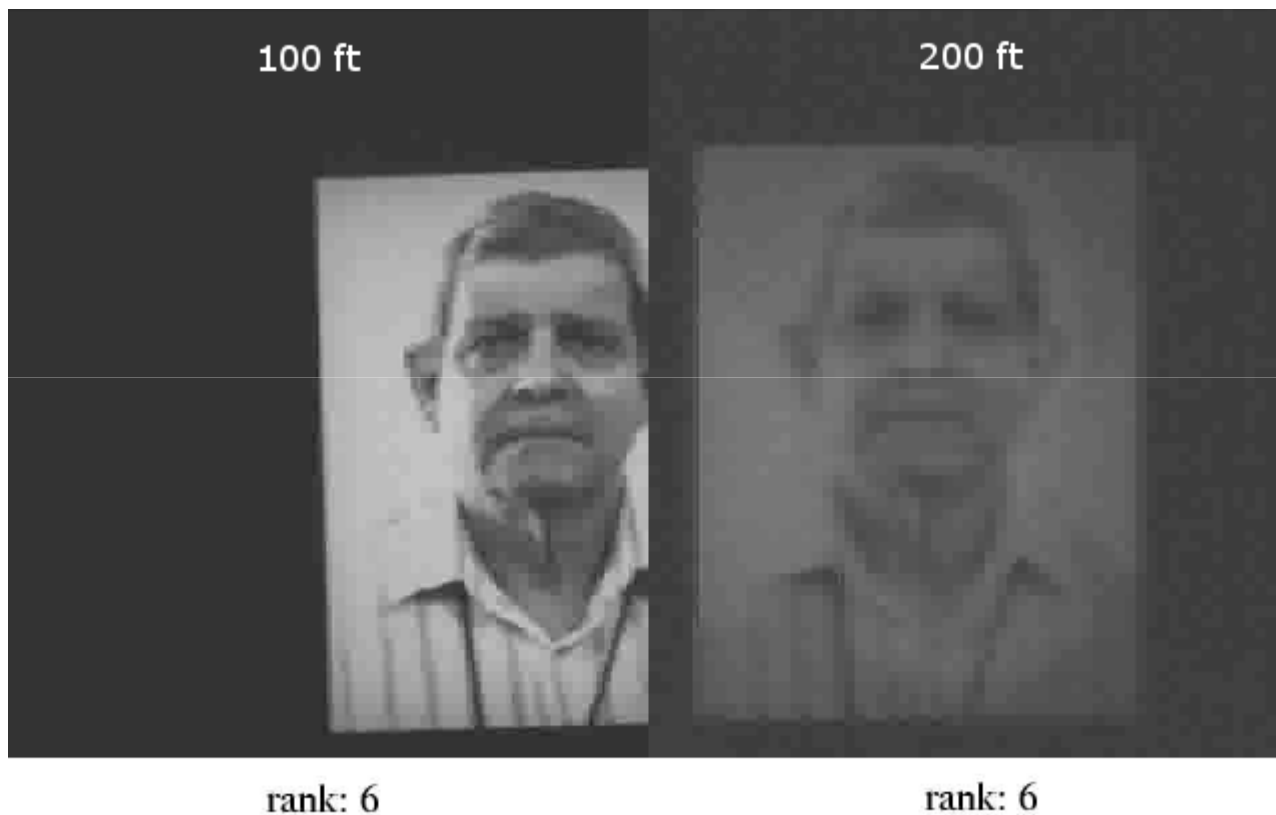
- for fingerprints, correlation between this criterion and matching performance is high, enabling NFIQ approach to work
- problem is no one has come up with a facial image representation (yet?) based on external visual appearance that has the same kind of robustness

# Apparent Facial Quality vs. Matcher Performance



T. Boult – Beyond Image Quality, 2006

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# Measuring Facial Image Quality

**Pre-analysis:** can be used as feedback to a system that tries to maximize the **possibility** of accurate biometric measurement

- minimize the variance of non-biometric elements
- e.g. filter facial images for “faceprints” – based on high level object detection and enforcements of specified constraints

➤ constrain the class of images to be considered for quality measurement

**Analysis:** can be used to guide image processing and analysis algorithms

- facial dynamic range, brightness, contrast, color balance, focus, facial texture detail, etc.

**Post-analysis:** can be used to temper the confidence of an identification or its contribution to a multi-biometric system

- matcher-agnostic approach: predicting failure for a given input image by analyzing similarity score distributions (see Riopka & Boulton, AVBPA 2005)

# Thank you!

Terry P. Riopka  
Director of Algorithm Development  
Aware, Inc.  
40 Middlesex Turnpike  
Bedford, MA 01730  
781.687.0473  
triopka@aware.com

