FRGC and ICE Workshop

Dr. P. Jonathon Phillips - NIST

March 22-23, 2006
NRECA Conference Facility
Arlington, Virginia

Workshop Agenda Overview

DAY 1:

- FRGC Overview and Experiment Results
- Individual Organization FRGC Results
- Guest Speaker
  - Alice O'Toole, University of Texas at Dallas
    - Human verses Machine Face Recognition Performance

DAY 2:

- ICE Overview and v1.0 Experiment Results
- Individual Organization ICE v1.0 Results
- Guest Speaker
  - Philip Wasserman, NIST Consultant
    - Iris Imaging Platform Design
- Next Steps – ICE Phase II

FRGC, FRVT 2006 & ICE Sponsors

Executing Agency

- National Institute of Standards and Technology — NIST
  ...working with industry to foster innovation, trade, security and jobs

Sponsoring Agencies

- Director of National Intelligence
  Intelligence Technology Innovation Center — ITIC
- Federal Bureau of Investigation
  www.fbi.gov
- Homeland Security
  - Science & Technology Directorate
  - Transportation Security Administration
- National Institute of Justice
  The Research, Development, and Evaluation Agency of the U.S. Department of Justice
- COMBATING TERRORISM
  TSWG
  TECHNICAL SUPPORT WORKING GROUP

FRGC and ICE Team

- **Program Manager for FRGC and ICE**
  - **P. Jonathon Phillips — *NIST***

- **Evaluation Team**
  - **Todd Scruggs — *SAIC***
  - **Matt Sharpe — *SAIC***
  - **William Worek — *SIAC***
  - **Kevin Bowyer — *University of Notre Dame***
  - **Patrick Flynn — *University of Notre Dame***
  - **Ross Beveridge — *Colorado State University***
  - **Alice O'Toole — *University of Texas at Dallas***

- **FRGC and ICE Liaison**
  - **Cathy Schott — *Schafer Corp***

Status Update

- FRVT 2006
- ICE 2006

FRVT 2006 Status Update

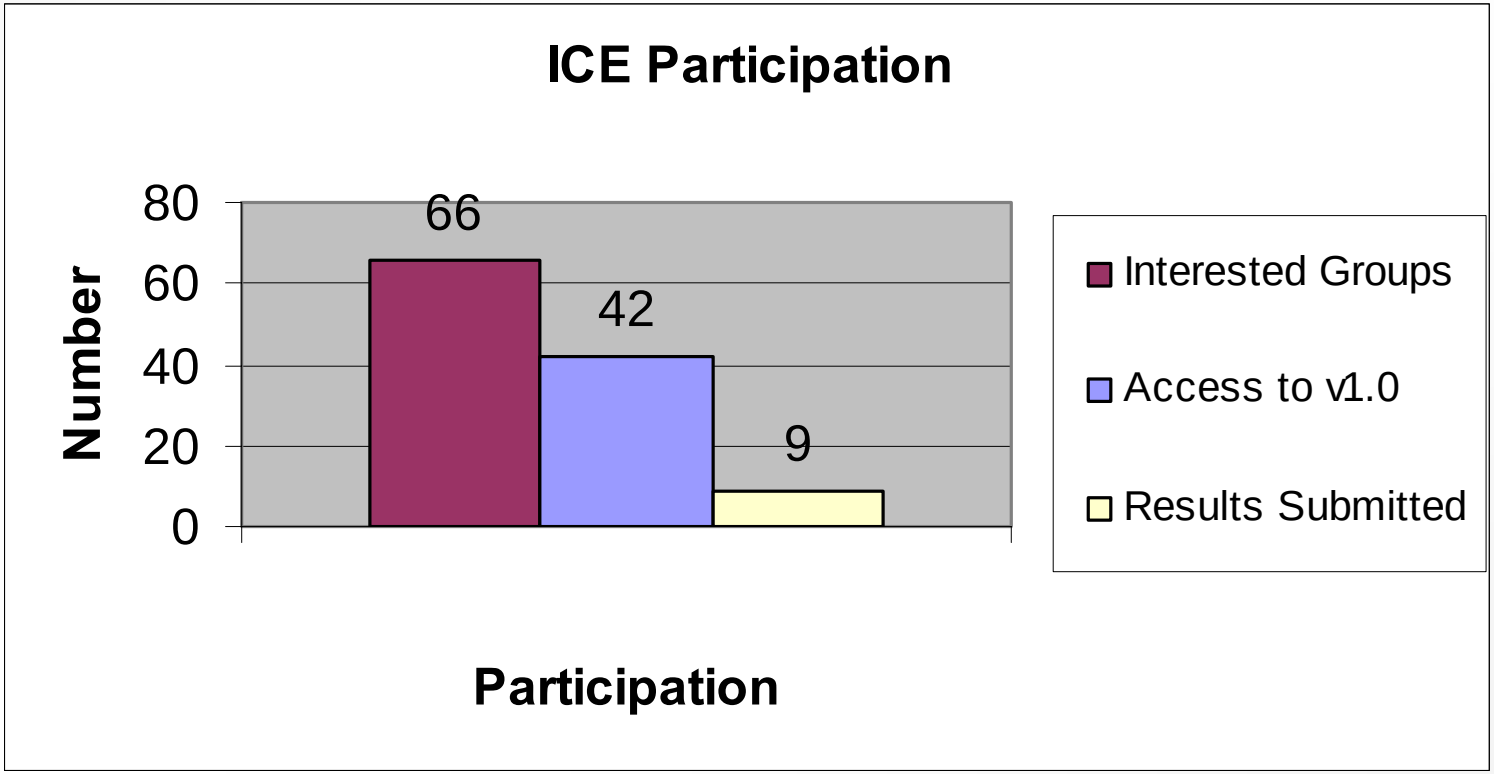
- The Face Recognition Vendor Test (FRVT) 2006
  - Began on 30 January 2006
  - Currently underway
    - Testing executables at this time
  - 22 Participants
    - 10 countries
    - 30% of Participants are from Academia

FACE RECOGNITION VENDOR TEST 2006

ICE Phase II = ICE 2006

- ICE 2006
  - Independent U.S. Government Evaluation
  - Planned start date is 15 June 2006
  - ICE 2006 protocol based on the FRVT 2006 protocol

ICE Participation



Face Recognition Grand Challenge Overview

NIST

Outline

- Overview of Face Recognition Grand Challenge (FRGC)
- Overview and Results of FRGC ver2.0
- Overview of the Face Recognition Vendor Test (FRVT) 2006
- Next Steps

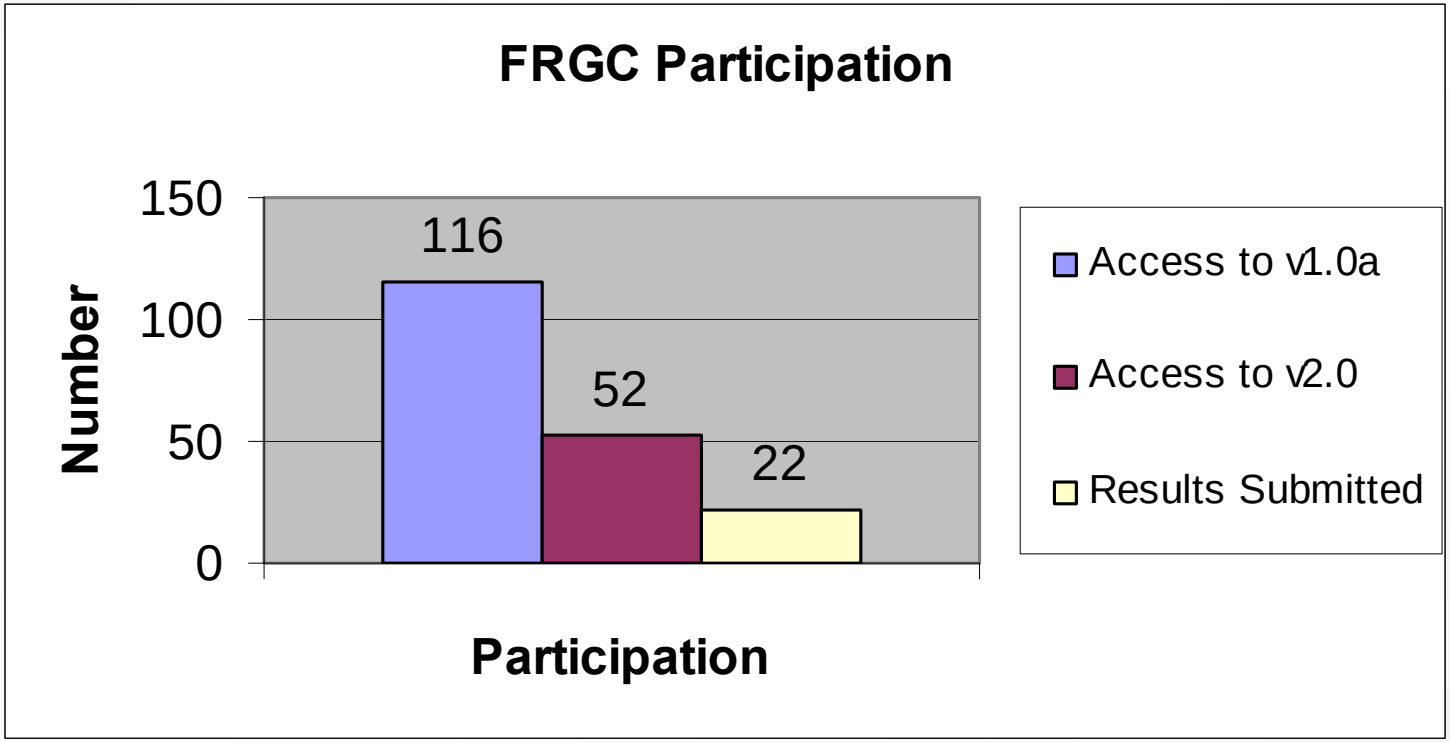
FRGC and FRVT 2006

- What is the difference between FRGC and FRVT 2006?
  - FRGC (May 2004 – March 2006)
    - Still and 3D face recognition algorithm development project
  - FRVT 2006 (30 January 2006)
    - Independent government evaluation of face recognition systems
    - Measure progress since FRVT 2002

FRGC Background

- Renewed interest in developing new methods for automatic face recognition
  - Fueled by advances in
    - Computer vision techniques
    - Computer design
    - Sensor design
    - Interest in fielding face recognition systems
- New techniques have potential to significantly reduce error rates

FRGC Participation



Background

Baseline

FRVT 2002

July 2002

Technology Development

FRGC

May 2004 – Mar 2006

Independent Evaluation

FRVT 2006

Oct 2005 – Dec 2006

FRGC Goal and Objective

- The primary goal of the FRGC is to:

Promote and advance face recognition technology to support U.S. Government face recognition efforts

- The primary objective of the FRGC is to:

Develop still and 3D algorithms to improve performance an order of magnitude over FRVT 2002

Select Point to Measure

- **Verification rate at :**
  - False accept rate = 0.1%
- **Current:**
  - 20% error rate (80% verification rate)
- **Goal:**
  - 2% error rate (98% verification rate)

Measuring Accuracy w/Error Rate of 2%

- Non-match scores:
  - Sufficient
- Match scores:
  - Need to design collection for sufficient number

1,000 match scores	=	~ 20 errors
10,000 match scores	=	~ 200 errors
50,000 match scores	=	~ 1,000 errors

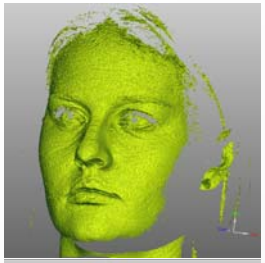
- Allows for error ellipses
- Minimal demographic analysis

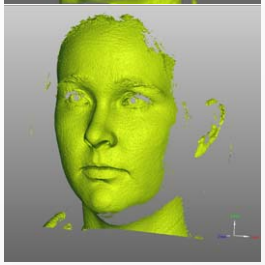
FRGC Modes Examined

Single Still

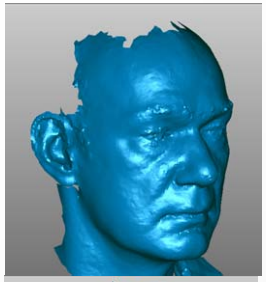
Outdoor/
Uncontrolled

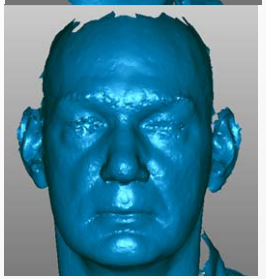
Multiple Stills





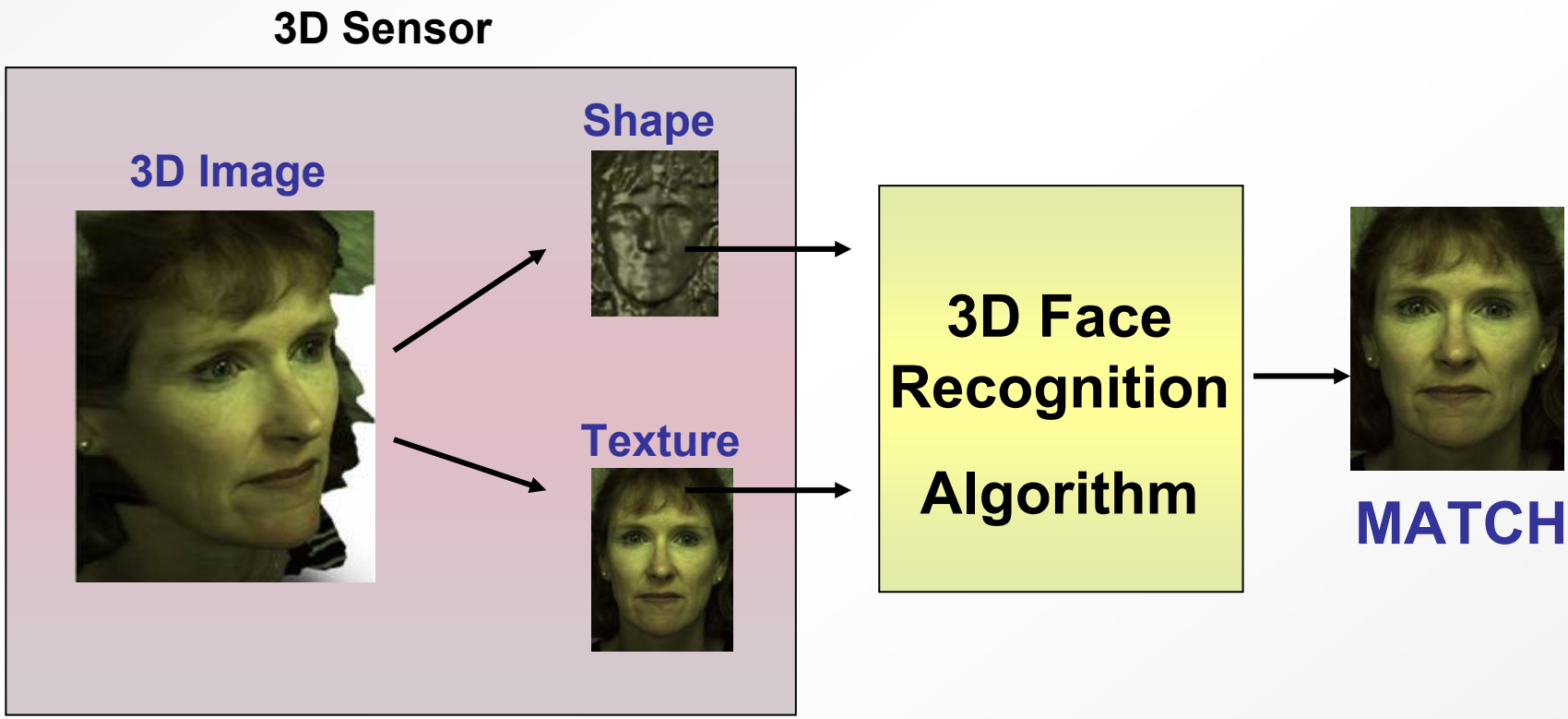
3D Single
view





3D Full Face

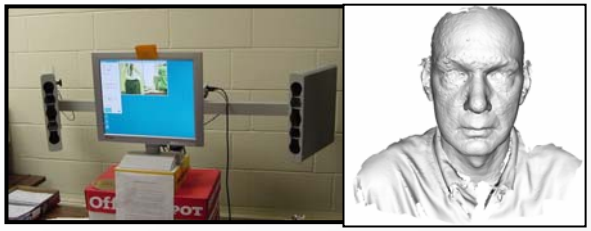
3D Images


3D Sensor
3D Image
Shape
Texture
3D Face Recognition Algorithm
MATCH

Data Collection & Distribution

- **Total data collected at Notre Dame**
  - **4950 subject sessions of 400+ subjects**
  - **125,000 2D and 15,000 3D images**
  - **125,000 irises (40,000 verified)**

Minolta Vivid 900 / 910



3DMD “Qlonerator”

Nikon

Grand Challenge Architecture

Accuracy of:

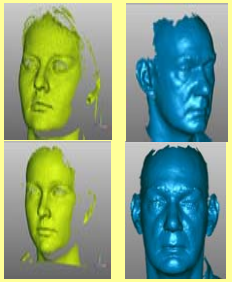
3D Sensors

3D from stills

Comparison

Algorithms/
Systems

Modes



Human
Performance

Preprocessing/
Reconstruction
Compression

Advanced
Statistical
Analysis

Image Quality
Measures

Meta data
- eye coordinates
- pose
- gender

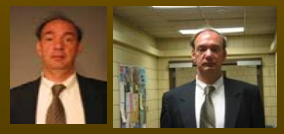
FRGC Experiments

Exp 1: Controlled indoor still versus indoor still

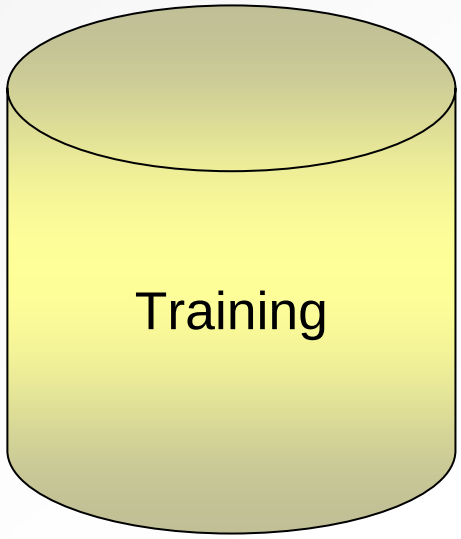
Exp 2: Multiple still versus multiple still

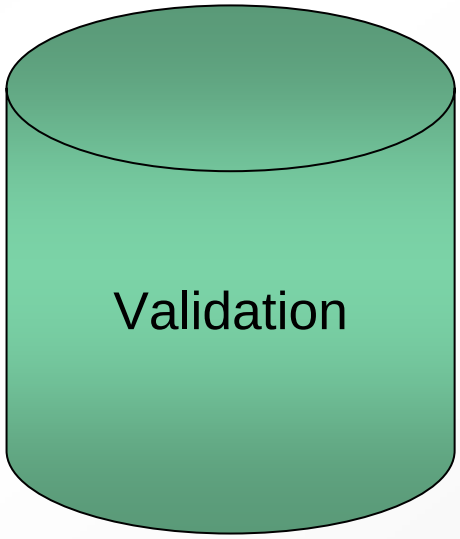
Exp 3: 3d versus 3D
3t - Texture only
3s - Shape only

Exp 4: Uncontrolled still versus indoor still



Training and Validation Partitions

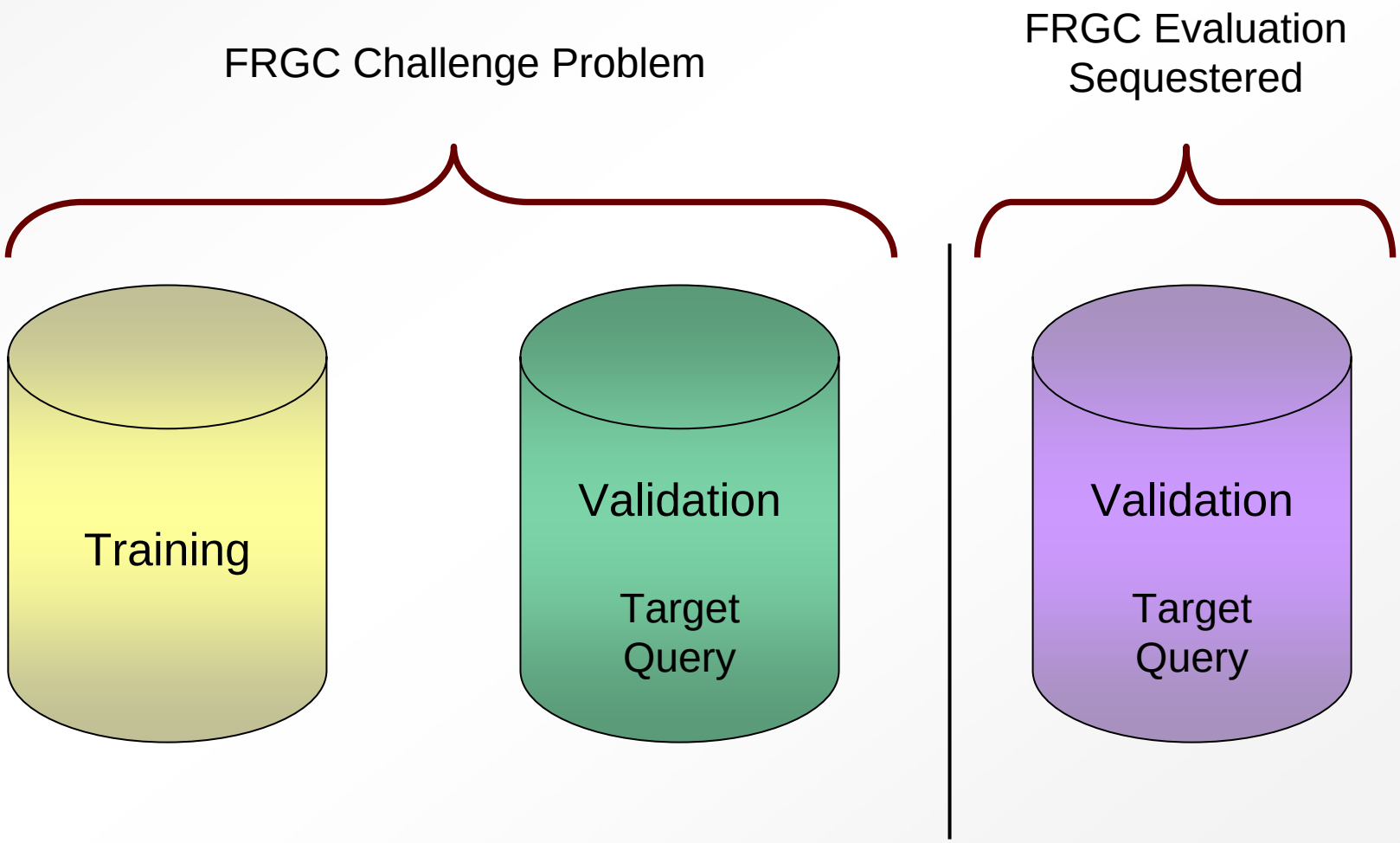




- Academic Year 2002-03
- 12,776 Large Still Training Set
- 943 3D Subject Sessions

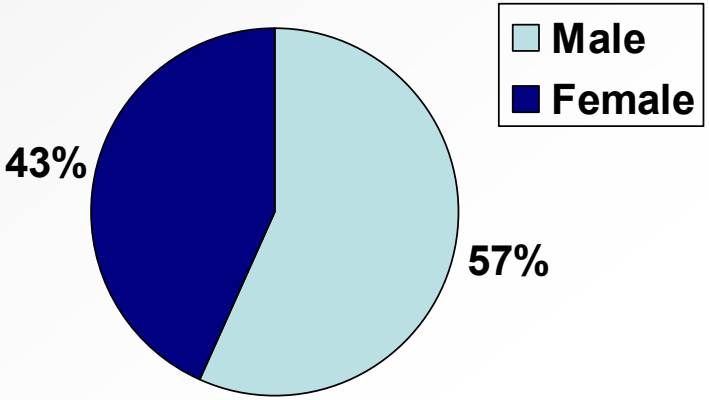
- Academic Year 2003-04
- 16,028 Controlled Stills
- 8,014 Uncontrolled Stills
- 4,007 3D Scans

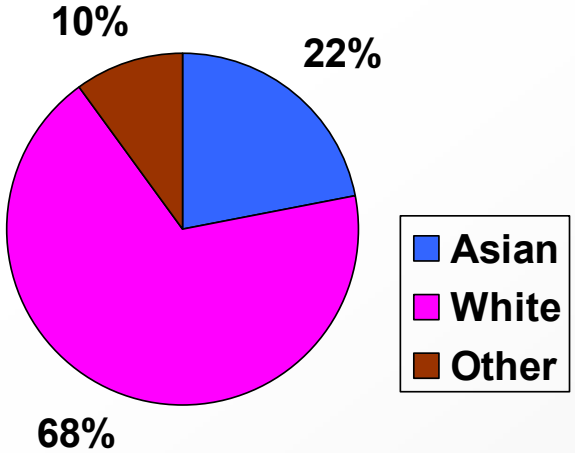
Three Data Sets

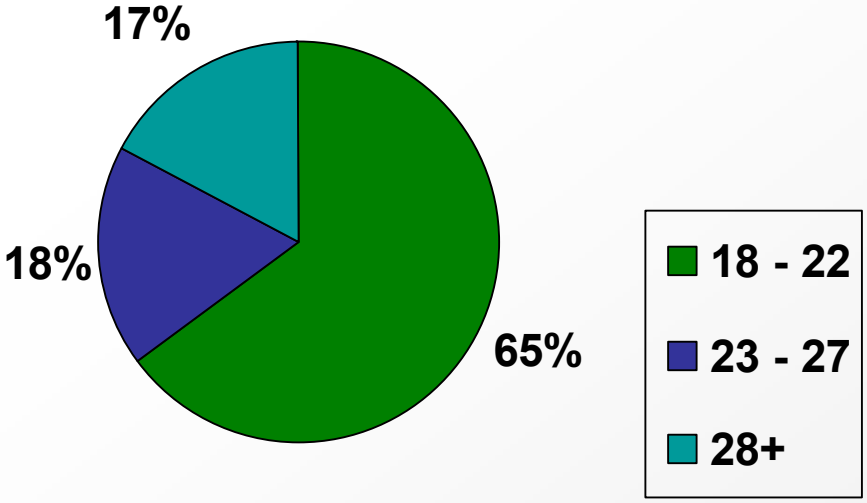


Demographics

(ver2.0 Validation Partition)







Size of Faces
(ver2 On Validation)

Pixels between center of eyes

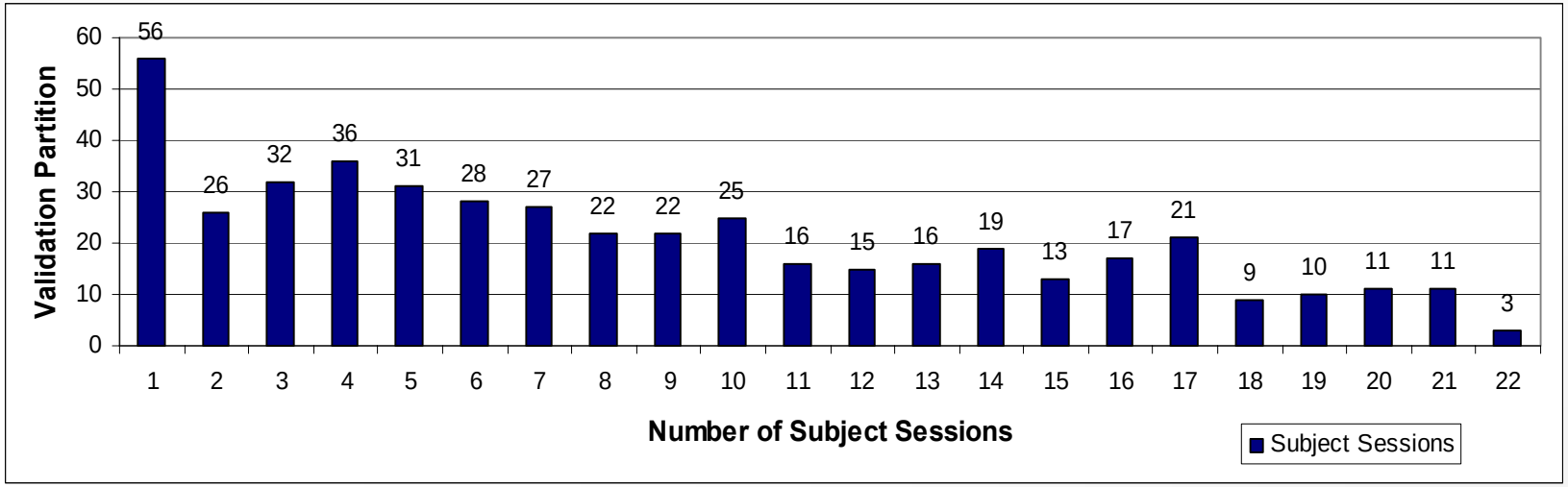
	Mean	Median	Std
Controlled	261	260	19
Uncontrolled	144	143	14
3D	160	161	15

Target / Query Sets

(ver2.0 Validation Partition)

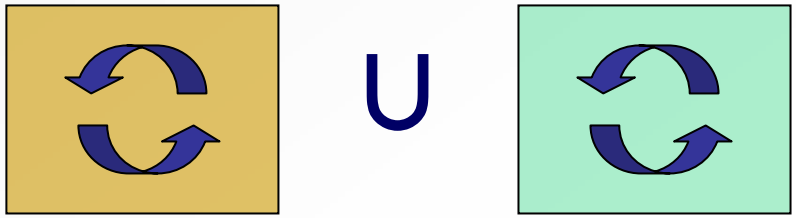
466 Subjects; 4,007 Subject sessions; 32,056 Recordings

Subject Sessions 2003-04



Three ROCs

ROC I - Within Semesters

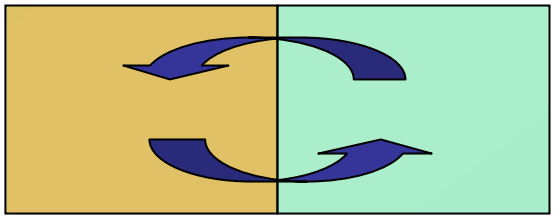


ROC I

Exp 1: 173k

Exp 3: 11k

ROC II – Within Year

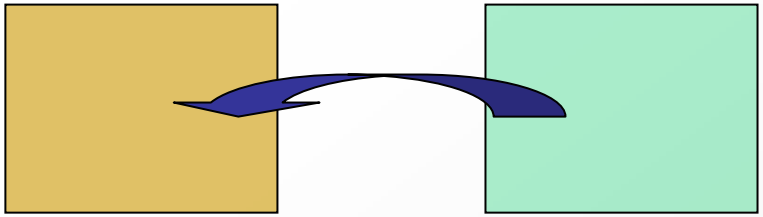


ROC II

Exp 1: 346k

Exp 3: 22k

ROC III – Between Semesters

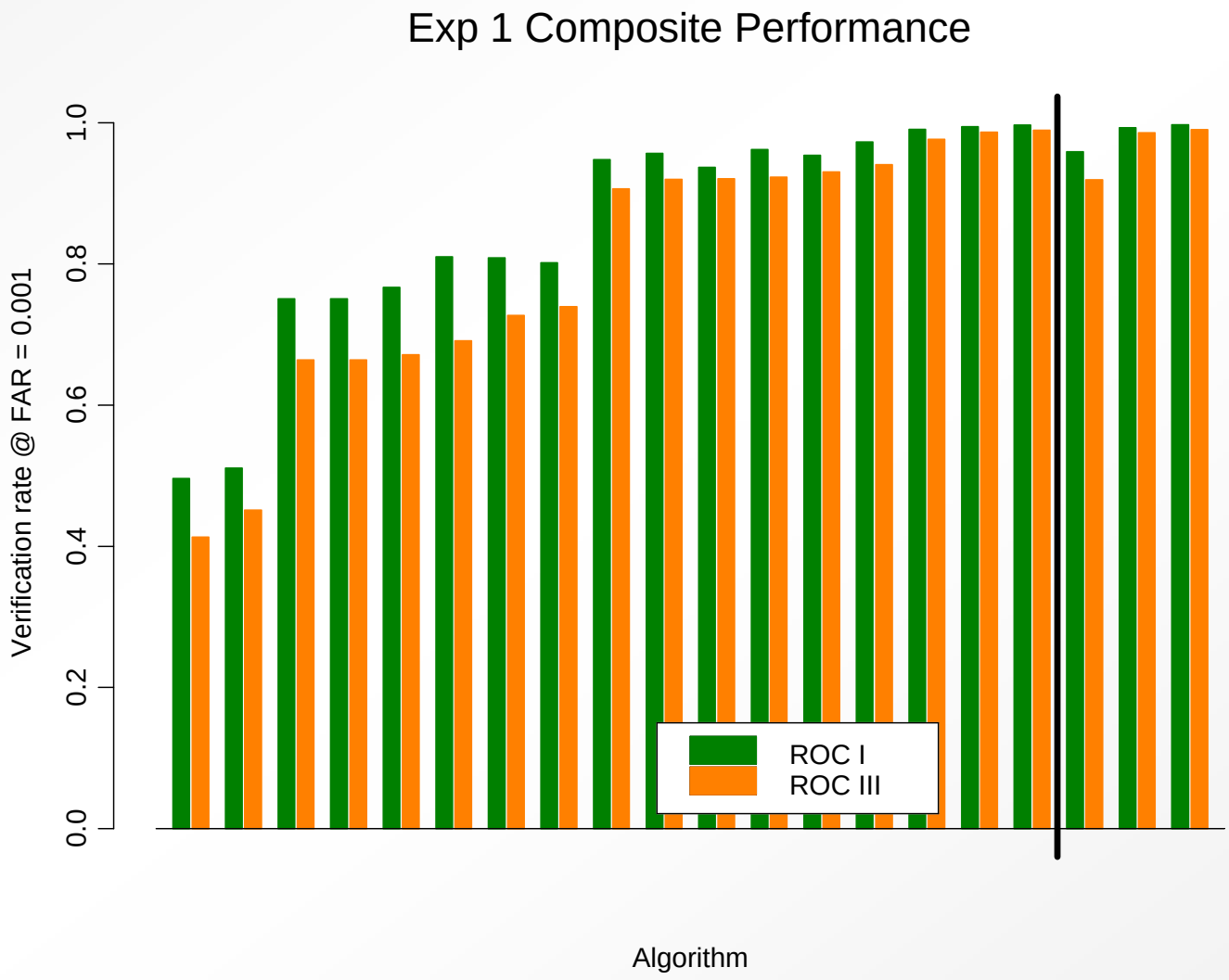


ROC III

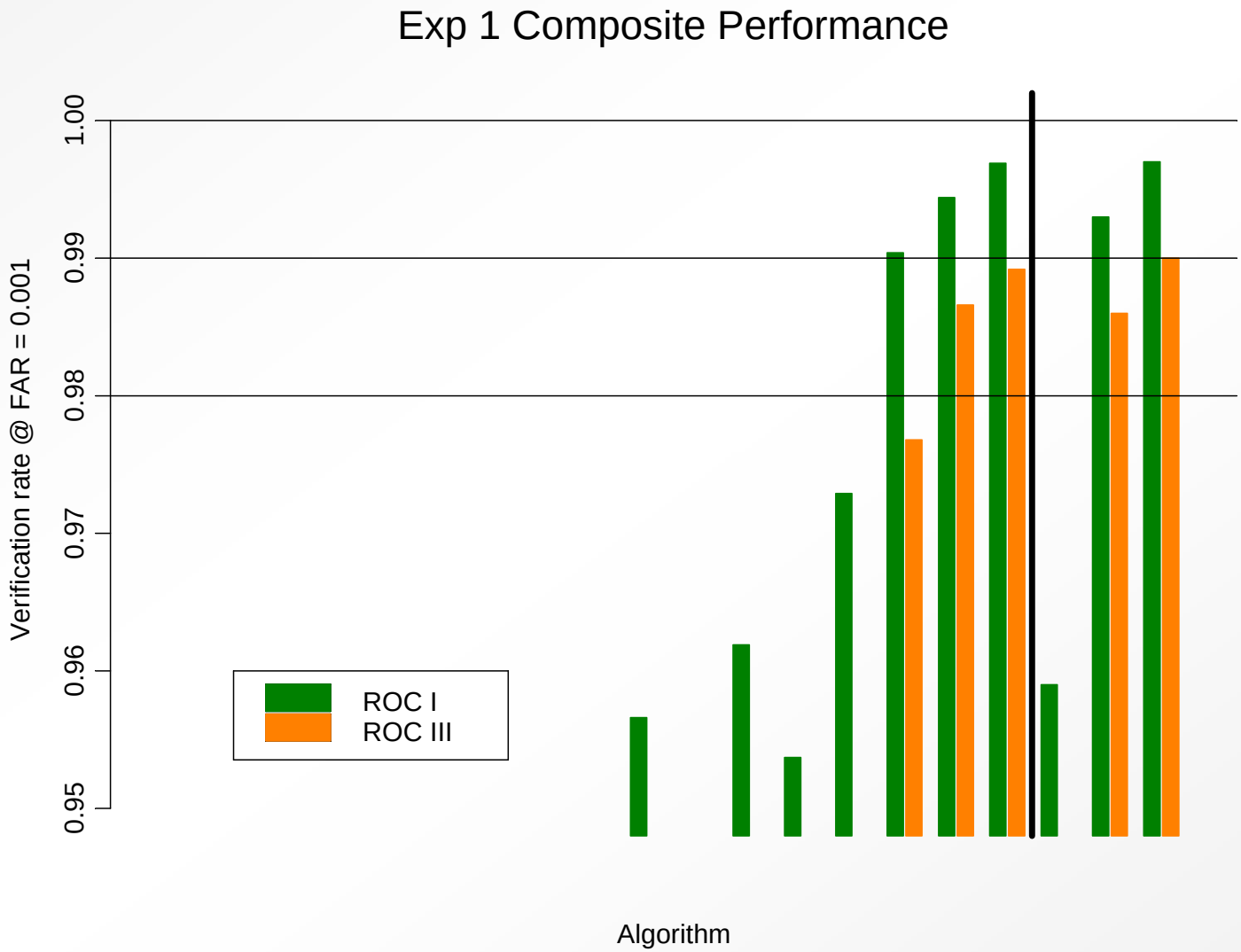
Exp 1: 173k

Exp 3: 11k

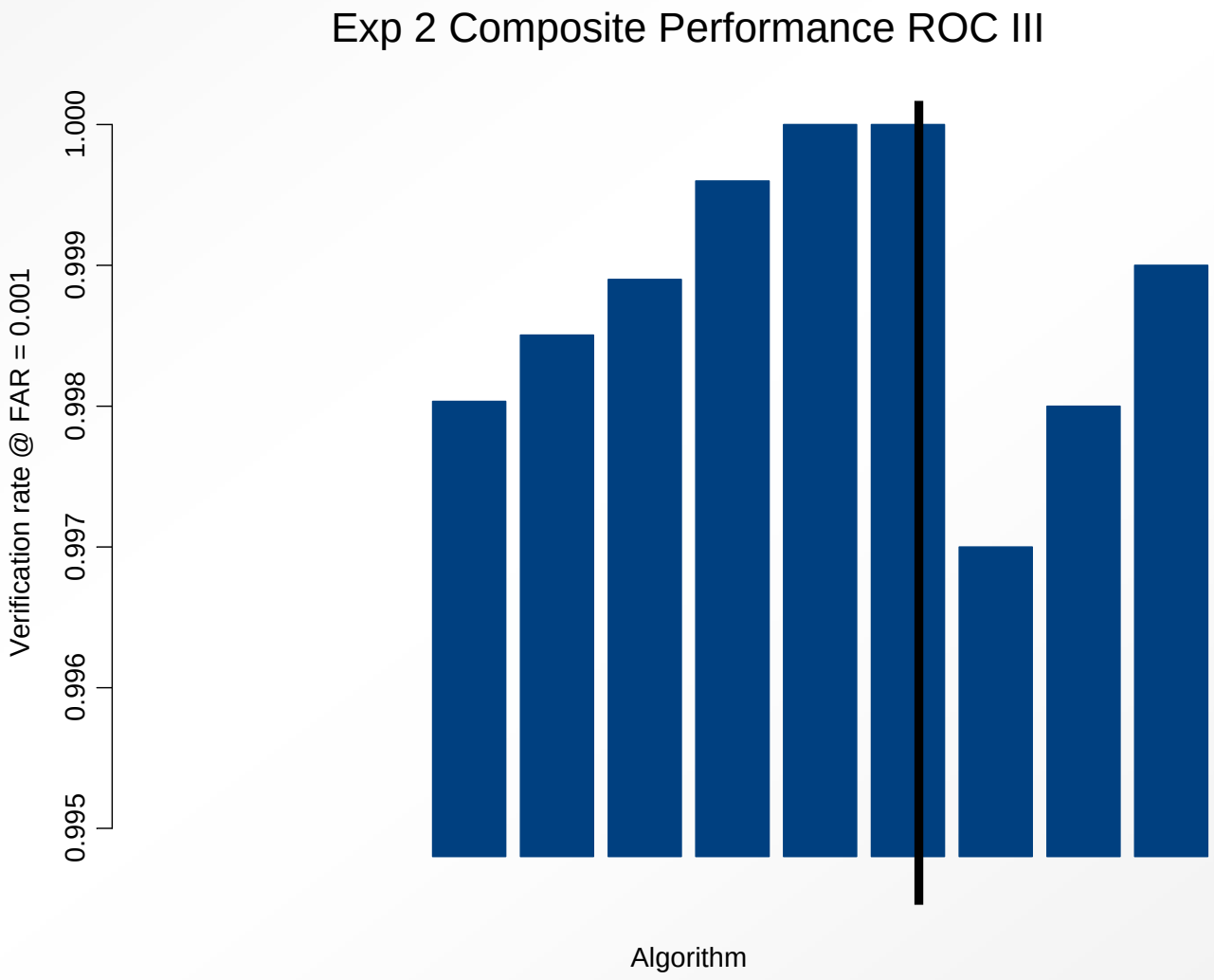
FRGCv2 Exp 1


Exp 1 Composite Performance
Verification rate @ FAR = 0.001
0.0
0.2
0.4
0.6
0.8
1.0
ROC I
ROC III
Algorithm

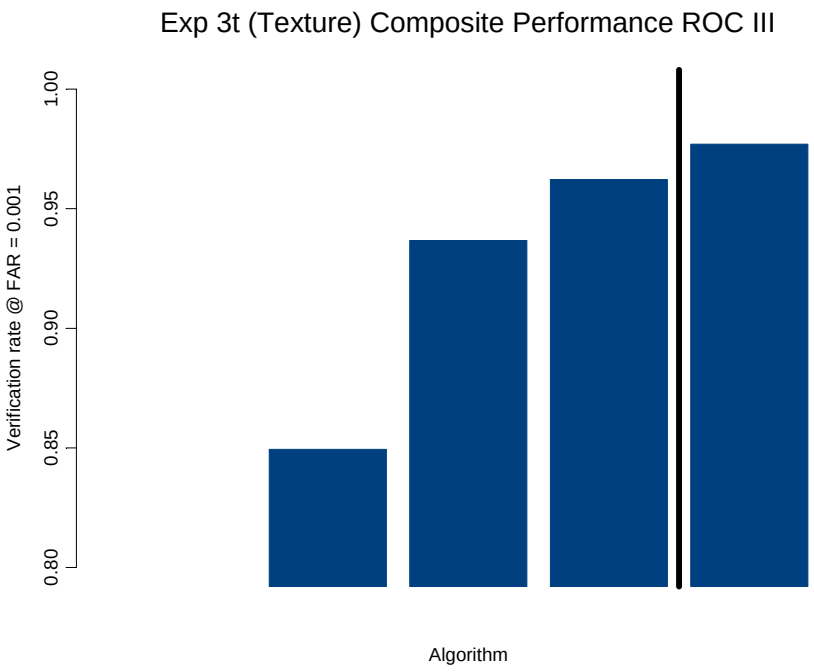
FRGCv2 Exp. 1

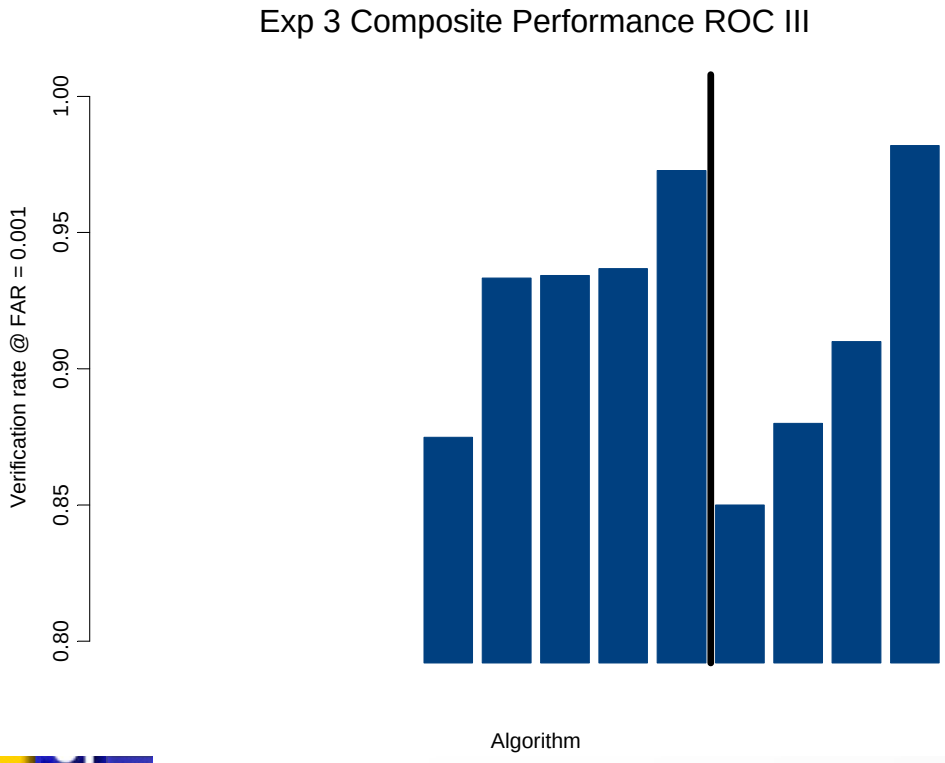

Exp 1 Composite Performance
Verification rate @ FAR = 0.001
1.00
0.99
0.98
0.97
0.96
0.95
ROC I
ROC III
Algorithm

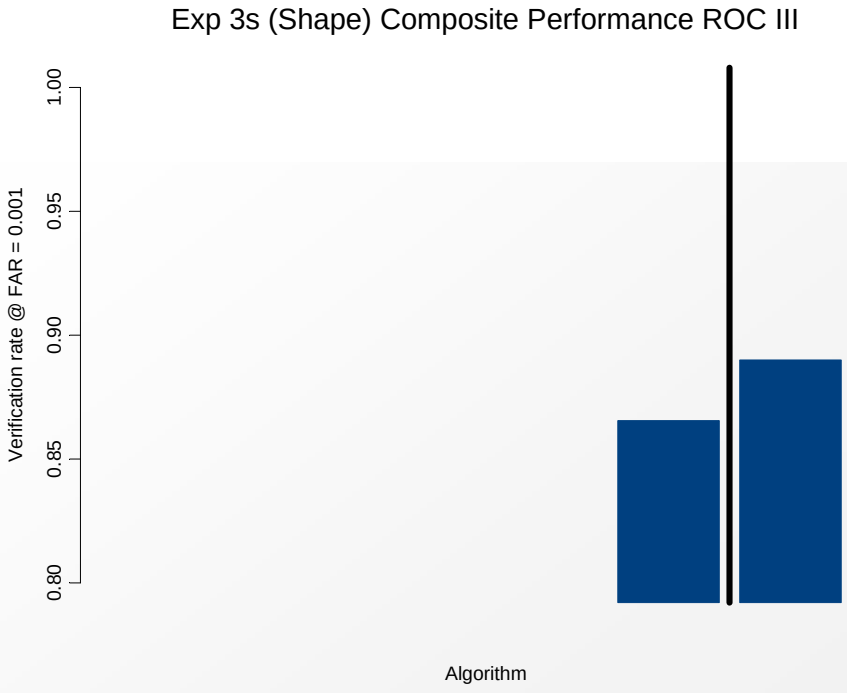
FRGCv2 Exp. 2


Exp 2 Composite Performance ROC III
Verification rate @ FAR = 0.001
0.995
0.996
0.997
0.998
0.999
1.000
Algorithm

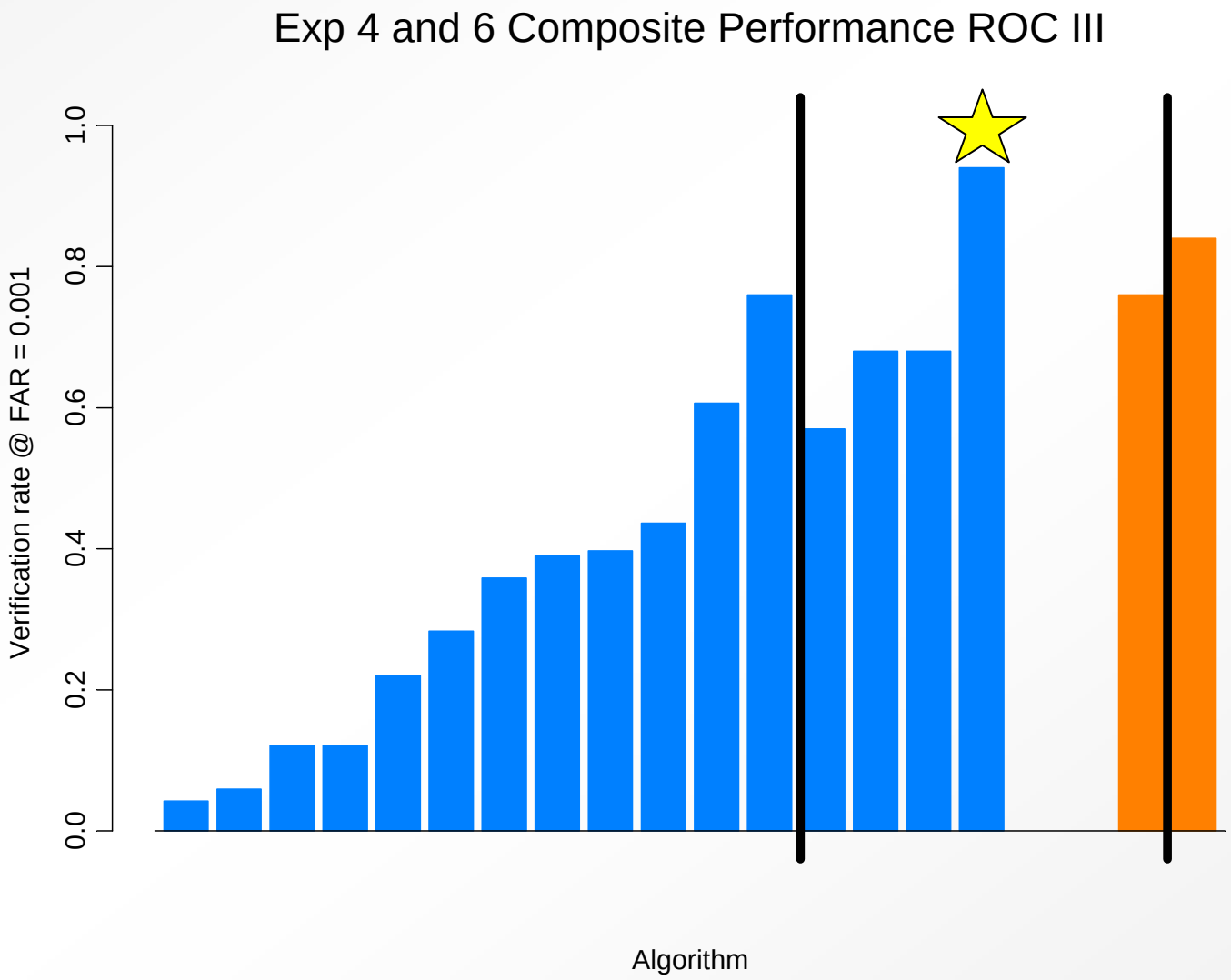
Exp. 3, 3s, and 3t







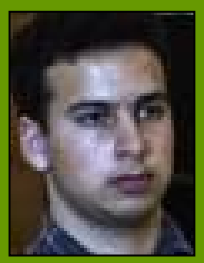
Exp 4 and 6


Exp 4 and 6 Composite Performance ROC III
Verification rate @ FAR = 0.001
0.0
0.2
0.4
0.6
0.8
1.0
Algorithm

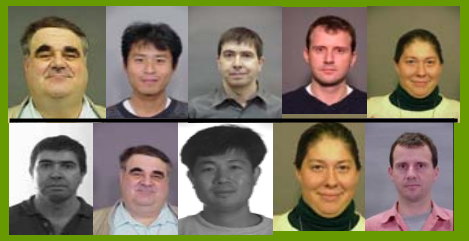
Scientific Questions

High Resolution

Computer Vision vs Pattern Recognition



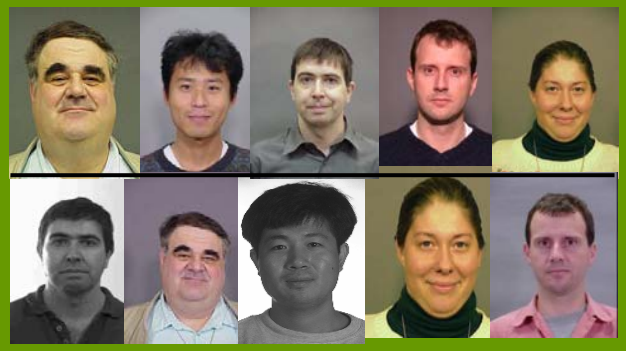
VS



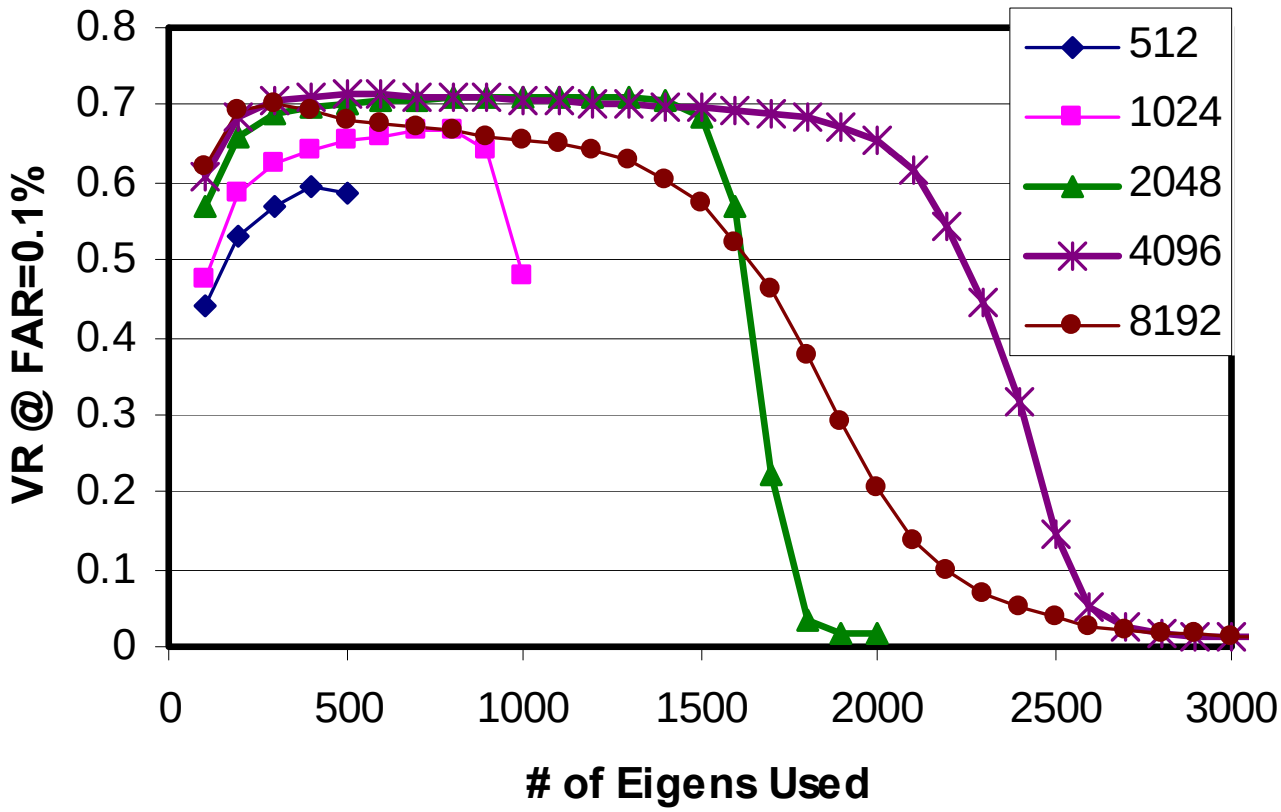
Scientific Questions

High Resolution

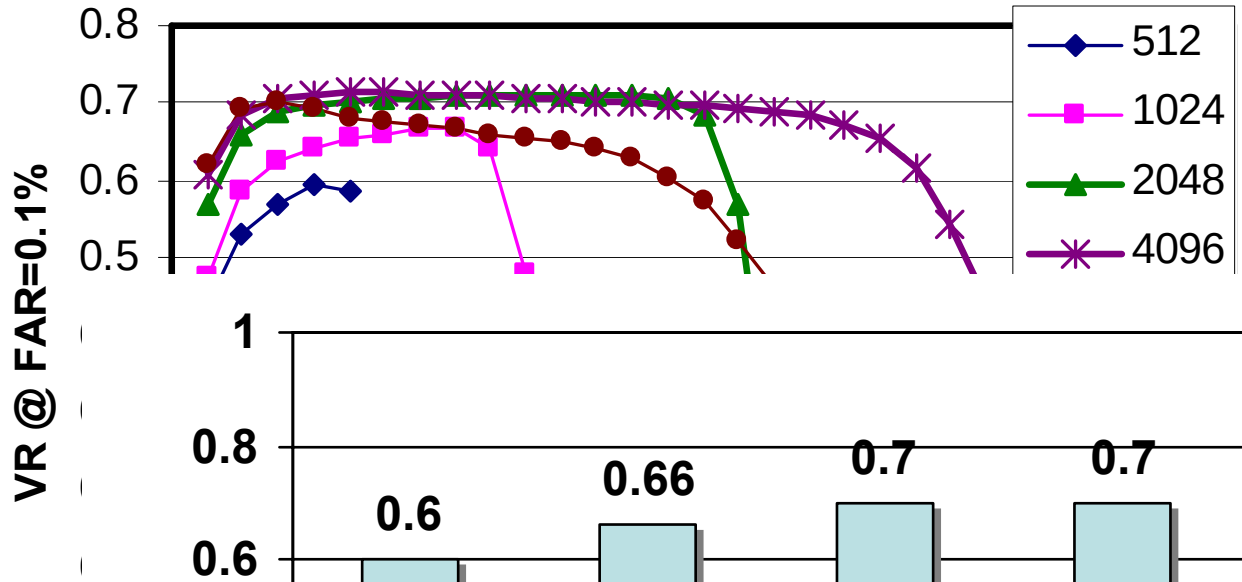
Effects of Training Set Size

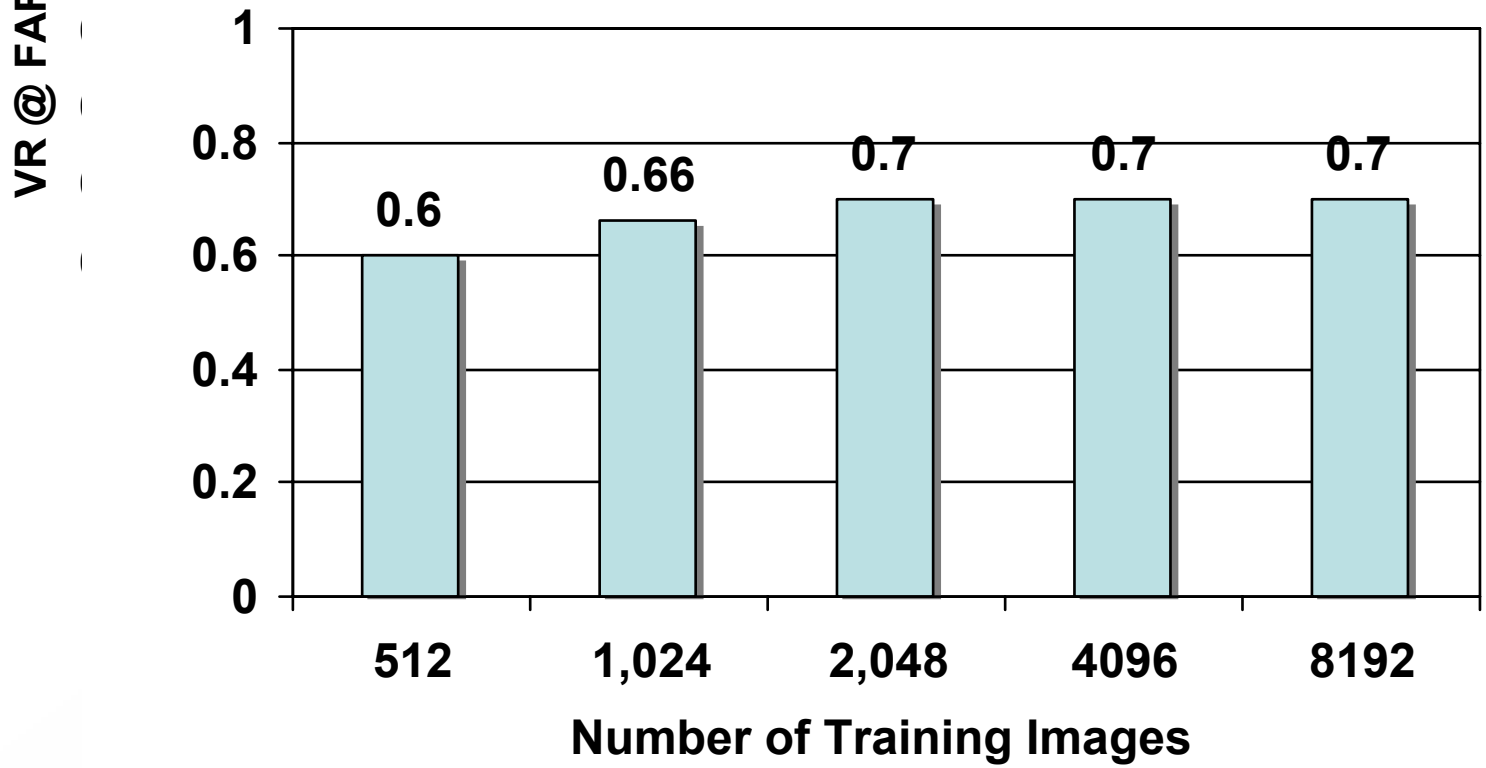


Training Set Size - Exp 1

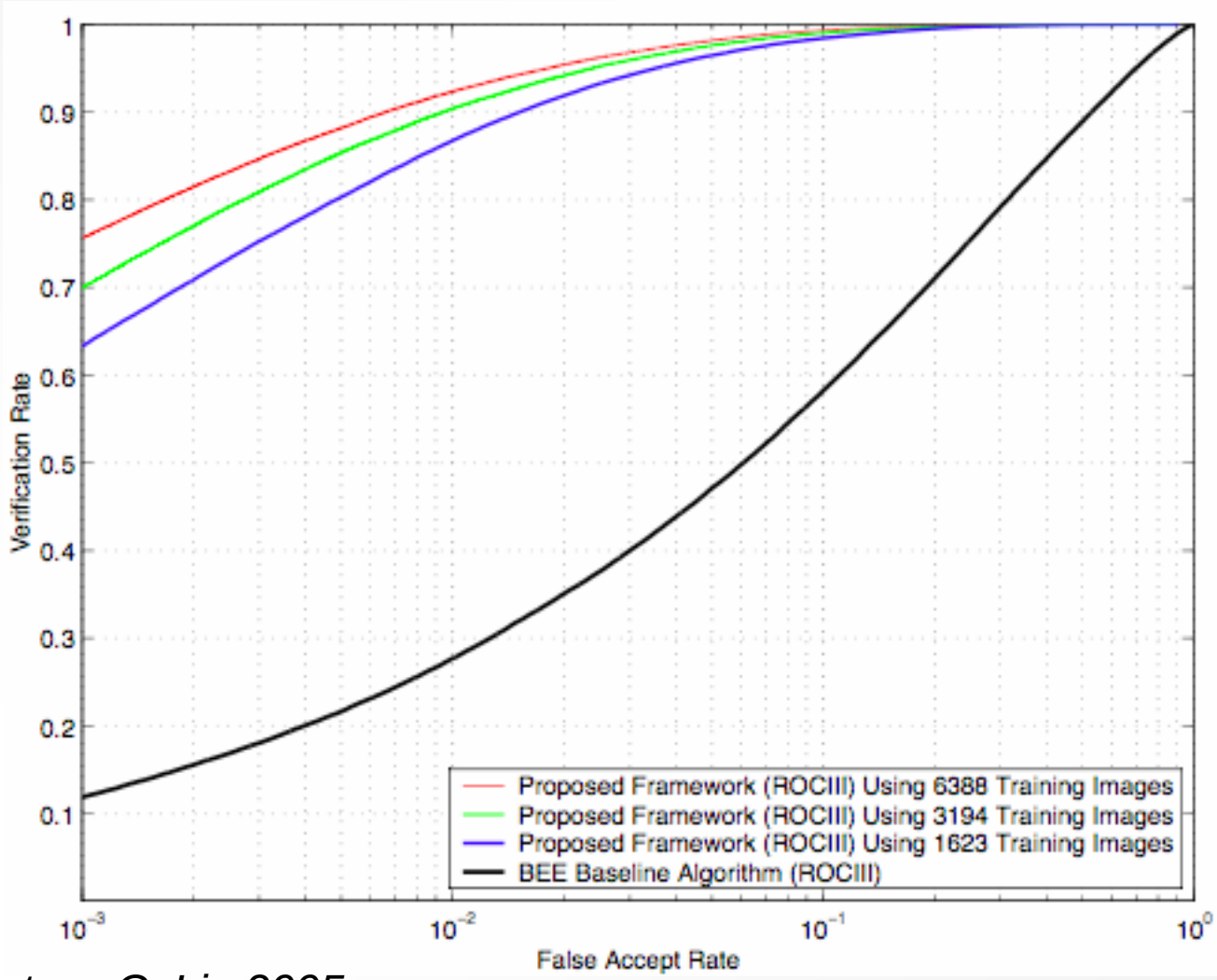


Training Set Size - Exp 1



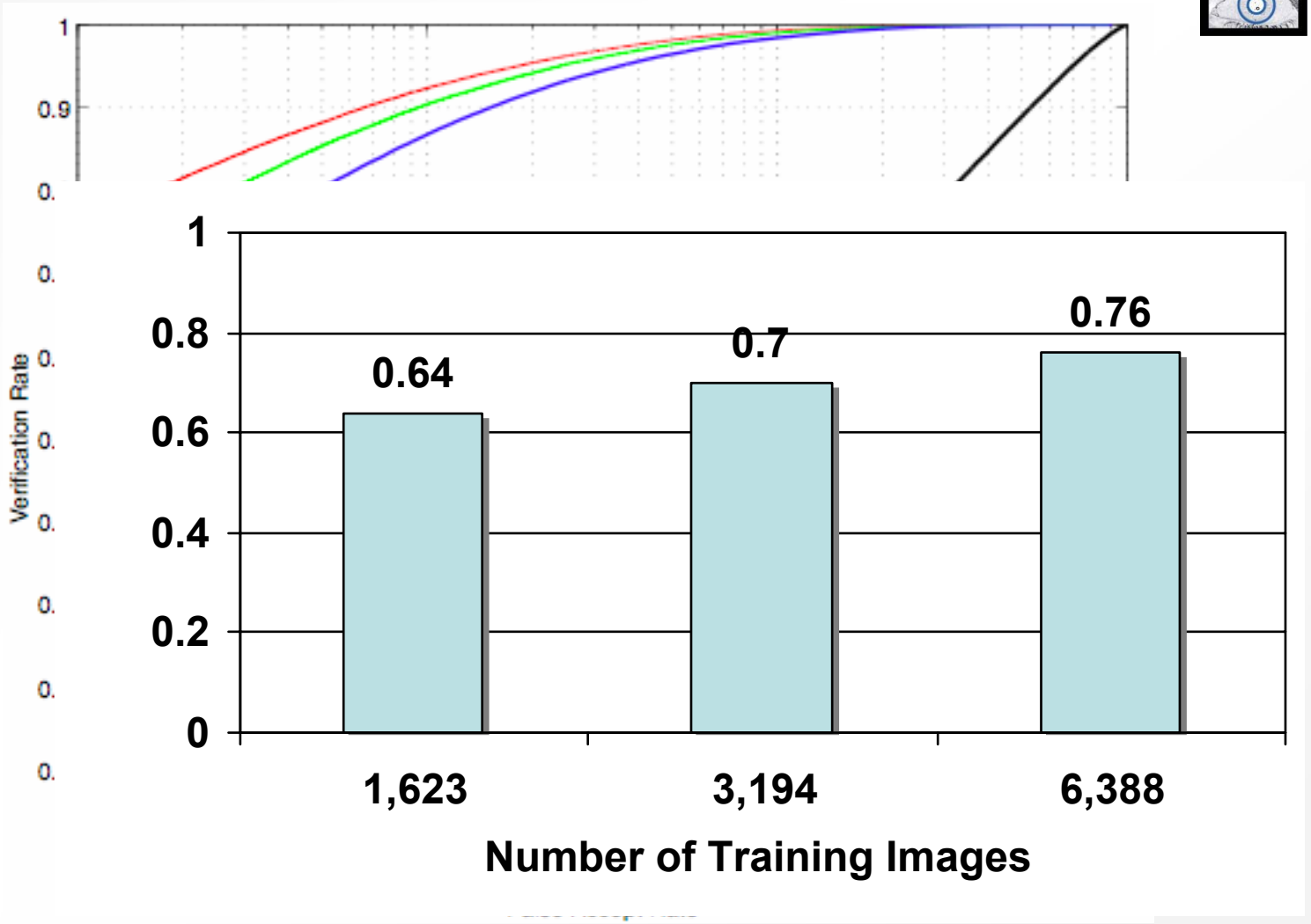


Training set size - Exp 4



Courtesy C. Liu 2005

Training set size - Exp 4



Courtesy C. Liu 2005

FRVT 2006

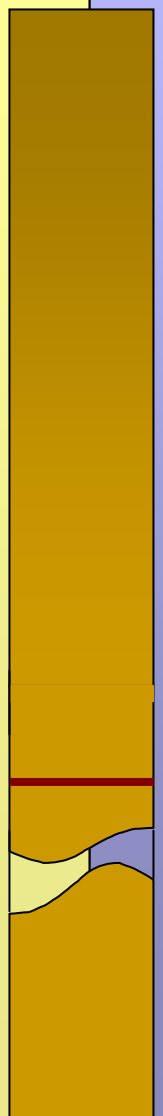
FACE RECOGNITION VENDOR TEST 2006

- Latest in a series of large scale independent evaluations for face recognition systems
  - Previous evaluations in the series were the FERET, FRVT2000, and FRVT 2002
- Primary goal is to
  - Measure progress of prototype systems/algorithms and commercial face recognition systems since FRVT 2002
  - Conduct comparison across modalities
  - Compare performance with FRGC goals

Performance Goals and Progress

Independent Evaluations (Gold Standard)

FRVT 2002



Starting Point 80%

Measured in FRVT 2002

FAR = 0.1%

Performance Goals and Progress

Independent Evaluations (Gold Standard)

Goal 98%

To be measured by FRVT 2006

Starting Point 80%

Measured in FRVT 2002

FAR = 0.1%

Performance Goals and Progress

Independent Evaluations (Gold Standard)

Goal 98%

To be measured by FRVT 2006

Starting Point 80%

Measured in FRVT 2002

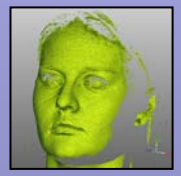
FAR = 0.1%

Face Recognition Grand Challenge (Qualified Results)

99.99% Multi-Still (Mar 06)

99% High Resolution Still (Mar 06)

98% Three-Dimensional (Mar 06)



* First set of results after 4 months in a 12 month period

Performance Goals and Progress

Independent Evaluations (Gold Standard)

FRVT 2006

Goal 98%

To be measured by FRVT 2006

Starting Point 80%

FRVT 2002

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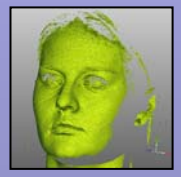

FRGC

* First set of results after 4 months in a 12 month period

Summary

- Face Recognition Grand Challenge
  - Order of magnitude increase in performance ☑
  - Systematically investigate still and 3D ☑
  - Formulate series of challenge problems ☑
  - Face Recognition Grand Challenge Completion March 2006 ☑

Next Steps

- FRGC Final Report
  - One more call for similarity files
    - Due **30 April 2006**
  - Provide a list of papers you've published on this subject

- FRVT 2006 Final Report
  - Completion estimated in Fall 2006

Publication of FRGC Results

- Check with sponsors to determine if they want to be cited

- Please include FRGC reference:
  - P. J. Phillips, P. J. Flynn, T. Scruggs, K. W. Bowyer, J. Chang, K. Hoffman, J. Marques, J. Min, W. Worek, *Overview of the Face Recognition Grand Challenge,* In Proceedings International Computer Vision and Pattern Recognition (CVPR) 2005.