Face & Ocular ChallengeS

(FOCS)

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NIST

Collaborators

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MBE 2010 Still Face

Problem Definition

- Frontal Faces
- One Face Image per Person

Problem 1: Controlled Studio Environment

Problem 2: Studio vs. Ambient Lighting

or

Technology Progress

1996 FERET

2000 Facial Recognition Vendor Test 2000

2002 FACE RECOGNITION VENDOR TEST 2002

2003 GAIT

2003 FRGC

2005 ICE 2005 IRIS CHALLENGE EVALUATION

2006 FACE RECOGNITION VENDOR TEST 2006

2006 ICE 2006 IRIS CHALLENGE EVALUATION

2009 MBGC

2010 MBE 2010

Development

1993

2010

- 17 Years
- 8 Evaluations
- 5 Challenge Problems (Technology Development)
- 3 Biometrics
- 150,000+ Face and Iris Images

NIST

Goals of MBE 2010 Still Face Track

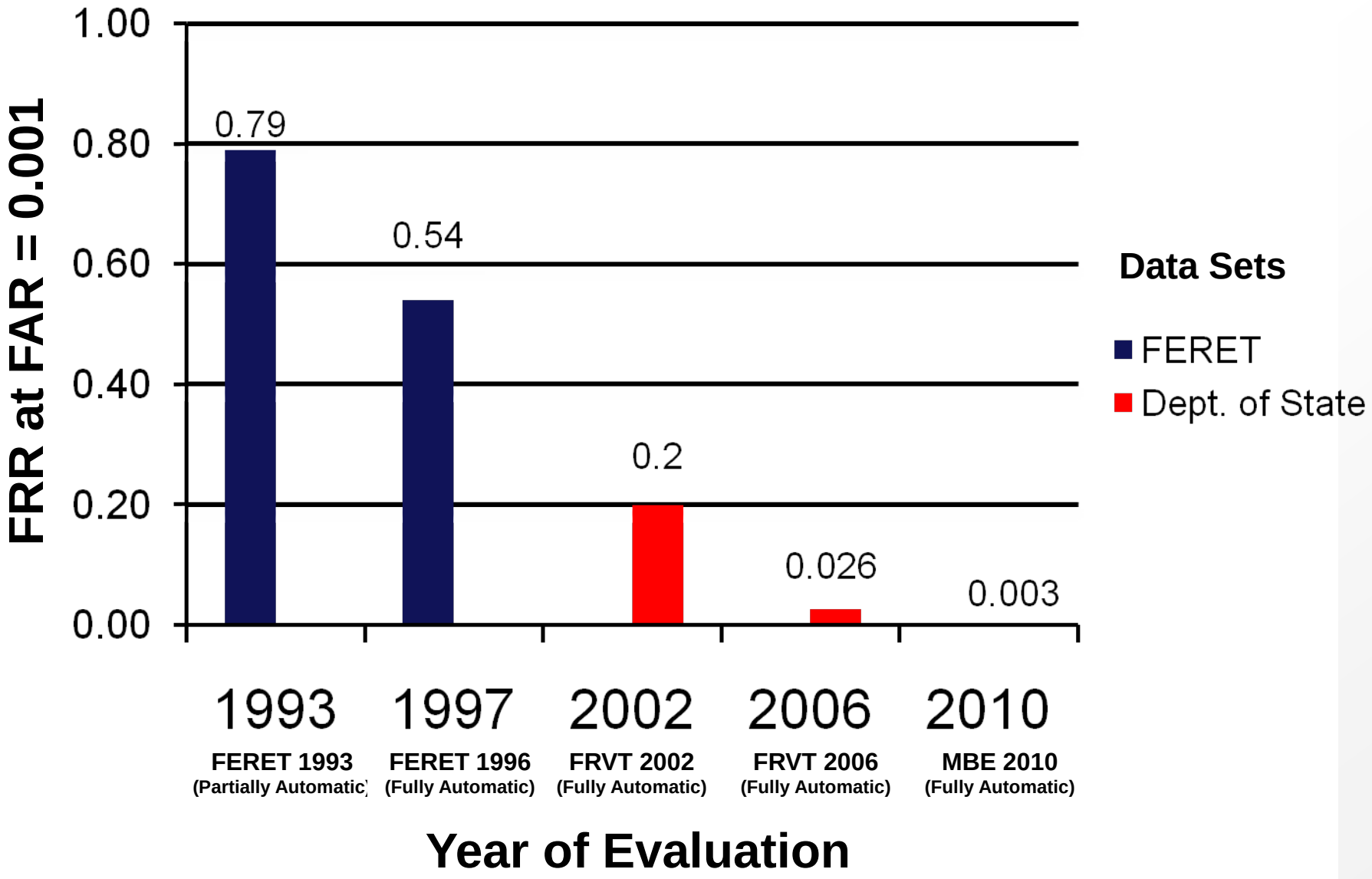
- Evaluation period: Jan – May 2010
  - Measure progress since FRVT 2006
  - Leverage massive operational data corpora.
  - To evaluate face recognition technologies in a proper one-to-many identification mode.
- *Multiple Biometric Evaluation 2010: Still Face Report*, P. Grother, G. Quinn, and P. J. Phillips, NISTIR 7709, 2010, http://face.nist.gov

From FERET to MBE 2010

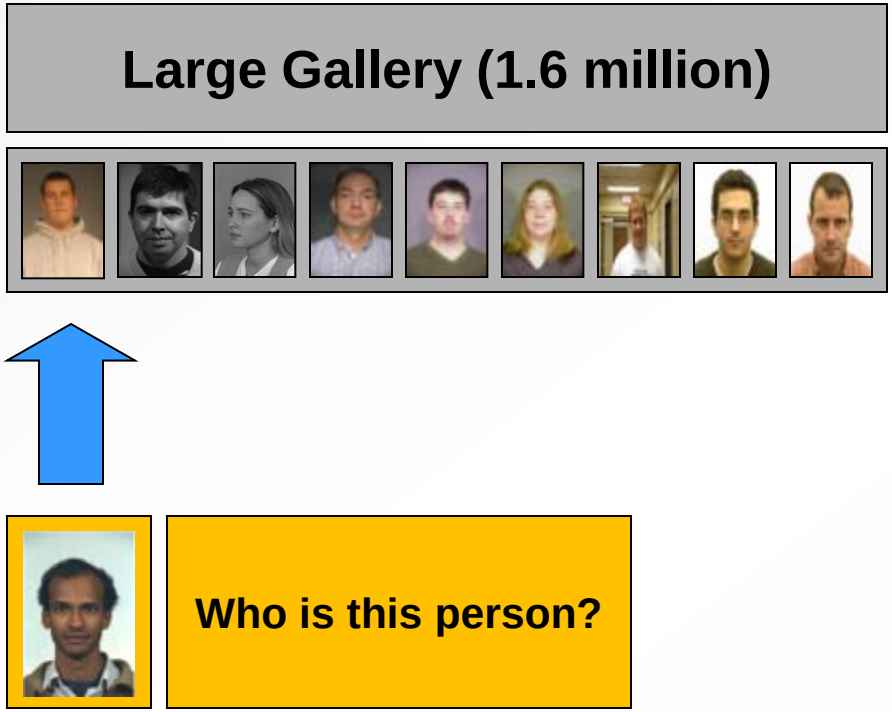
- One Face Image per Person

Problem 1: Controlled Illumination vs. Controlled Illumination

From FERET to MBE 2010

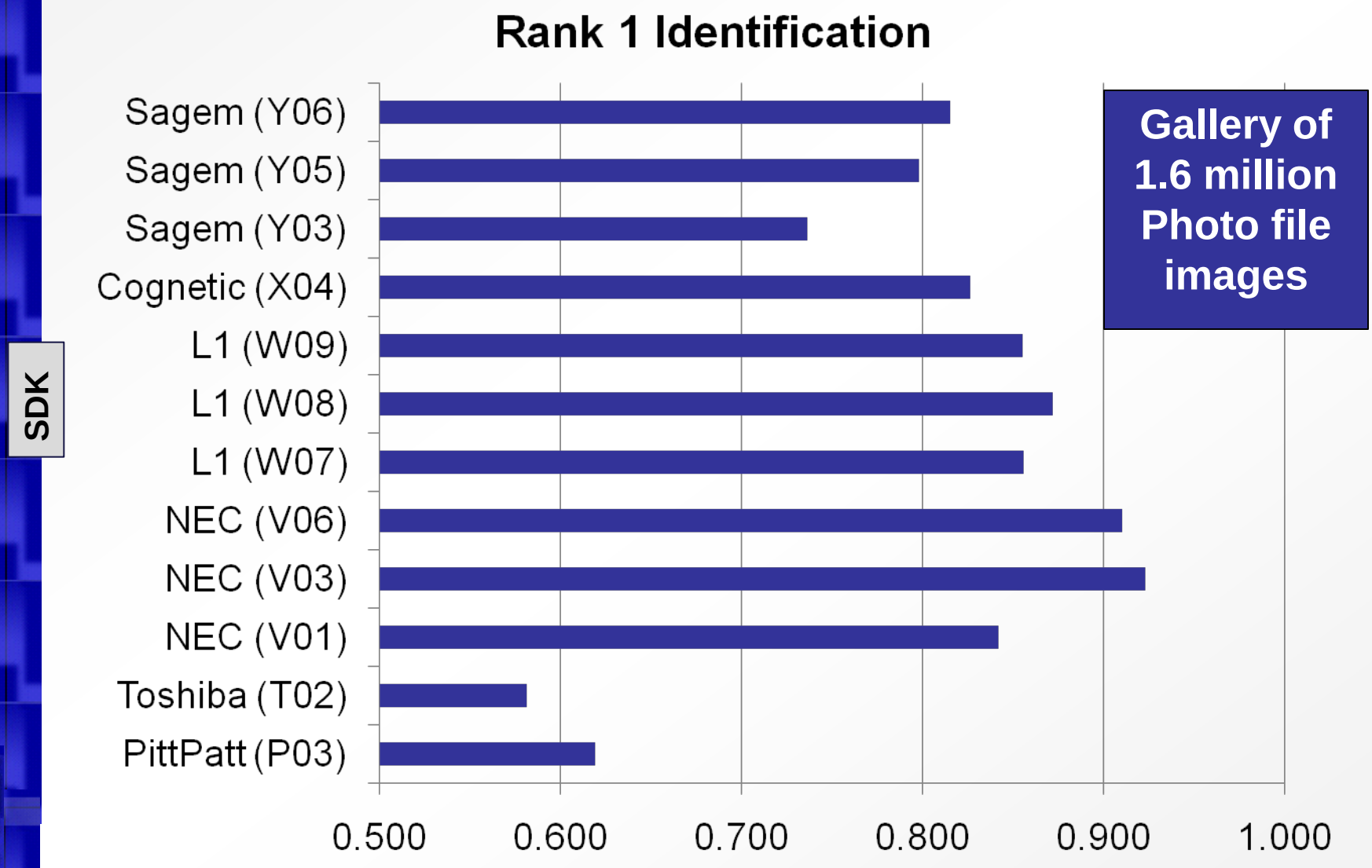


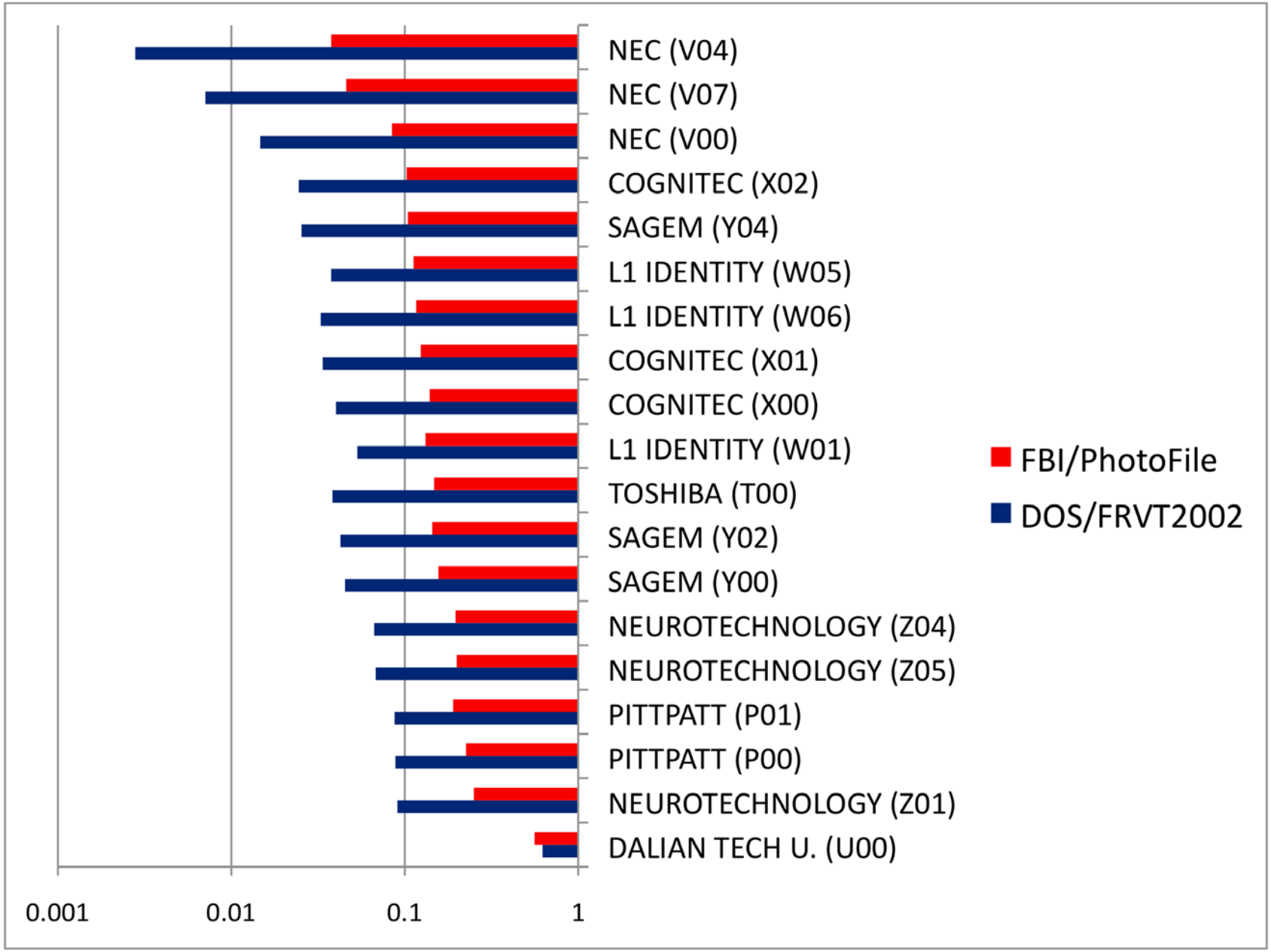
Closed-set Identification



- All probes in gallery
- Score: Rank 1 Identification
- Selectivity: Number of average matches returned

Closed-set Identification





SDK

False Reject Rate at False Alarm Rate = 0.001

Main Results

- Improvements in 1-1 verification
  - Three order improvement since 1993
  - FRR = 0.003 at FAR of 1 in 1,000
- Closed Set Identification
  - Gallery of 1.6 million faces
  - Rank 1 ID = .93
- Is face recognition solved?
  - Not for unconstrained environments

Face & Ocular Challenges (FOCS)

- Video
- The Good, the Bad, & the Ugly
- NIR Ocular
- Performance Prediction

Video

(MBGC ver2)

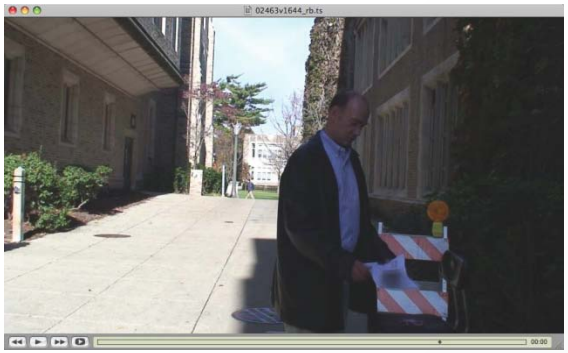
Walking vs. Activity
Activity vs. Activity

Walking

976 sequences

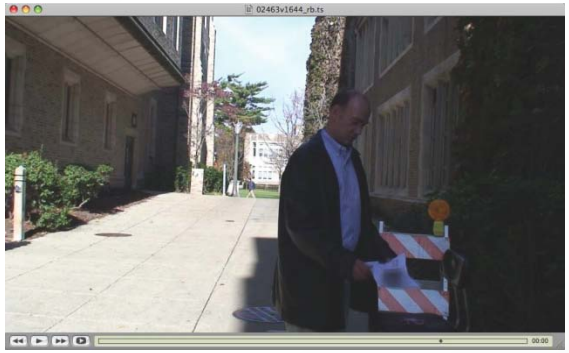
Activity

784 sequences



Activity

784 sequences



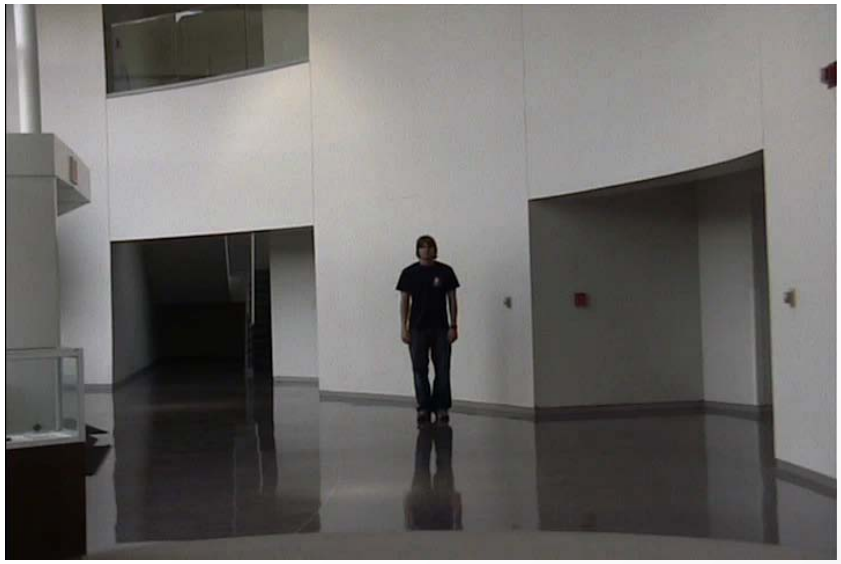
Activity

784 sequences

Human Performance on Video

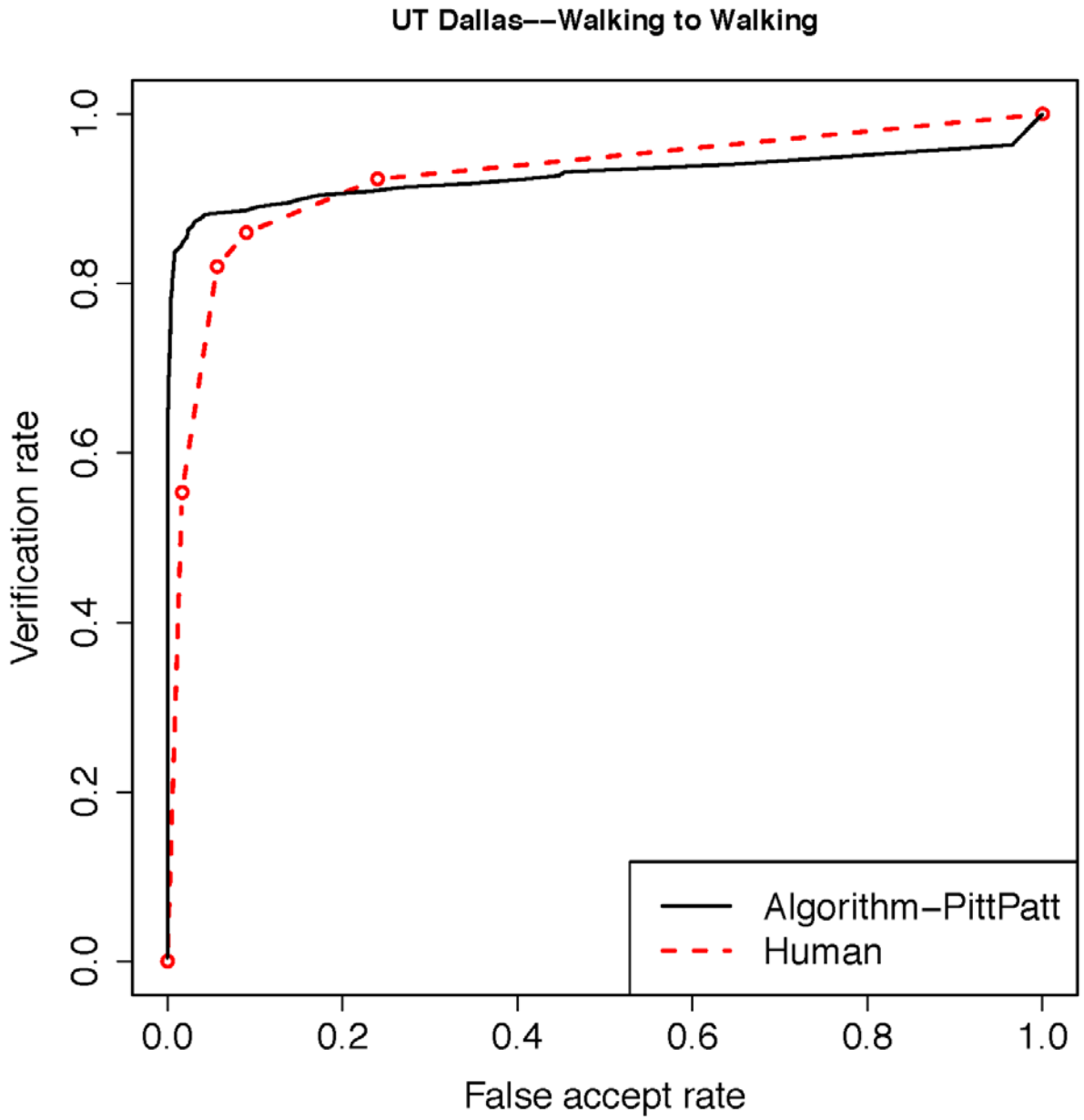
Recognizing people from dynamic and static faces and bodies: Dissecting identity with a fusion approach ," P. J. Phillips, A. J. O'Toole, S. Weimer, D. Roark, J. Ayadd, R. Barwick, J. Dunlop, Vision Research, in press, 2010.

Video: Walking vs. Walking



- **Human subject raters respond…**
  - **1. sure they are the same person**
  - **2. think they are the same person**
  - **3. not sure**
  - **4. think they are not the same person**
  - **5. sure they are not the same person**

Video: Human & Machine Performance



Video: Walking vs. Conversation

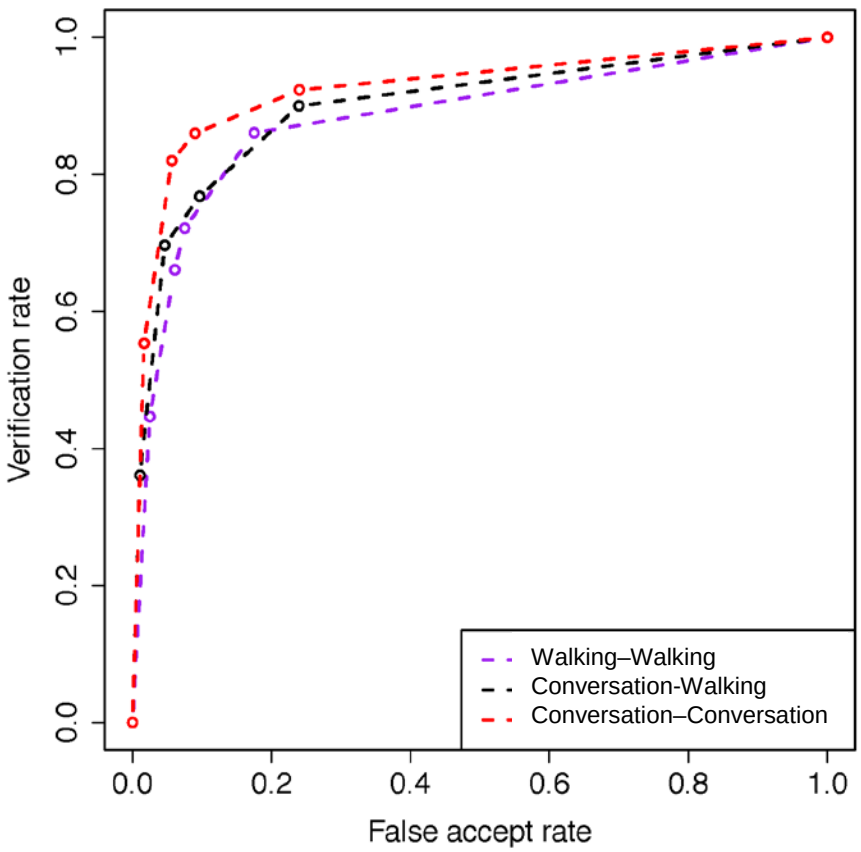
- **Human subject raters respond…**
  - **1. sure they are the same person**
  - **2. think they are the same person**
  - **3. not sure**
  - **4. think they are not the same person**
  - **5. sure they are not the same person**

Video: Conversation vs. Conversation

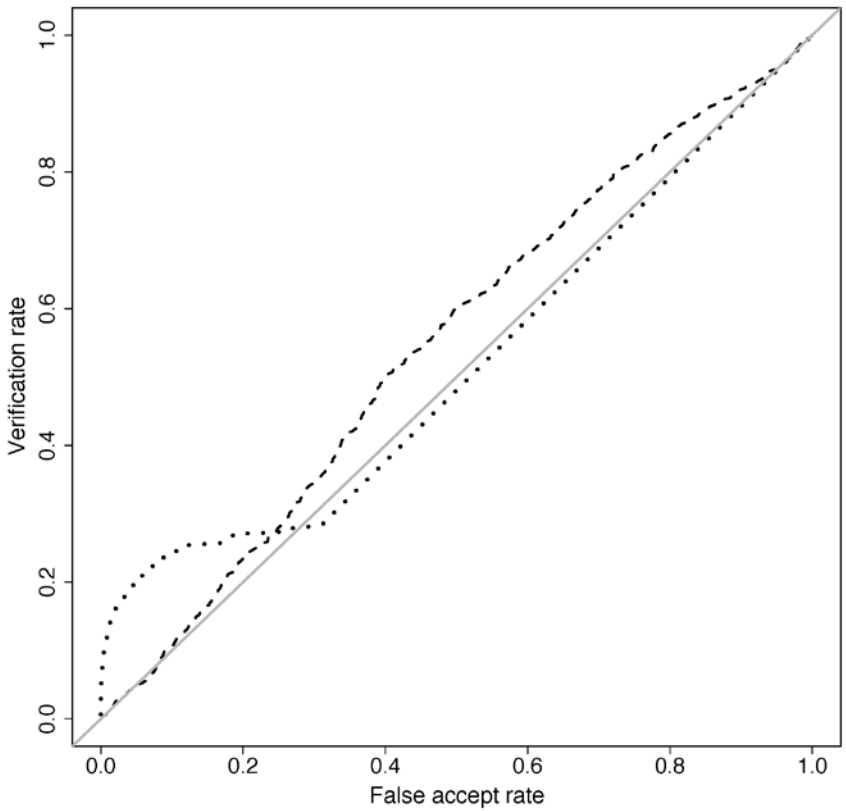
- **Human subject raters respond…**
  - **1. sure they are the same person**
  - **2. think they are the same person**
  - **3. not sure**
  - **4. think they are not the same person**
  - **5. sure they are not the same person**

Video: There is Head Room

Human Performance



Machine Performance



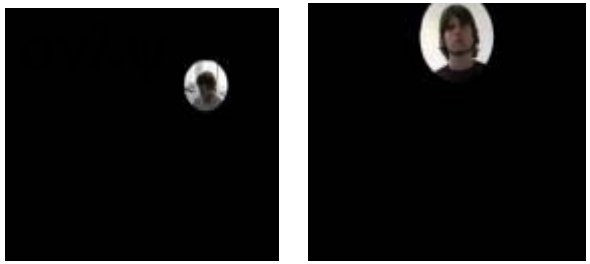
Gait Experiments

gait video

conversation video

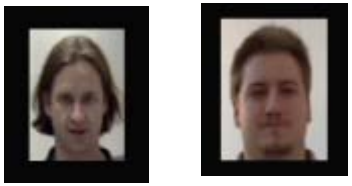
body only

face

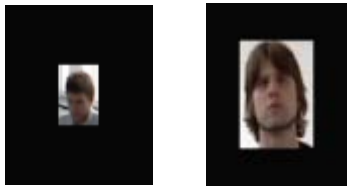


Static Face

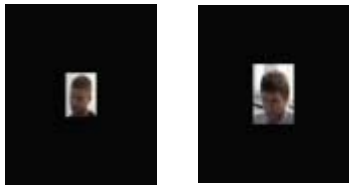
GG



CG



CC



Next Directions

- In hard cases (poor viewing conditions), humans take advantage of video, face, & video
- Evidence: algorithms do NOT take advantage of video, face, & body/gait
- Learn from the human visual system.
- Incorporate into algorithm design.

The Good, the Bad, and the Ugly
Still Face Challenge

Goal of GBU

- Encourage development of “hard” still frontal face recognition algorithms
- Improvement not at expense of “non-hard” images
- Three performance levels
  - Good
  - Bad
  - Ugly
- Discover the “phantom” covariates to which humans appear immune.

Experiment Specifics

- Nikon D70-6 Mpixels
- Uncontrolled images
  - Indoors
  - Outdoors
- 9,307 pool of images
- 437 qualified subjects
- Images in MBGC
- Images included in FRVT 2006
- Select by FRVT 2006 algorithms

Experiment Specifics

- Same number of images per subject
  - Each Sig Set
  - Each Partition
- Variation in performance on image attributes

Data Set	*Target Size*	*Query Size*
The Good	1085	1085
The Bad	1085	1085
The Ugly	1085	1085

Face Pairs

Good

Challenging

Very Challenging

Face Pairs

Good

Challenging

Very Challenging

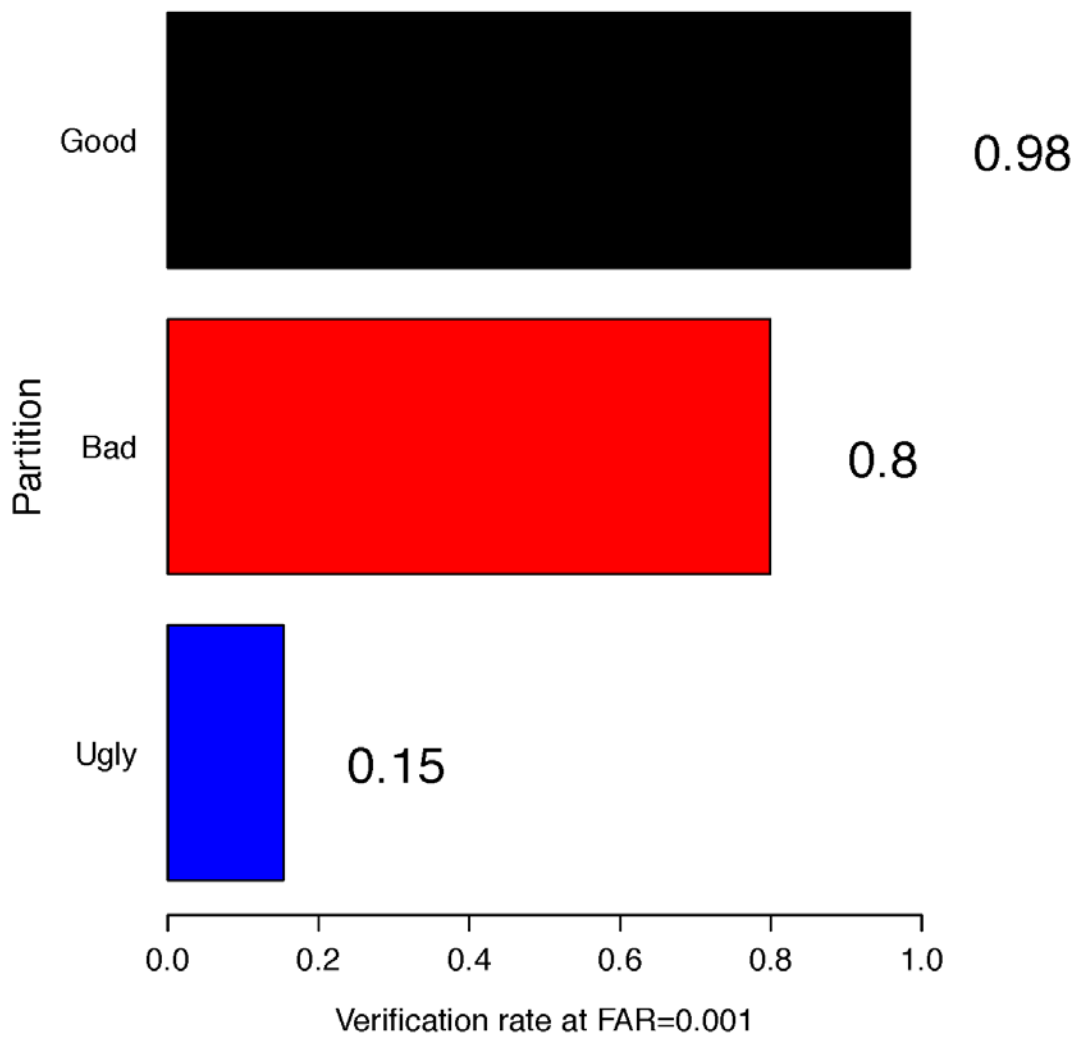
Face Pairs

Good

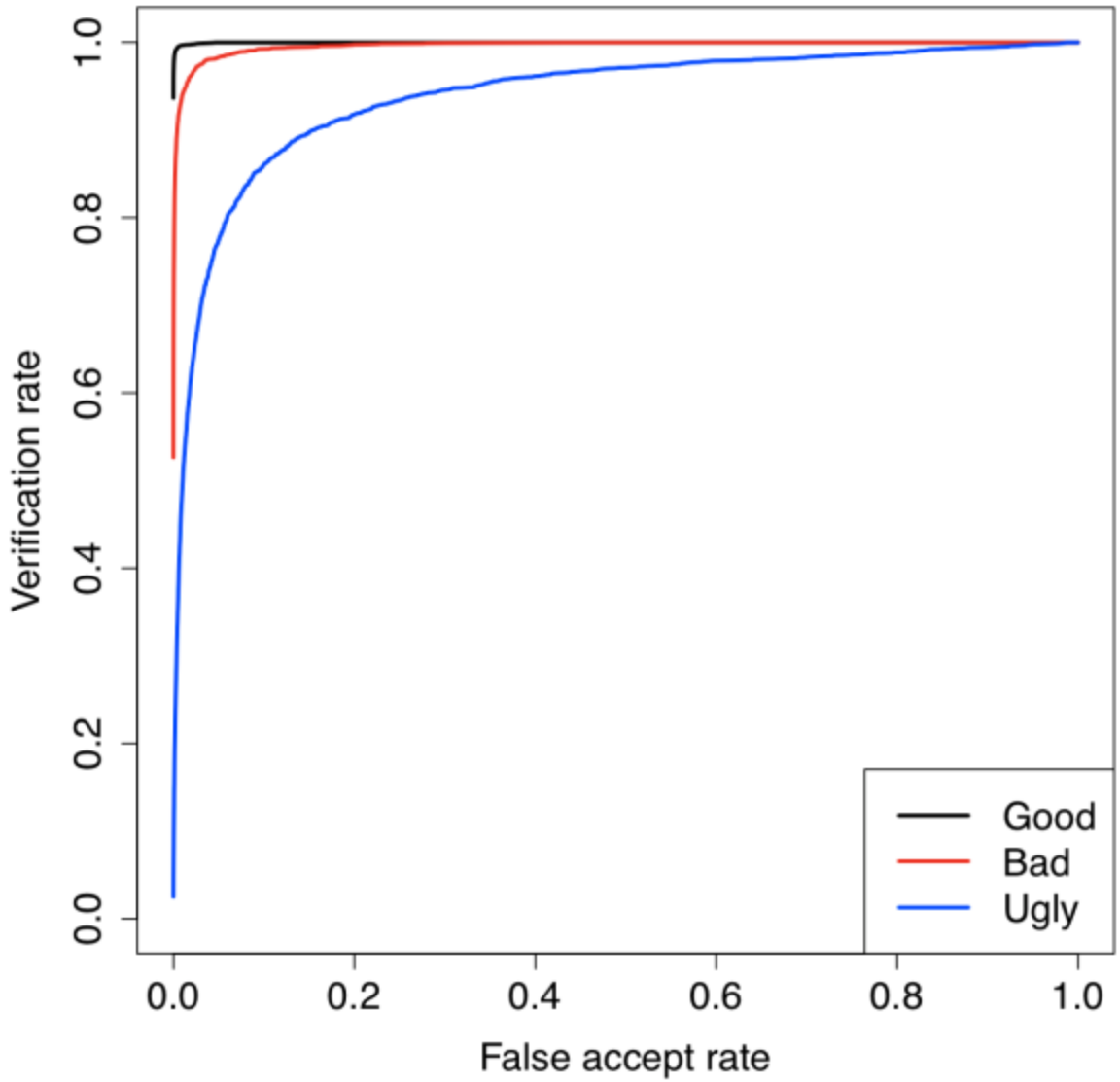
Challenging

Very Challenging

Good, Bad, Ugly Performance



GBU Fusion ROC



Big “Four” Problems in Face Recognition

A – Aging (time lapse)

P – Pose

I – Illumination

E - Expression

“Four” Big Problems in Face Recognition

~~**A** – Aging~~	Collected same academic yr
~~**P** – Pose~~	All frontal images
I – Illumination	✓
E - Expression	✓

Lighting & Expression

Same lighting, Same expression

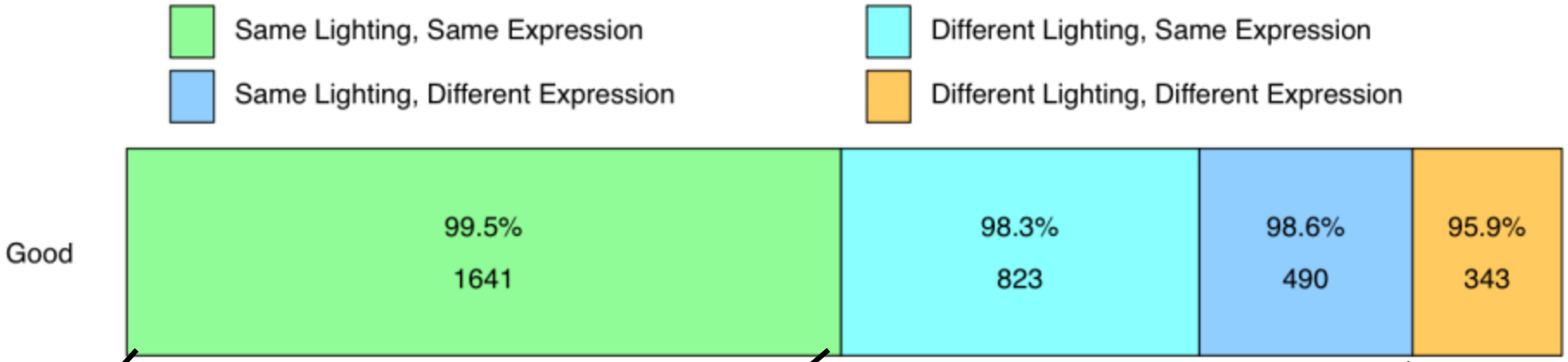
Different lighting, Same expression

Same lighting, Different expression

Different lighting, Different expression

Lighting & Expression

Verification rate @ FAR = 0.1%



Same lighting, Same expression

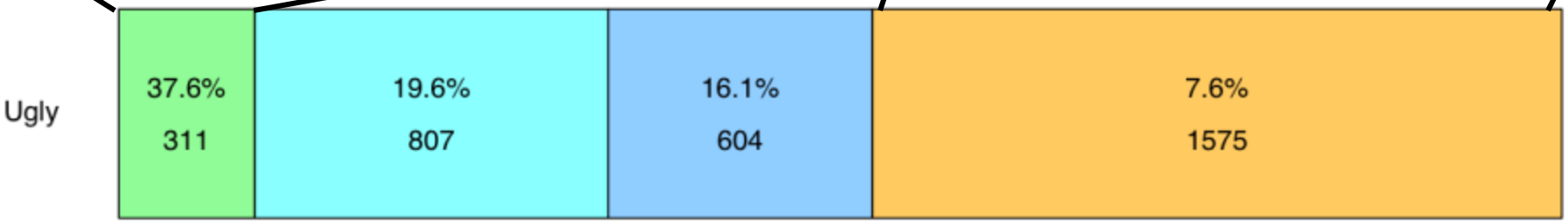
Different lighting, Different expression

Lighting & Expression

Verification rate @ FAR = 0.1%

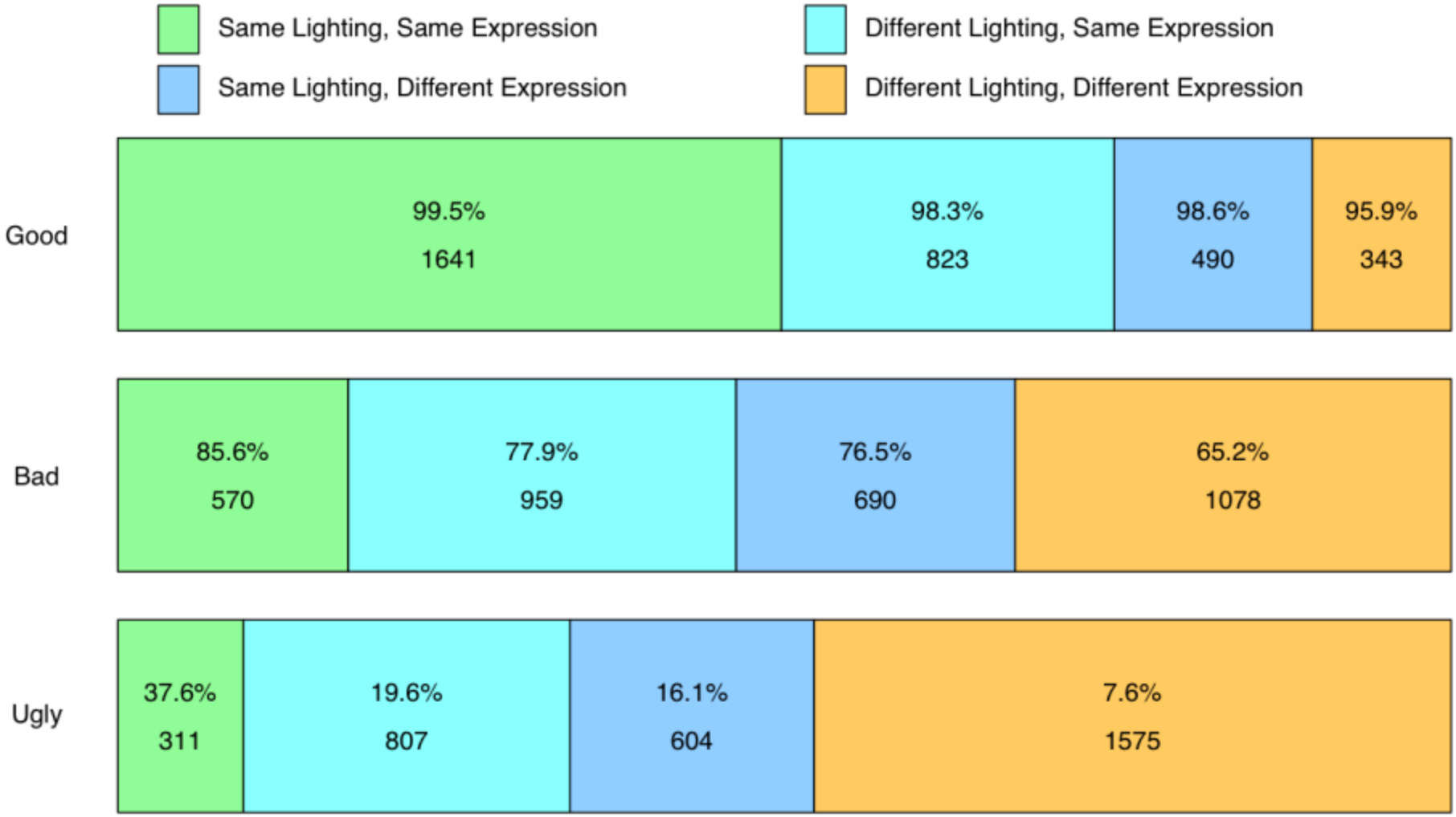
Same lighting, Same expression

Different lighting, Different expression

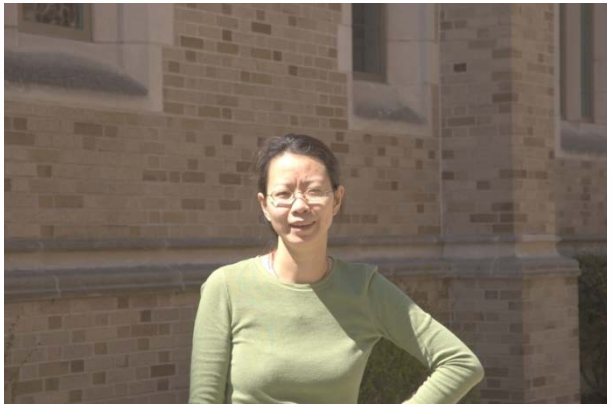


Lighting & Expression

Verification rate @ FAR = 0.1%

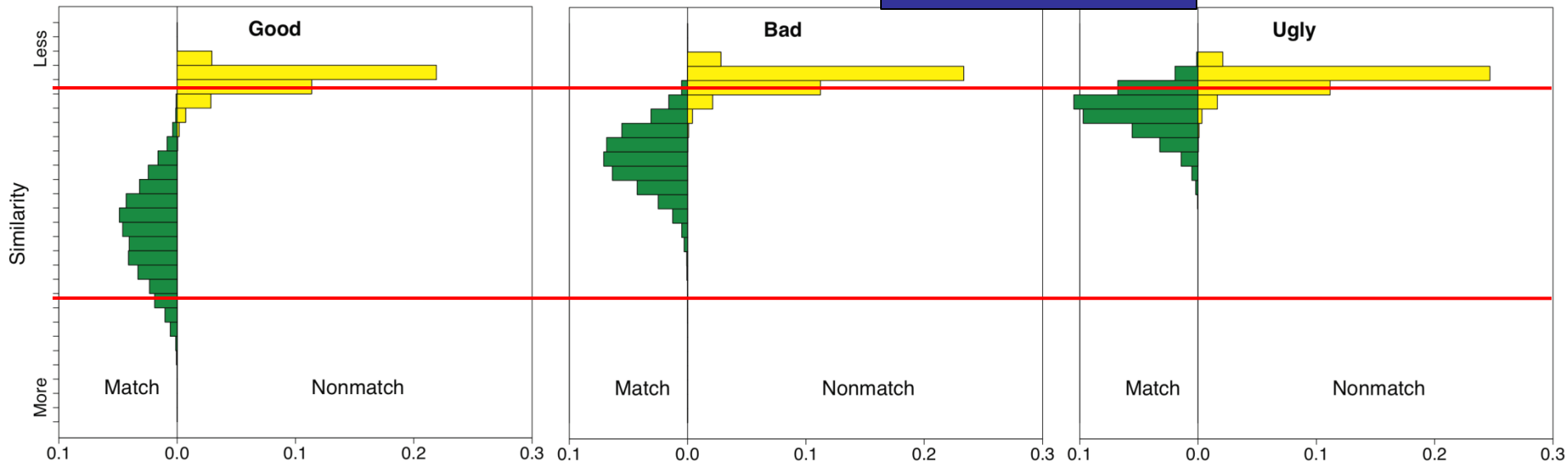


What is the quality of these images?



Hard and Easy to Match

Hard to Match



Easy to Match

Quality comes in Pairs

Hard to Match

Hard to Match

Quality comes in Pairs

Easy to Match

Easy to Match

Quality comes in Pairs

Hard to Match

Easy to Match

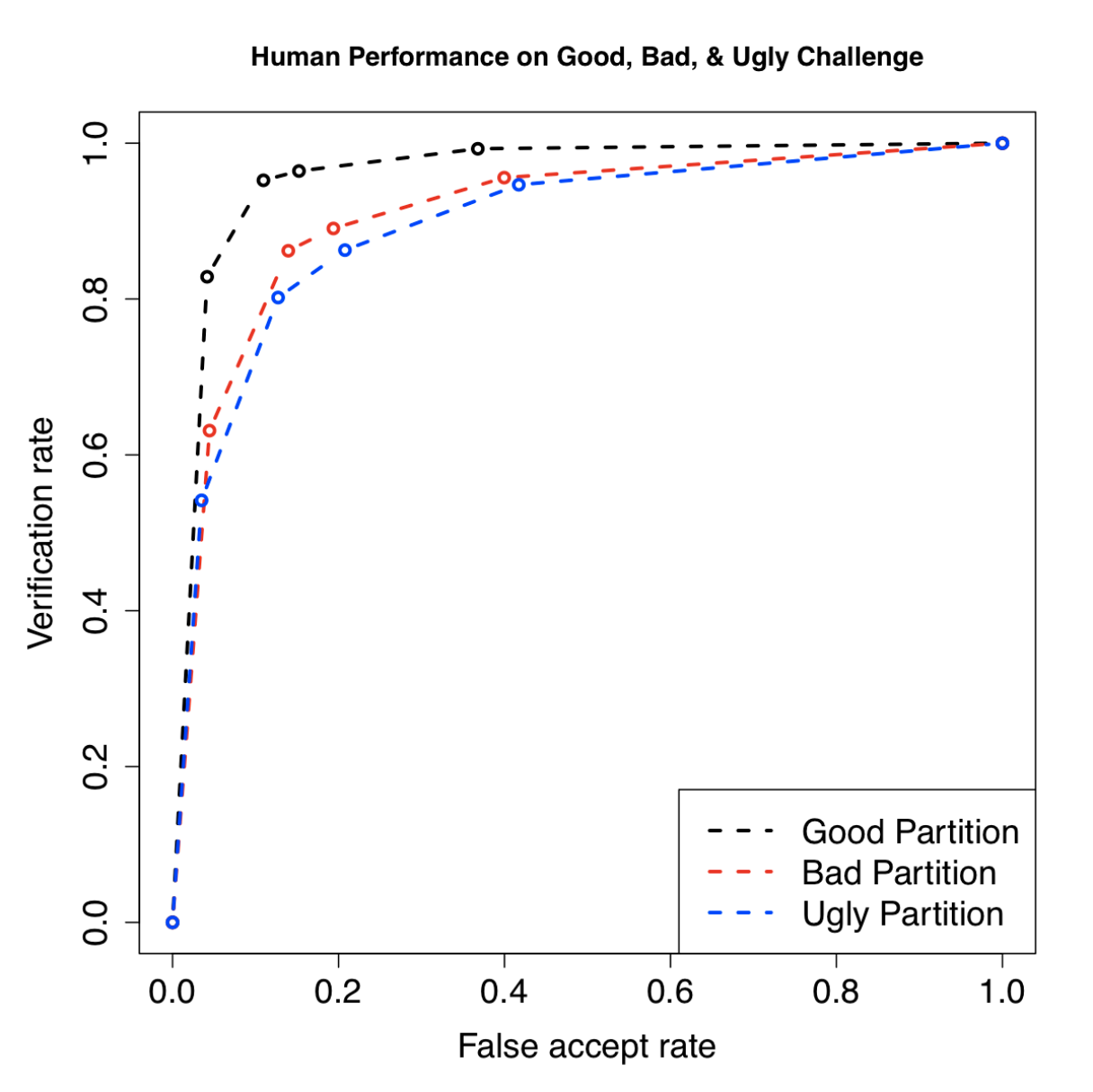
Easy to Match

Hard to Match

Human Performance Procedure

- Human subject raters respond…
  - 1. sure they are the same person
  - 2. think they are the same person
  - 3. not sure
  - 4. think they are not the same person
  - 5. sure they are not the same person

GBU Human Performance

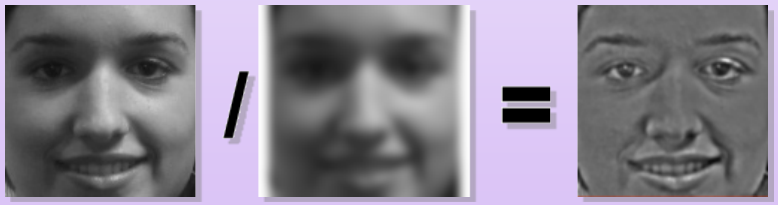


CSU/NIST GBU Baseline Algorithm

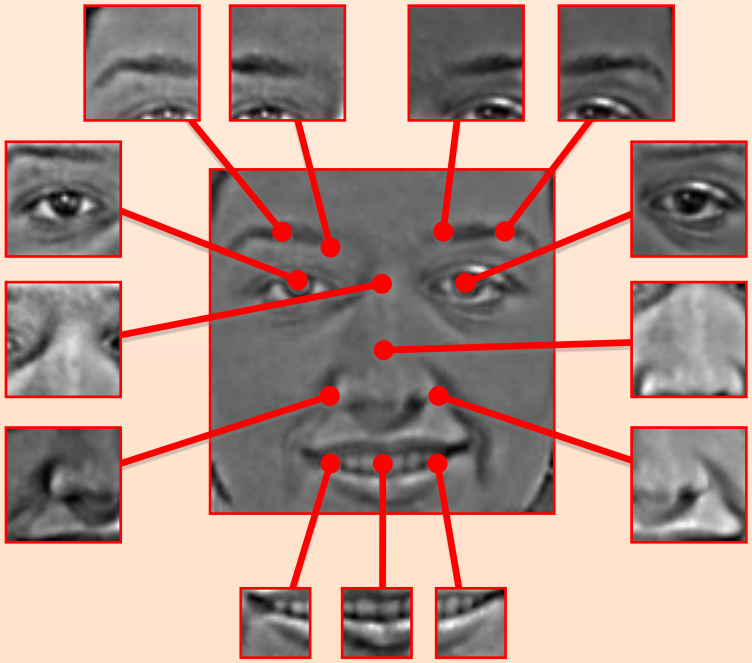
Local Region PCA Algorithm

- *13 Local Features +Whole Face*
- *Self Quotient - Lighting Removal*
- *PCA based whitening*
  - *250 basis vectors per feature.*
  - *3500 total basis vectors.*
- *Fisher Criterion Weighting*
- *All features combined*
- *Similarity based upon Correlation*

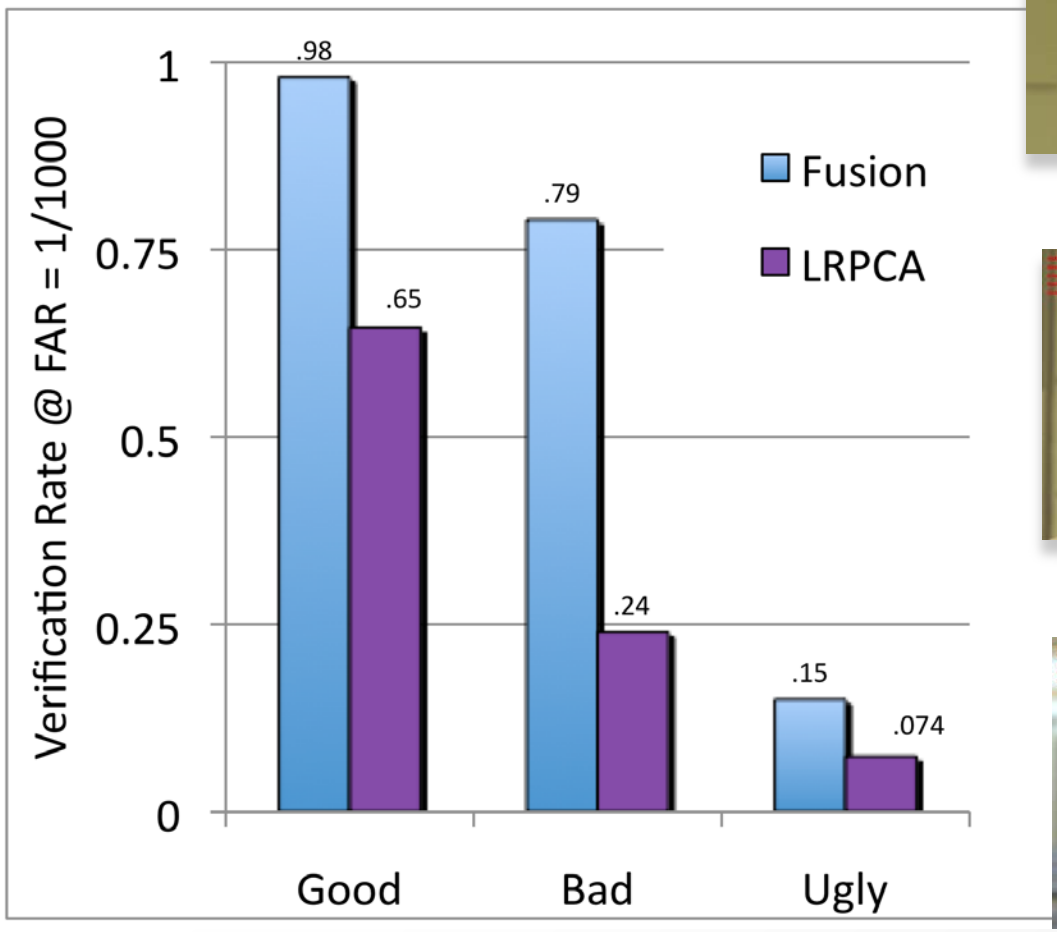
Self Quotient Preprocessing

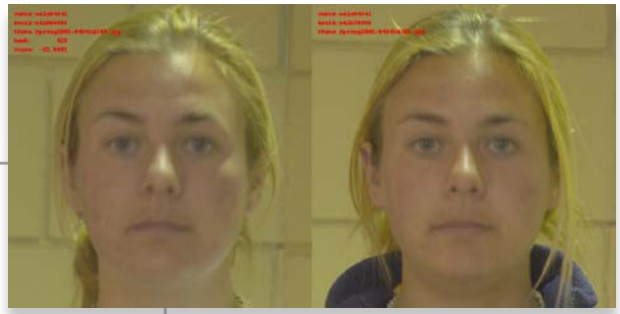


Local Regions



Performance on GBU





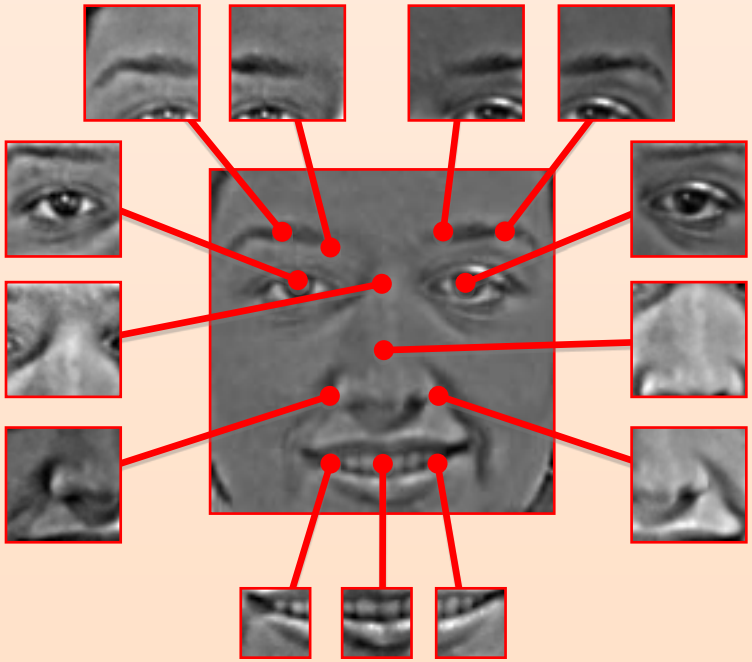
Sample match from Good Data

Sample match from Challenging Data

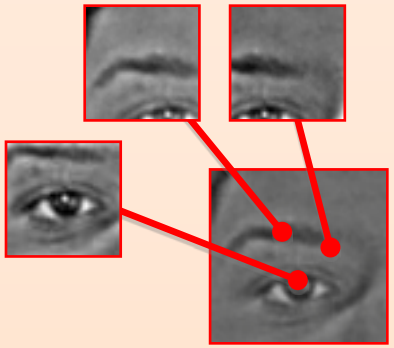
Sample match from Very Challenging Data

From Face to Ocular GBU Baseline Algorithm

Whole Face 14 Local Regions



Left Ocular 3 Local Regions



MPF Ocular `94, `98

IEEE TRANSACTIONS ON IMAGE PROCESSING

Volume: 7 Issue: 8 Date: Aug 1998

IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 7, NO. 8, AUGUST 1998

Matching Pursuit Filters Applied to Face Identification

P. Jonathon Phillips, *Member, IEEE*

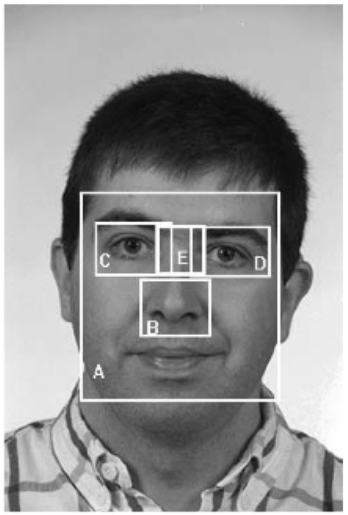
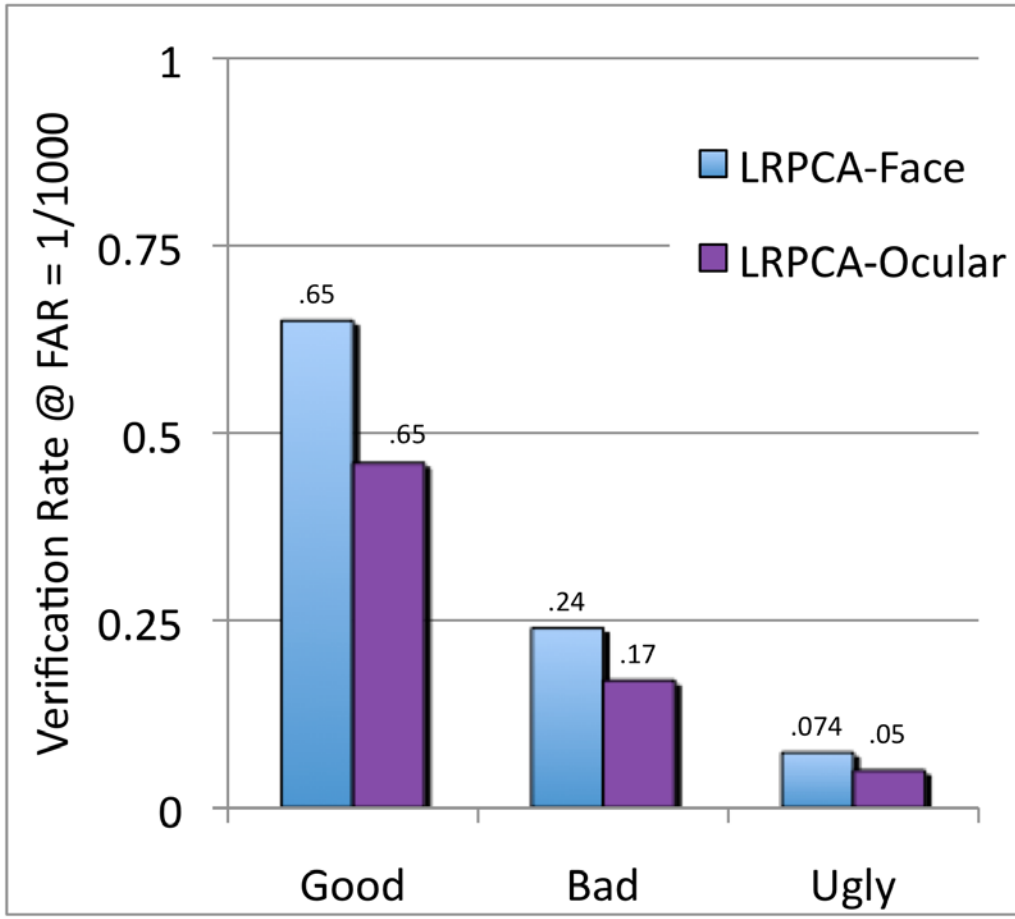
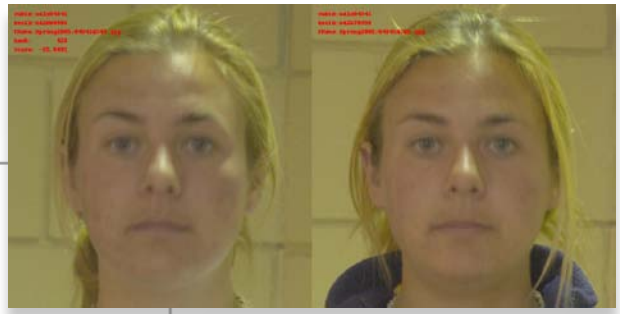


Figure 3.2: The facial features used. A is the interior the face. B is the tip of the nose. C and D are the left and right eyes. E is the bridge of the nose.

Top match	Left & Right Eyes	Tip of Nose & Left Eye	Left Eye Only
1	87.1%	89.4%	81.4%
2	88.7%	91.3%	85.5%
3	88.7%	93.2%	86.8%
4	88.7%	93.4%	88.4%

Performance on GBU





Sample match from Good Data

Sample match from Challenging Data

Sample match from Very Challenging Data

GBU Performance

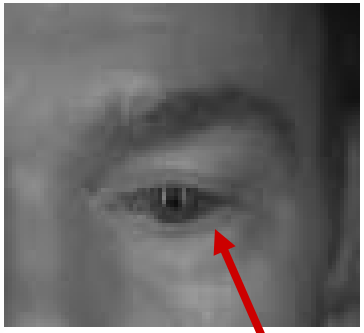
- Three partitions
  - Same subjects
  - Differences are image covariates
  - More than expression and lighting direction
- Human Performance
  - Bad & Ugly partitions statistically not different
- Machine Performance
  - Bad & Ugly partitions different
- Humans “Blind” to Algorithm Differences
- Human Performance as Benchmark

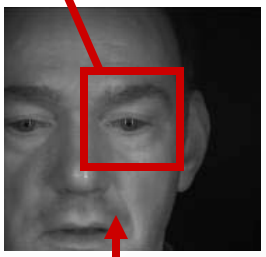
Ocular

Ocular Data

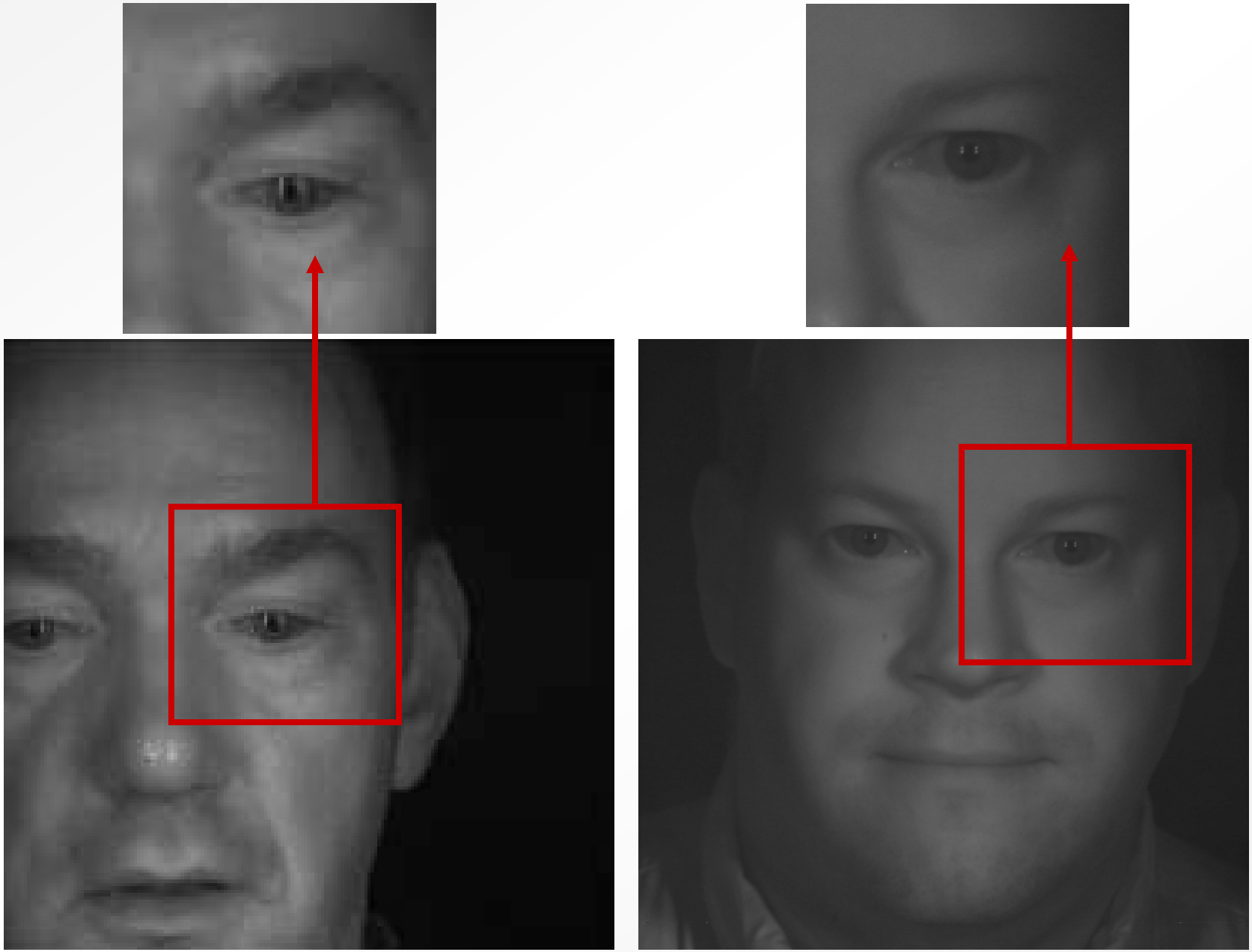
- Individual frames of IOM data can be used increase or decrease the level of difficulty in ocular recognition.
- Measure improvement over iris only recognition algorithm.

Ocular data from IOM

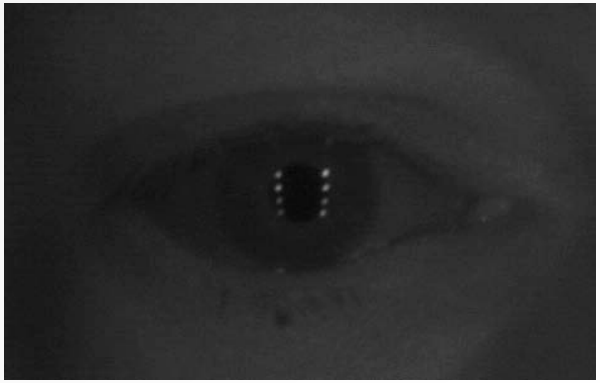


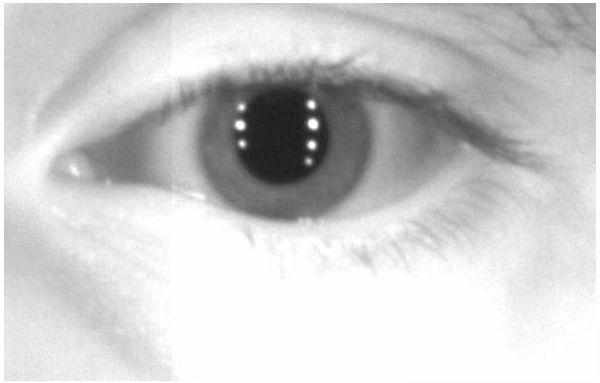


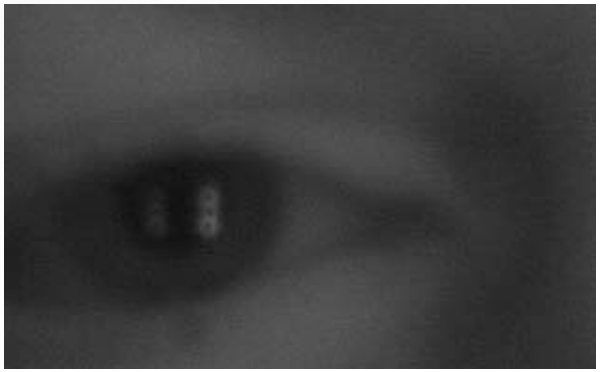
Ocular data difficulty

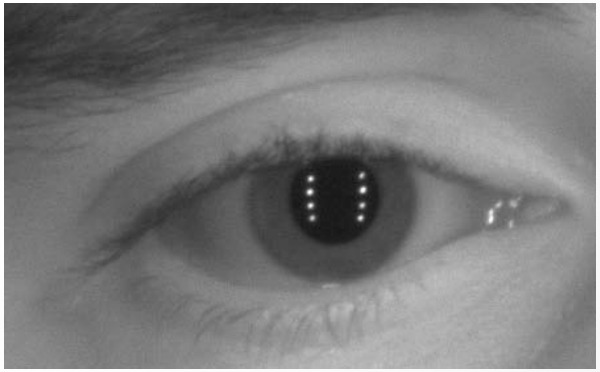


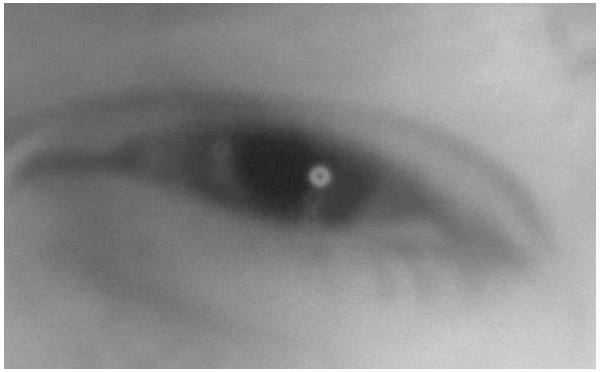
Recognition performed across all combinations

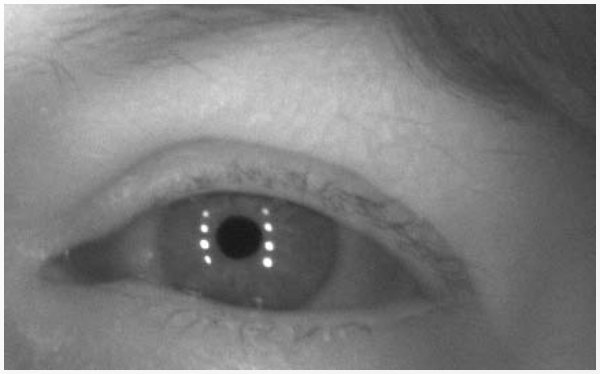










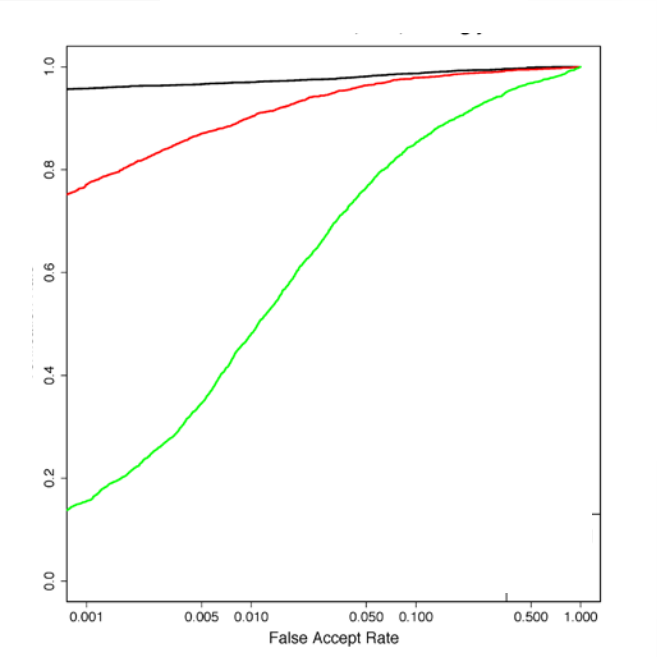


Predicting Performance

Predicting Performance

Target Set

Query Set



New Target Set

New Query Set

Levels of Predictions

- General Assessment
- Measuring Improvement
- Ranking of Algorithms
  - Relative performance
  - Ranking stable across data sets
  - Limited success
- Predict Performance

Considerations

- Modeling
  - Demographics
  - Acquisition conditions
  - Queries to be processed
- Deep questions
  - Ability to generalize?
  - Specific to algorithm?
  - Specific to task?
- Links
  - Quality
  - Failure/error analysis
  - Biometric-completeness

Conclusions

- Challenges in Unconstrained Face Recognition
  - Video: MBGC Video Challenge
  - Still: Good, Bad, & Ugly
- Ocular
  - Visible: GBU
  - NIR: At a distance sequences
- Performance Prediction

Questions?