Cognitec

The face recognition company

Some quality measures for face images and their relationship to recognition performance

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Contents

- Terms and definitions
- Some sample properties of face images
- Relationship to recognition performance
- Some final thoughts

Terms and Definitions

- **Sample property**: any property of a biometric sample, possibly affecting quality
- Two aspects of sample property:
  - **Character**: features of the sample source (e.g. pose, expression)
  - **Fidelity**: accuracy with that the sample represents its source (e.g. sharpness, resolution)
- **Utility** of a sample: Impact on performance of a biometric system; function of character and fidelity
- **Quality score**: value indicating utility

Some Sample Properties

Sample properties found to have considerable influence on the performance of Cognitec's latest face recognition engine:

- Sharpness
- Openness of eyes
- Deviation from frontal pose (here, frontal means: within 5 degrees yaw and pitch angle)
- Wearing of glasses

Sharpness

F: face section of image sample

F': result of applying 3x3 mean filter to **F**

D = abs(**F** – **F'**)

Sharpness: average pixel value over image **D**

Well-focused images get high sharpness values, blurred images low ones

Character Properties

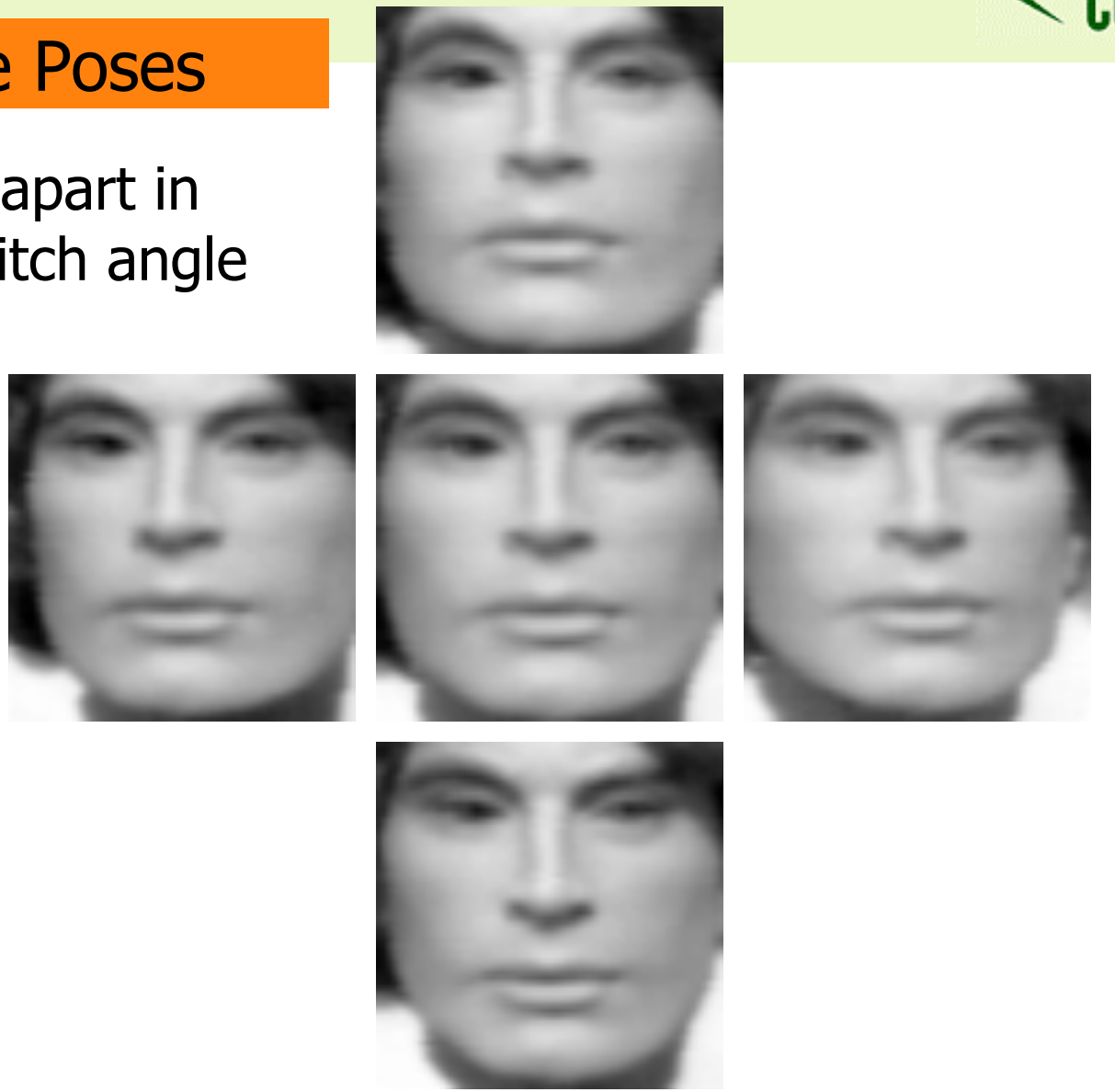
Other three sample properties (openness of eyes, deviation from frontal pose, wearing of glasses) are determined as follows:

- Apply wavelet transform to relevant portion of face image
- To result, apply support vector machine trained on labeled image samples

Note: The properties are defined through that process; the values assigned to a sample can be counterintuitive

Sample Poses

6 degrees apart in yaw and pitch angle



Test Databases

Two databases for investigating relationship between the four sample properties and the performance of Cognitec's recognition engine:

- ~10,000 still images from Face Recognition Grand Challenge (FRGC) data, controlled and uncontrolled
- Yale Face Database B (~5,700 images)
  (see A. S. Gheorgiades, P. N. Belhumeur, D. J. Kriegman: "From Few To Many: Generative Models for Recognition under Variable Pose and Illumination", IEEE Int. Conf. on Automatic Face and Gesture Recognition, 2000)

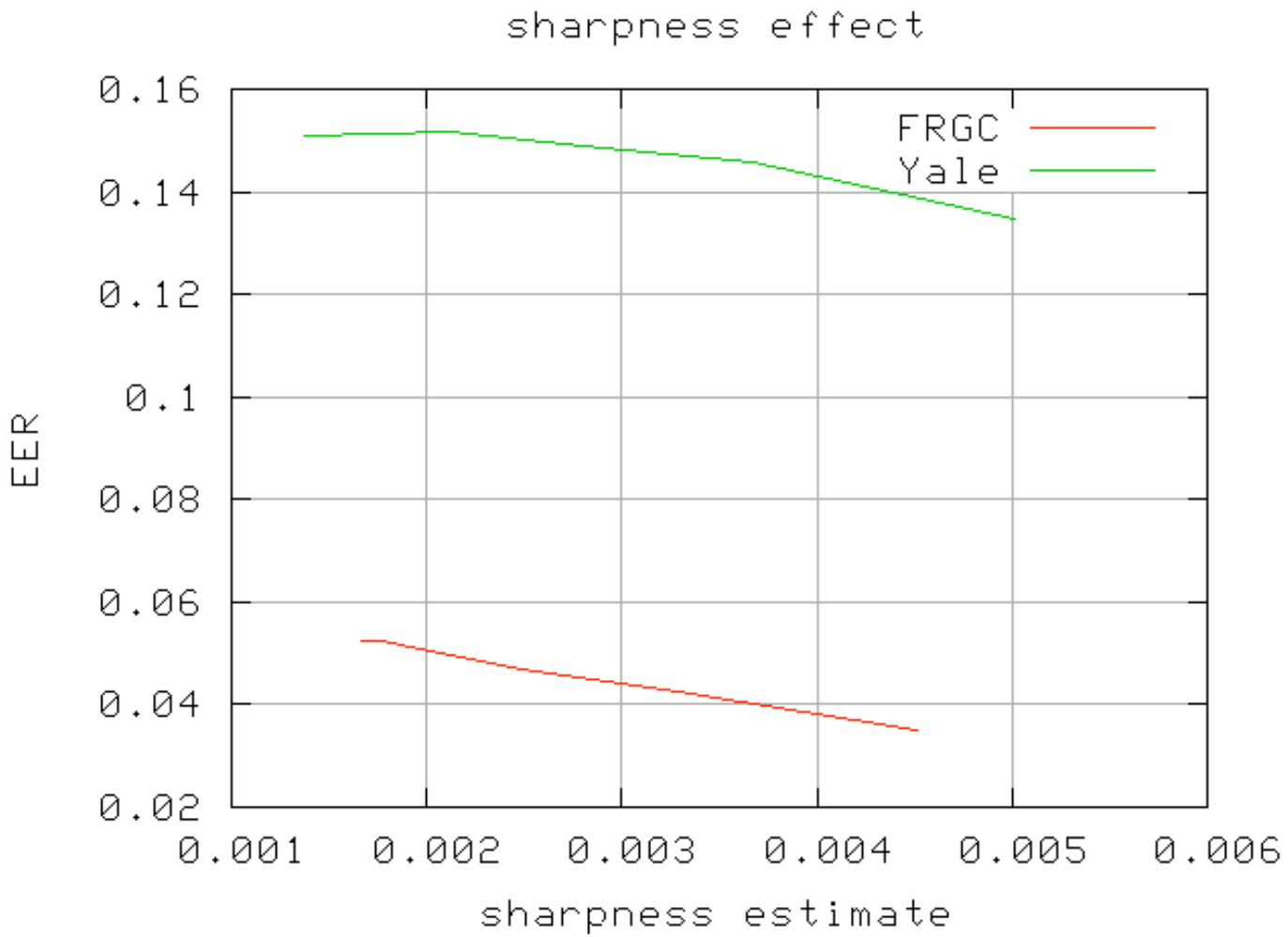
Some Examples from Yale DB



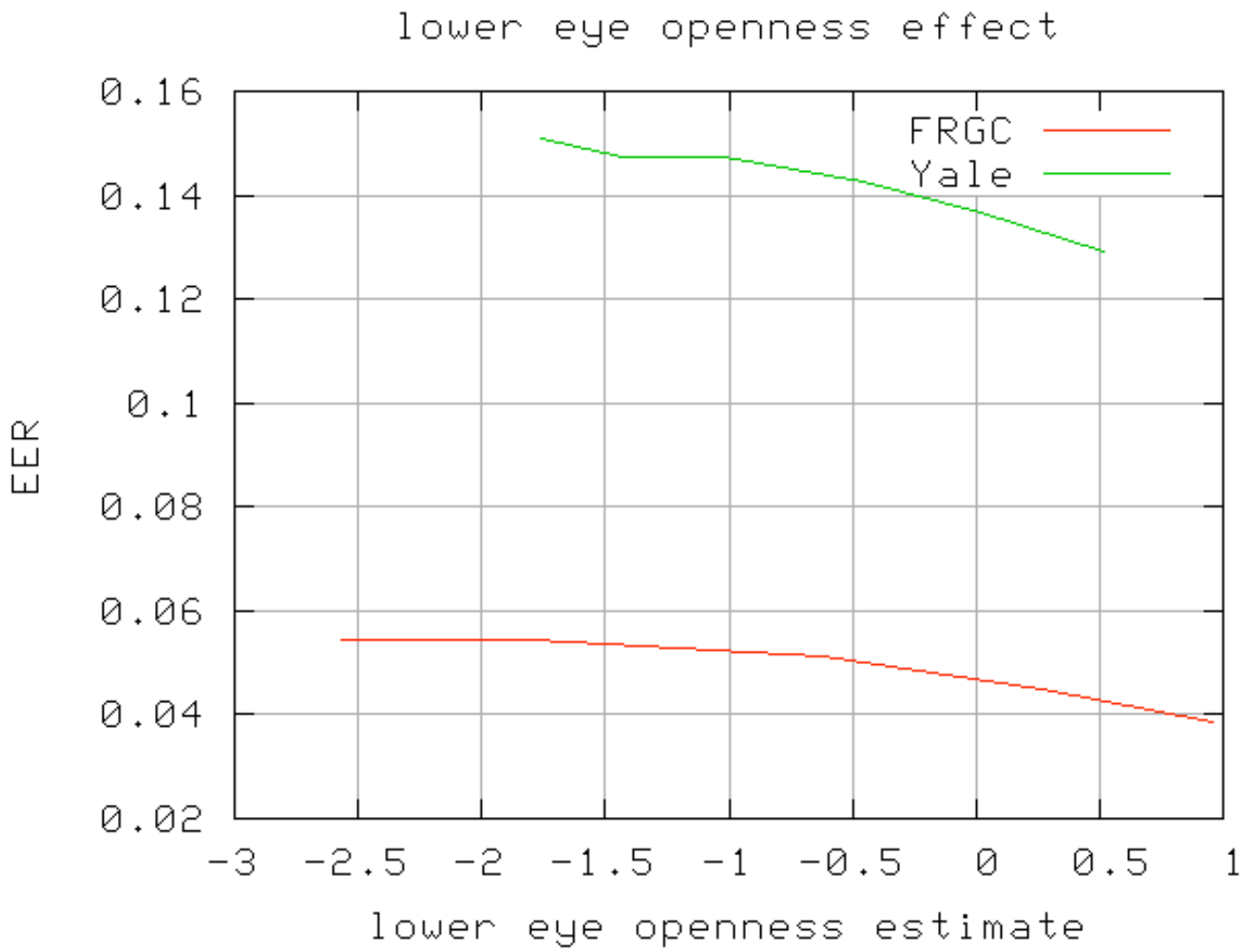
Relationship to Performance

- Qualitative effect of sample properties is known from earlier tests (e.g. higher deviation from frontal pose leads to lower performance)
- For each test DB and each property, determine fractions having the "worst" values; here fractions of sizes 0.5%, 1%, 2%, 5%, 10%, 20% of the DB size are used
- For each fraction, compute the EERs from the full similarity matrix after eliminating the fraction from the image set

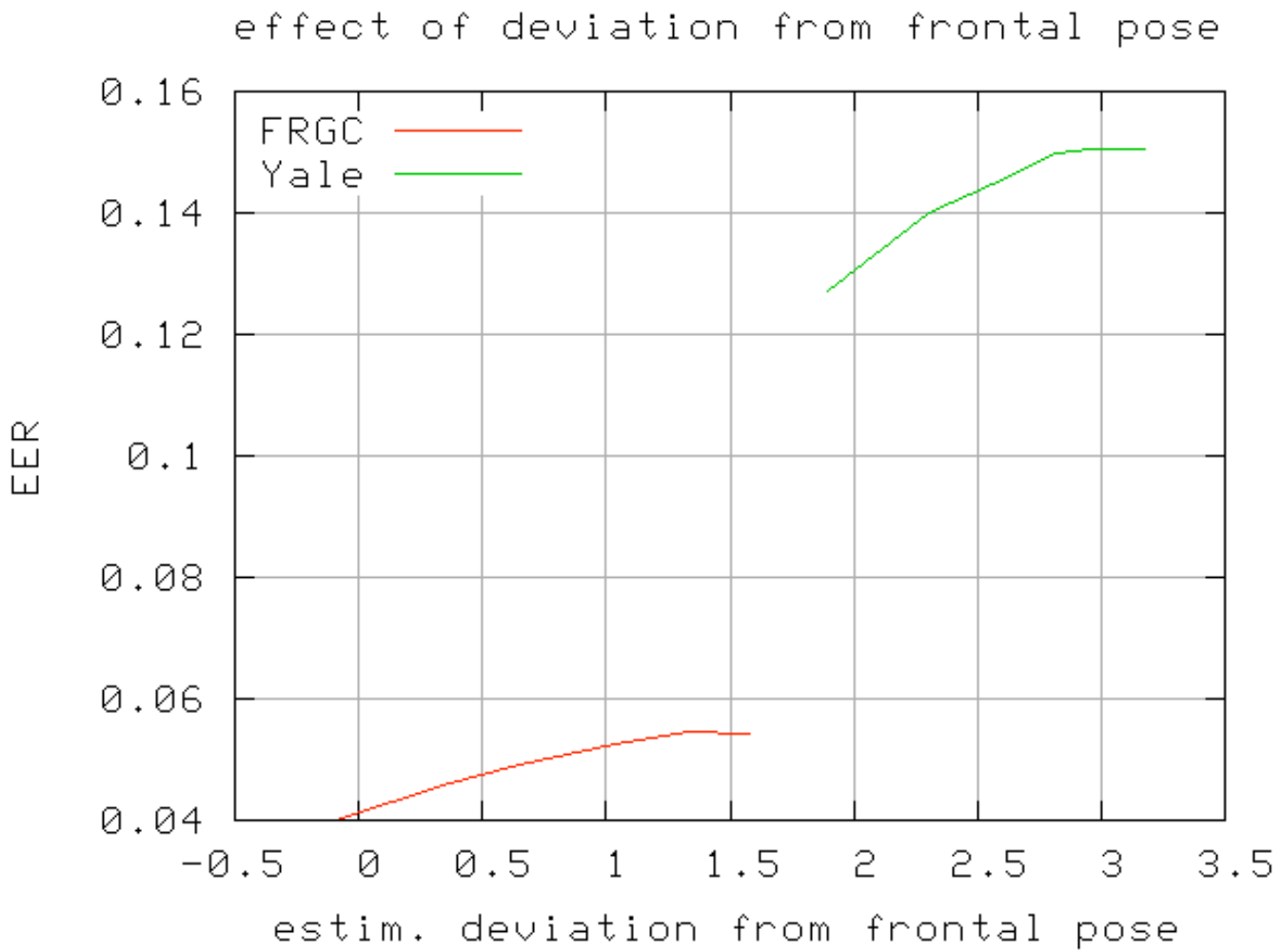
Effect of Sharpness Property



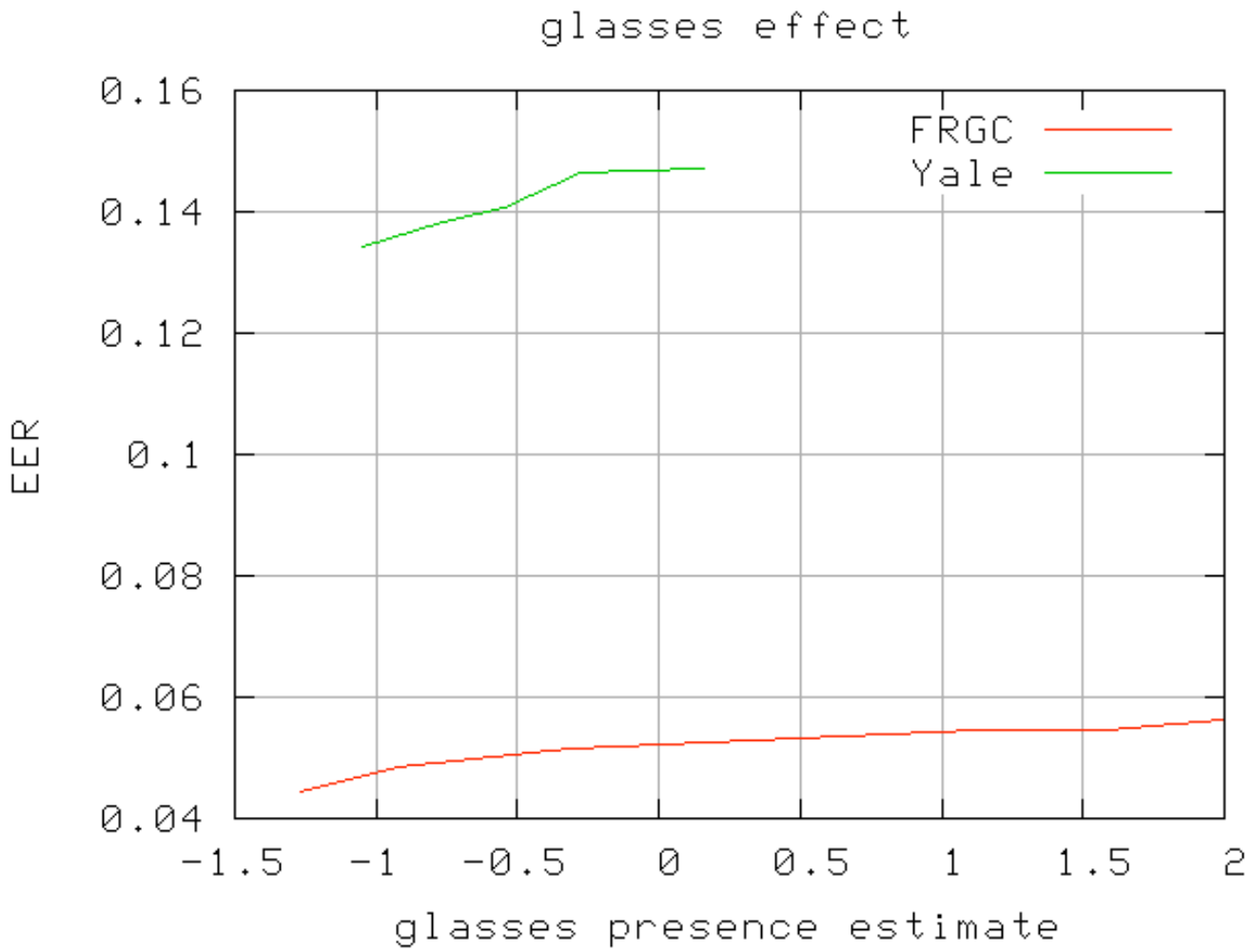
Effect of Eye Openness Property



Effect of Nonfrontalness of Pose



Effect of Glasses Property



Completing the Analysis

- For each sample property, extend the range of values under consideration, by eliminating larger image sets
- Separate the effects of individual sample properties by constructing image sets in that all but one property are at approximately the same level
- Investigate potential interactions between properties
- Formulate mapping from sample property tuples to quality score
- Test effectiveness of quality score on independent database (compare subsets elimination based on quality score with random eliminations)

Some Final Thoughts

- Properties p1, …, pn, samples S1, S2:
  Q(p1(S1), …, pn(S1), p1(S2), …, pn(S2))
  = performance indicator
- Define levels for each property, partition gallery into subsets belonging to different level combinations; compute performance of complete probe set against each subset -> interactions can be found more easily
- Use complete genuine and impostor distribution as performance indicator -> provides better handle to put match score into perspective