Welcome to the Third FRGC Workshop

Dr. P. Jonathon Phillips - NIST

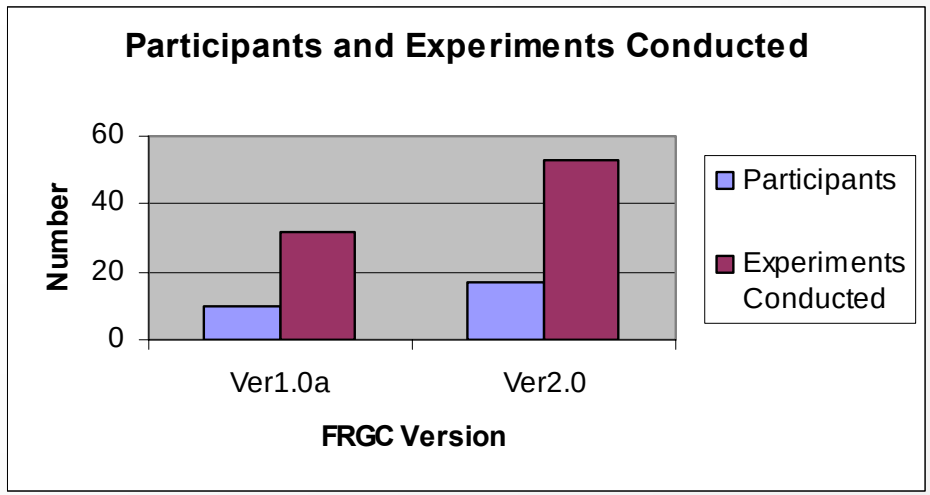
February 16, 2005

Sponsors

- Department of Homeland Security (DHS)
- Federal Bureau of Investigation (FBI)
- Intelligence Technology Innovation Center (ITIC)
- National Institute of Justice (NIJ)
- Technical Support Working Group (TSWG)

Participation

- Results received from ver1.0a by deadline
  - 10 Participants
  - 32 Experiments
- Results received from ver2.0 by deadline
  - 17 Participants
  - 53 Experiments



3rd FRGC Workshop Agenda

- FRGC Overview and Experiment Results
- Introduction to FRVT 2005
- Break
- Guest Speakers
  - Ross Beveridge, Colorado State University
  - David Kriegman, KBVT
  - Alice O'Toole, University of Texas at Dallas
  - Klaus Keus and Christoph Busch, German Face Recognition Testing
- Lunch
- Technical Presentations
- Adjourn

FRGC and FRVT 2005

Grand Challenge Team

- P. Jonathon Phillips—Director, FRGC
- Patrick Flynn—Notre Dame
- Todd Scruggs—SAIC
- Joe Marques—Mitre
- Kevin Bowyer—Notre Dame
- Jin Chang—Notre Dame
- Kevin Hoffman—SAIC
- Jaesik Min—Notre Dame
- William Worek—SIAC

Outline

- Overview of Face Recognition Grand Challenge (FRGC)
- Overview and Results of FRGC ver2.0
- Introduction to the Face Recognition Vendor Test (FRVT) 2005

FRGC and FRVT 2005

- What is the difference between FRGC and FRVT 2005?
  - FRGC (May 2004 – August 2005)
    - Still and 3D face recognition algorithm development project
  - FRVT 2005 (August/September 2005)
    - 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 Goal

- The primary goal of the FRGC is to:

> Promote and advance face recognition technology designed to support existing face recognition efforts in the U.S. Government

FRGC Primary Objective

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

Data Collection

Fall Semester

(Gallery)

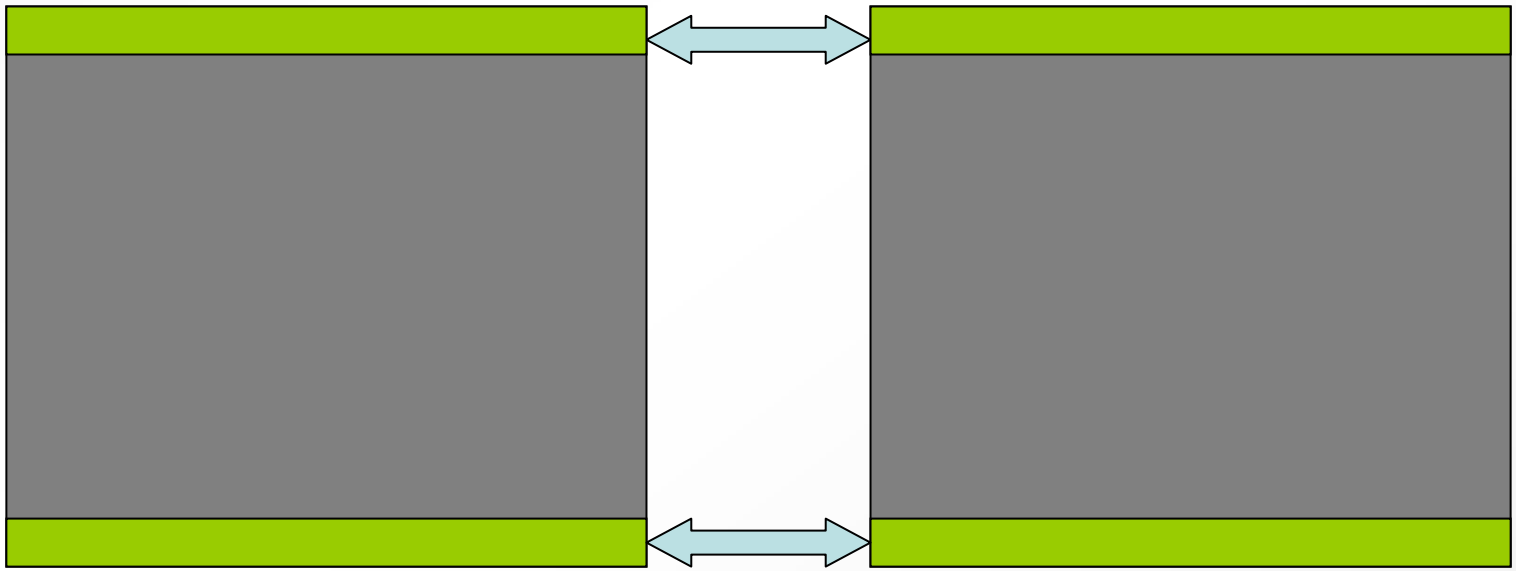
15 Weeks

Spring Semester

(Probes)

15 Weeks

200 People



200 People

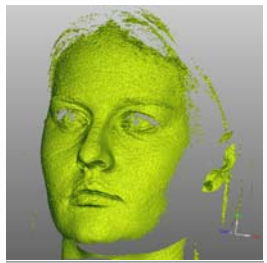
All match scores ~ 50,000

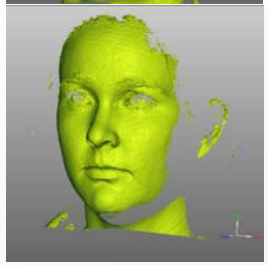
Modes Examined

Single Still

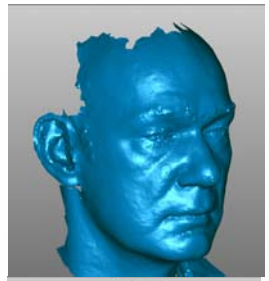
Outdoor/
Uncontrolled

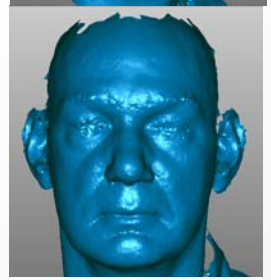
Multiple Stills





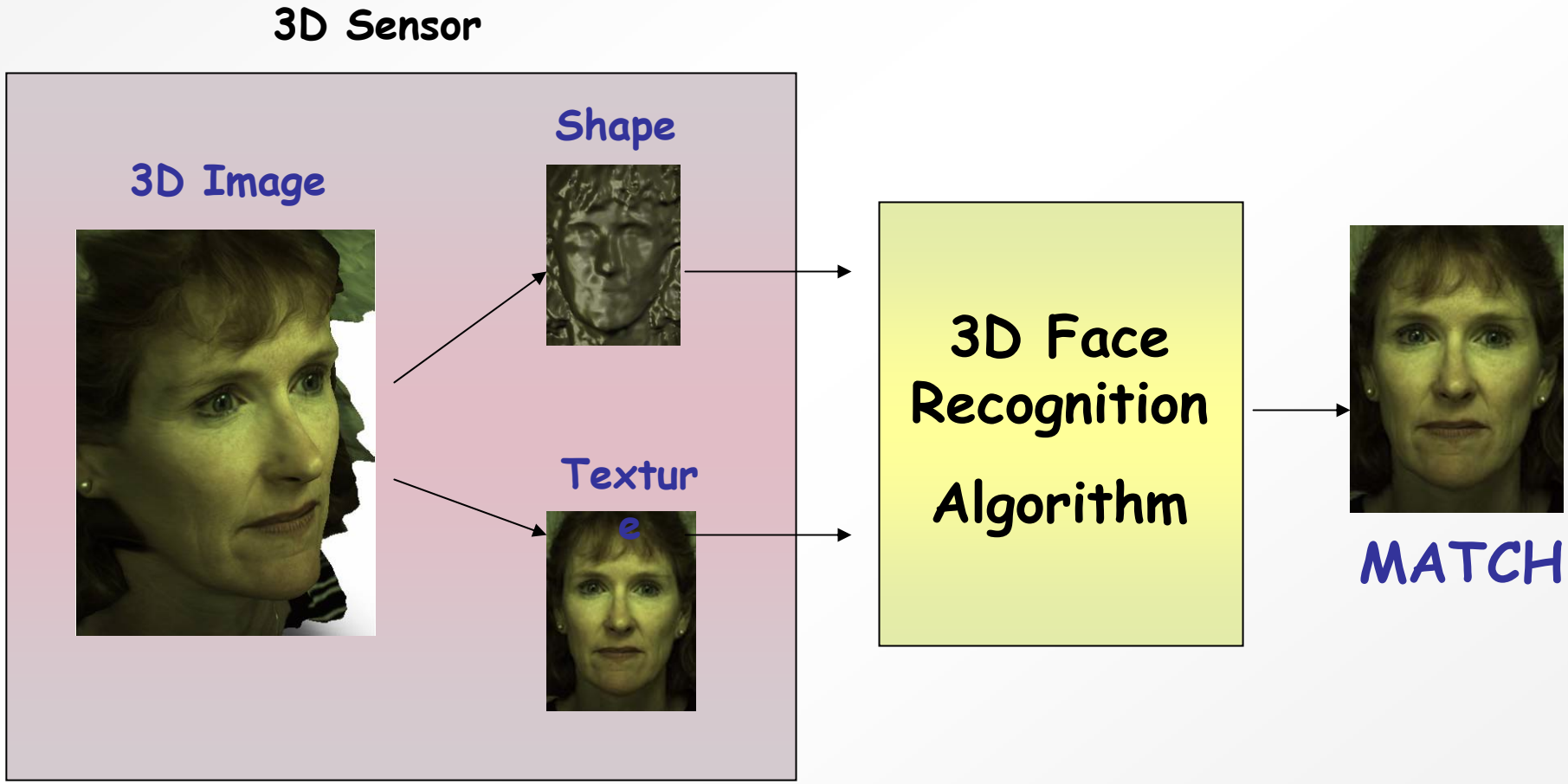
3D Single
view





3D Full Face

3D Images


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

Measure Progress on:

- Indoor cooperative face recognition
- Outdoor cooperative face recognition
- Comparison of still & 3D face recognition
- Effect of multiple images
- Effect of High Dynamic Range cameras on outdoor face recognition
- Comparison between human and machine performance

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

Grand Challenge Schedule

Aug-05	Face Recognition Grand Challenge Completion
21-Jun-05	FRGC Workshop at IEEE CVPR
Apr-05	Release Challenge Problem v2.X
Feb-05	**Third FRGC Workshop** - Participants Present Results from v2.0 - Announce Challenge Problem v2.X - Introduce FRVT 2005
14-Jan-05	Results to Challenge Problem v2.0 Submitted
27-Sep-04	Release Challenge Problem v2.0
10-Sep-04	**Second FRGC Workshop** - Participants Present Results from v1.0 - Explain Challenge Problem v2.0
5-May-04	Release Challenge Problem v1.0
5-May-04	**First FRGC Workshop** - Explain challenge problem v1.0 in detail

Completed

Challenge Problem

- Experimental Data set
  - Training set
  - Validation set
- Set of Experiments
  - Target & Query sets
- Biometric Experimentation Environment (BEE)
  - Infrastructure for Experiments
- Scoring Routines
- Baseline Algorithms

Three Challenge Problems

- Ver1.0a
  - Released 5 May 2004
  - 275 Subjects; 943 Subject sessions; 7544 Recordings
- Ver2.0
  - Released 27 September 2004
  - 466 Subjects; 4,007 Subject sessions; 32,056 Recordings
- Ver2.X
  - To be released April 2005

FRGC Challenge Problems

- FRGC consists of a series of three progressively difficult challenge problems
  - Ver1.0a: small data set to introduce problem area
  - Ver2.0: large data set designed for improving face recognition
  - Ver2.X: Additional data and experiments

FRGC Challenge Problems

- Ver2.X:
  - Additional data
    - Samples from AY 2004-05 data collection
    - Compression
  - New Experiments
  - Covariate analysis
  - Normalization

How to Participate

- To participate in the FRGC:
  - Send email request to: jonathon@nist.gov
  - Once approved, obtain the two parts of ver1.0a
    - Part 1 is the data
      - Obtain data by contacting Pat Flynn at: flynn@nd.edu and signing the data license agreement
    - Part 2 is the Biometrics Experimentation Environment (BEE), which includes the 6 experiments
      - Obtain BEE by contacting Todd Scruggs at wendell.t.scruggs@saic.com and signing the BEE license
  - Register on bulletin board for FRGC updates at http://bbs.bee-biometrics.org

Getting the FRGC v2 Data

- Roughly 50 K files, 70 GB storage

  - **Submit ver1.0 results to Jonathon**
  - **Receive OK from Jonathon**

- Get new license from FRGC ver2.0 topic Sign v2 release form obtained from www.bee-biometrics.org
- Obtain a 120GB or larger external drive with FireWire (IEEE1394) or USB 2.0 interface
- Send form and disk to address on form
- Receipt of disk will be acknowledged by e-mail
- Disks will be shipped 1 to 2 weeks after their receipt
- Data will reside on a Linux ext2 filesystem on the disk's first partition
- Disks will be return by UPS ground shipping cheap rate.

Overview and Results
FRGC ver1.0a

Goals of ver1.0a

- Introduce participants to FRGC
- Provide sample of data
- FRGC challenge problem
- BEE
  - Architecture
  - Baseline Algorithms

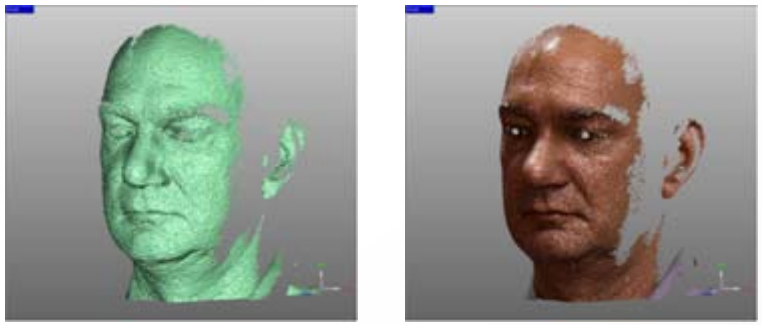
Ver1.0a Timeline

- 5 May '05: ver1.0a released
- 10 Aug '05: Results due for ver1.0a
- 10 Sept '05: Second FRGC Workshop
  - Summary of results for ver1.0a

Example subject session

Controlled Still

Uncontrolled Still

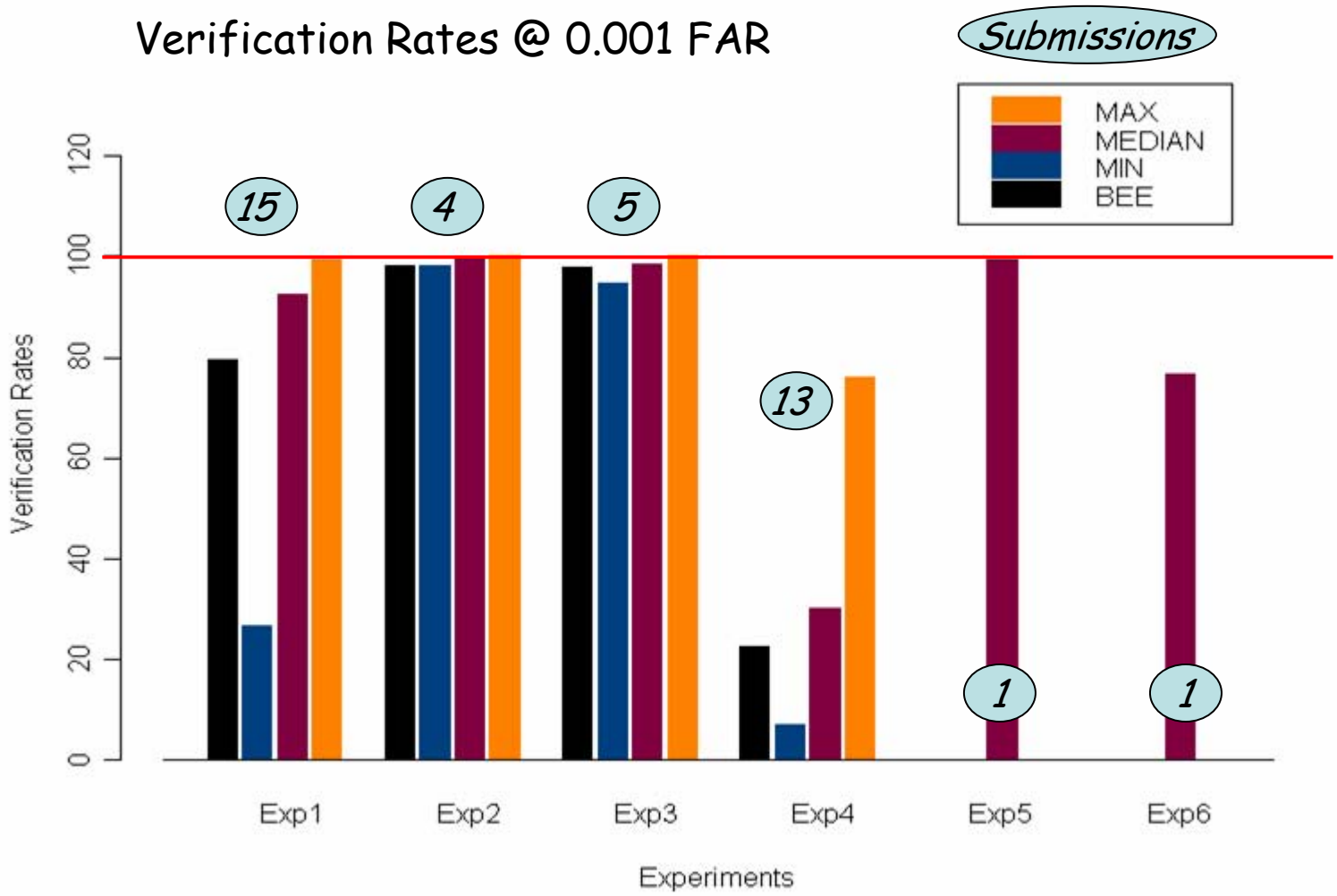


3D Image

FRGC Core Experiments

- Exp 1: Controlled indoor still versus indoor still
- Exp 2: Indoor multi-still versus indoor multi-still
- Exp 3: 3D versus 3D
- Exp 4: Controlled indoor still versus uncontrolled still
- Exp 5: 3D versus controlled single still
- Exp 6: 3D versus uncontrolled single still

Experimental Results Summary



Overview and Results of ver2.0

Outline

- Data and challenge problem
- Generalized verification protocol
- Baseline Performance
- Results from Ver2.0

Goals of ver2.0

- FRGC challenge problem
  - Test ability to run experiments on very large data set
  - Challenge researchers to meet the FRGC performance goal
    - Increase FR performance levels by an order of magnitude

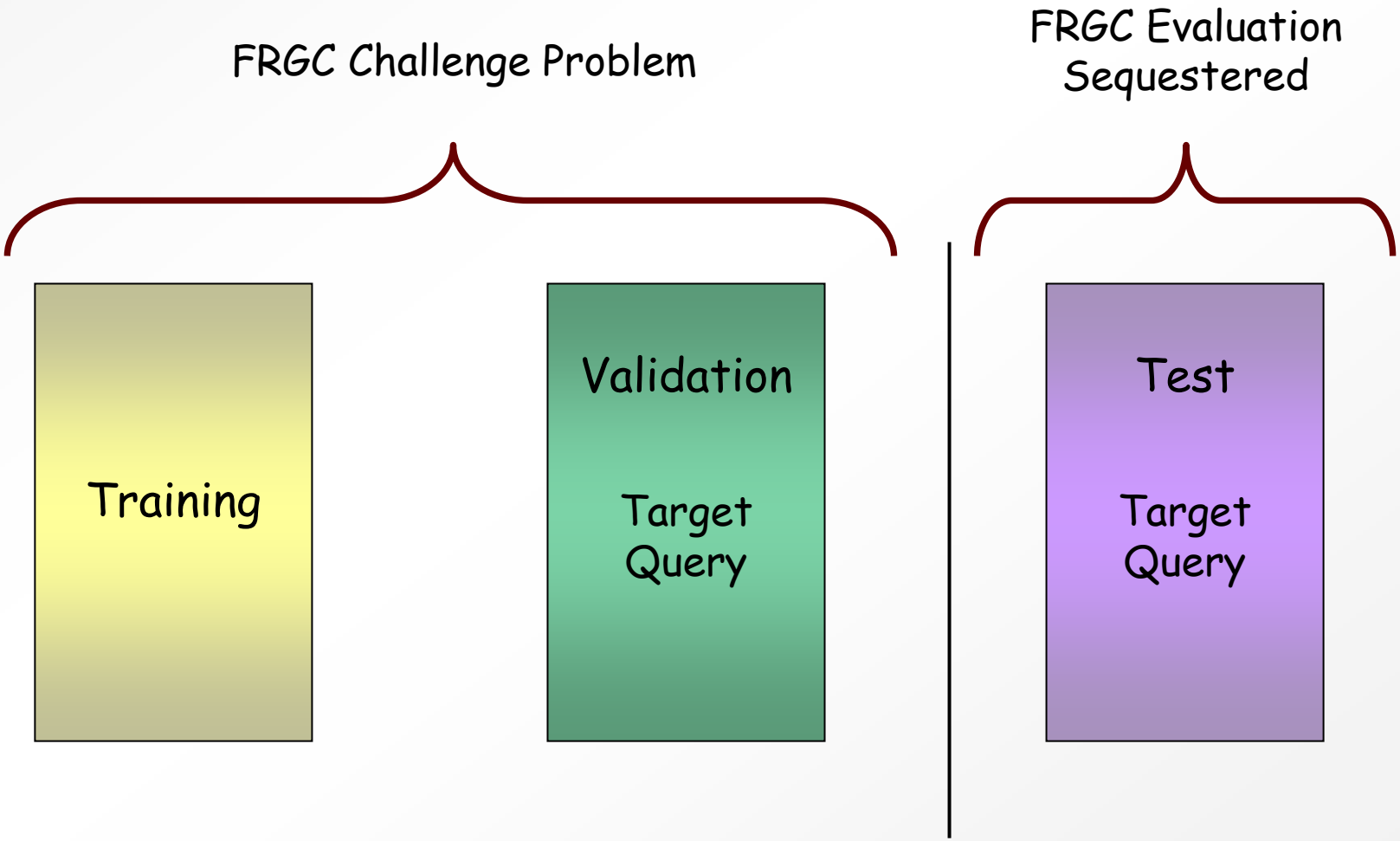
Ver 2.0 Timeline

- 27 September 2004: Release ver2.0
- 14 January 2005: Similarity matrices results due
- 16 February 2005: Third FRGC Workshop
  - Summary of Results

Training and Validation Partitions

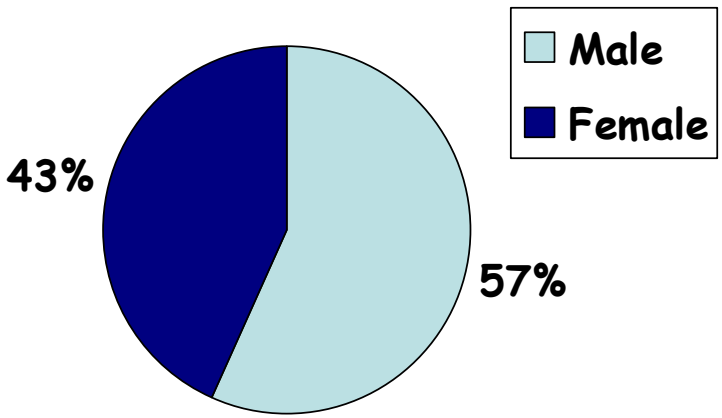
Training	Validation
- Academic Year 2002-03 - 12,776 Large Still Training Set - 943 3D Subject Sessions	- Academic Year 2003-04 - 16,028 Controlled Stills - 8,014 Uncontrolled Stills - 4,007 3D Scans

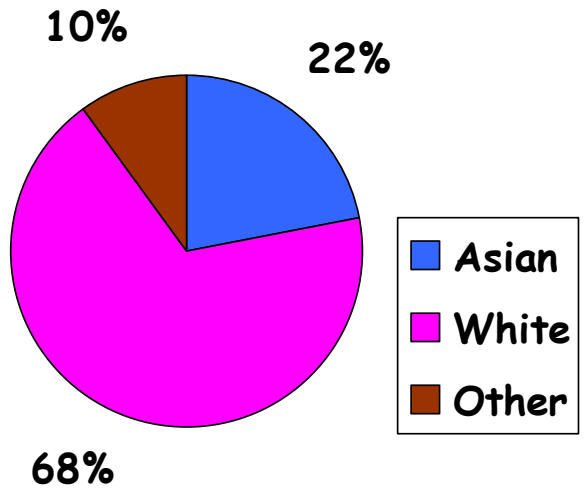
Three Data Sets

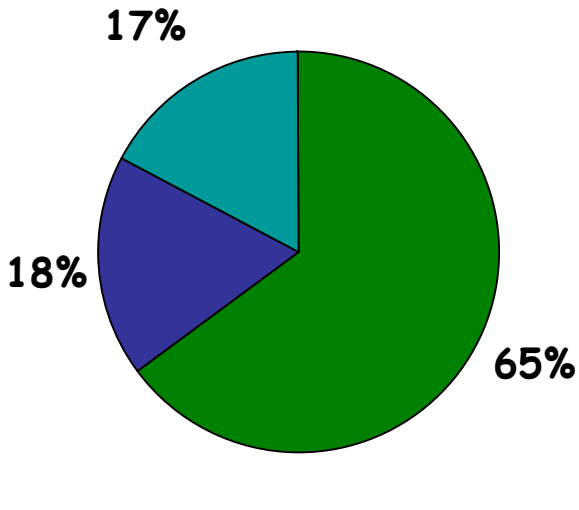


Demographics

(ver2.0 Validation Partition—Final)







Size of Faces
(ver2 On Validation)

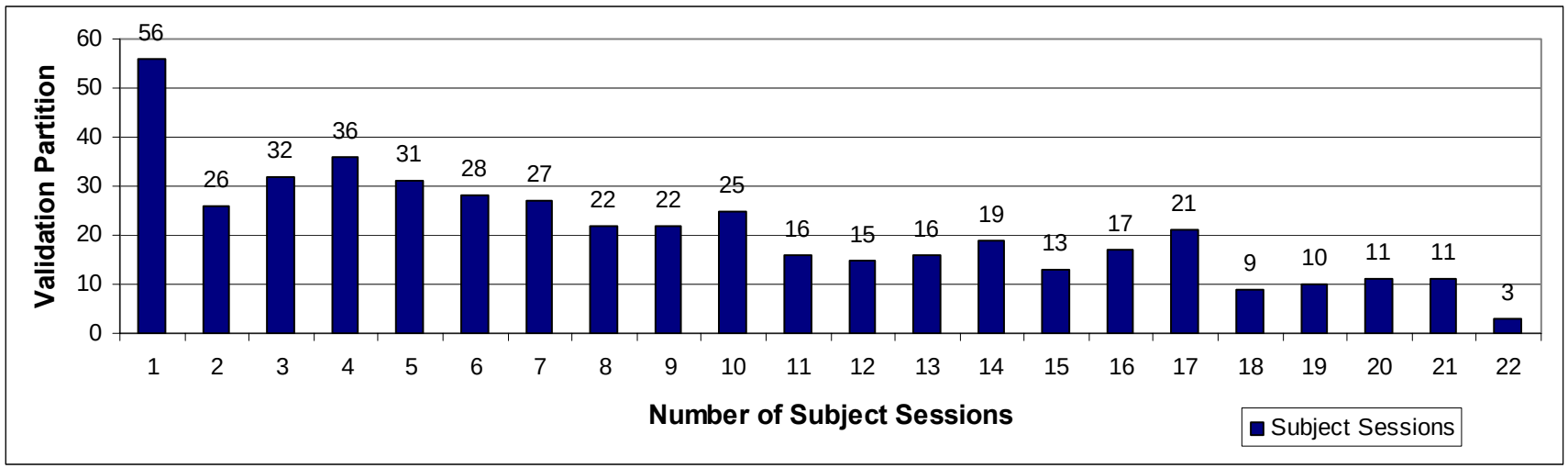
Pixels between center of eyes

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

Target / Query Sets

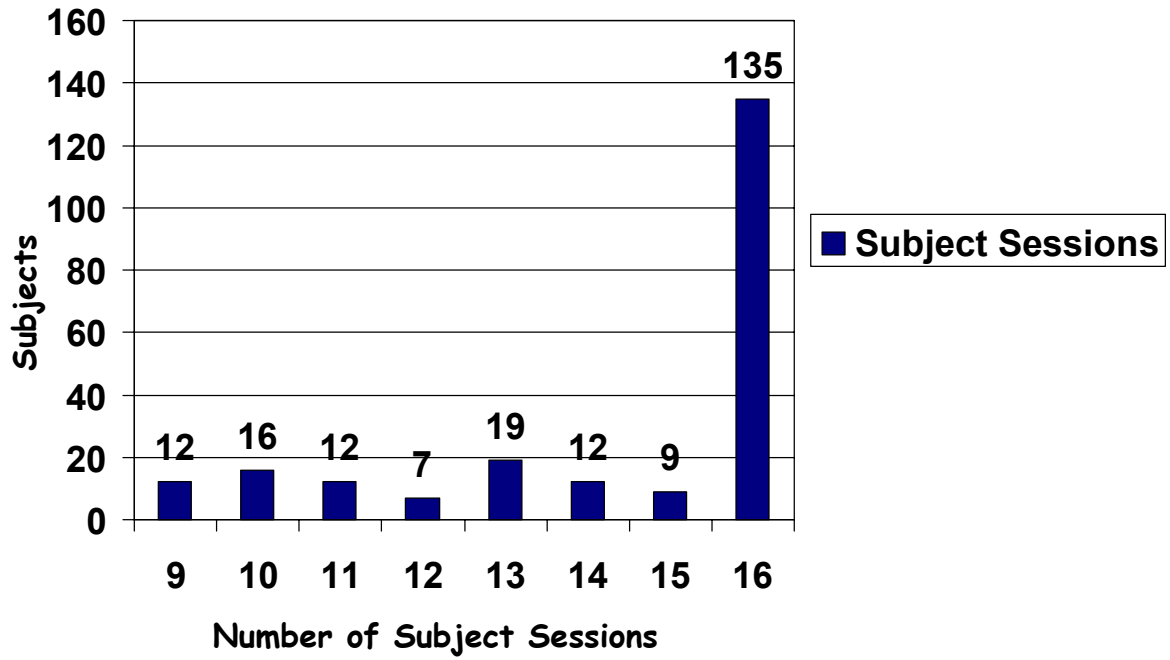
(ver2.0 Validation Partition—Final)

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



Large Still Training Set

222 Subjects; 100 Subject sessions; 12,776 Recordings



Generalized Verification Protocol

- Motivation
  - Increase number of match scores
  - Covariate analysis
  - Sampling of match and non-match distributions

Generating Match Scores

Fall

1 Image per Person

5 People

Spring

5 Images per Person

5 People

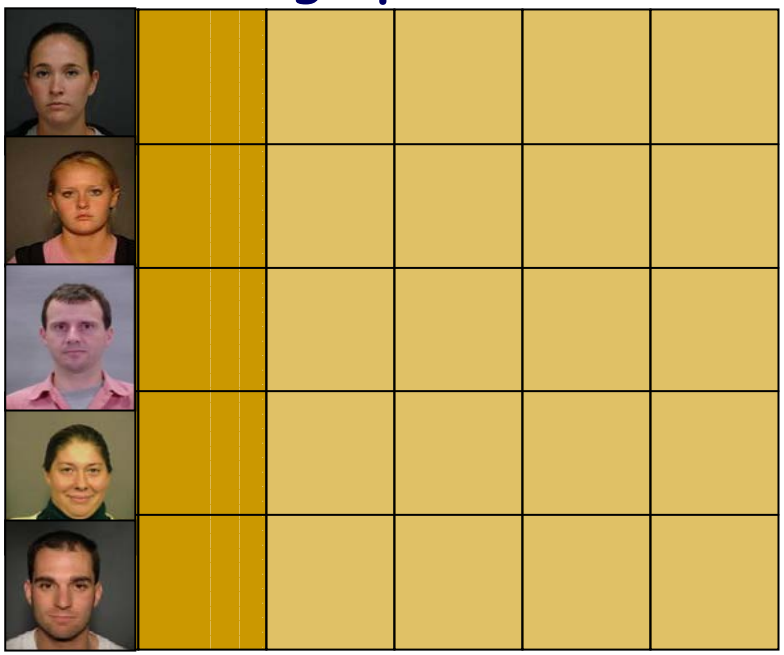
1 • 5 • 5 = 25 Match Scores

Generating Match Scores

Fall

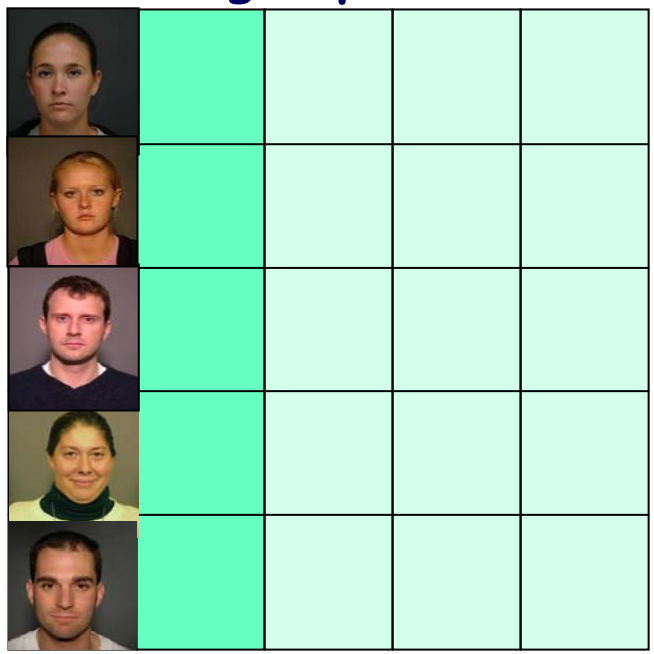
6 Image per Person

5 People



Spring

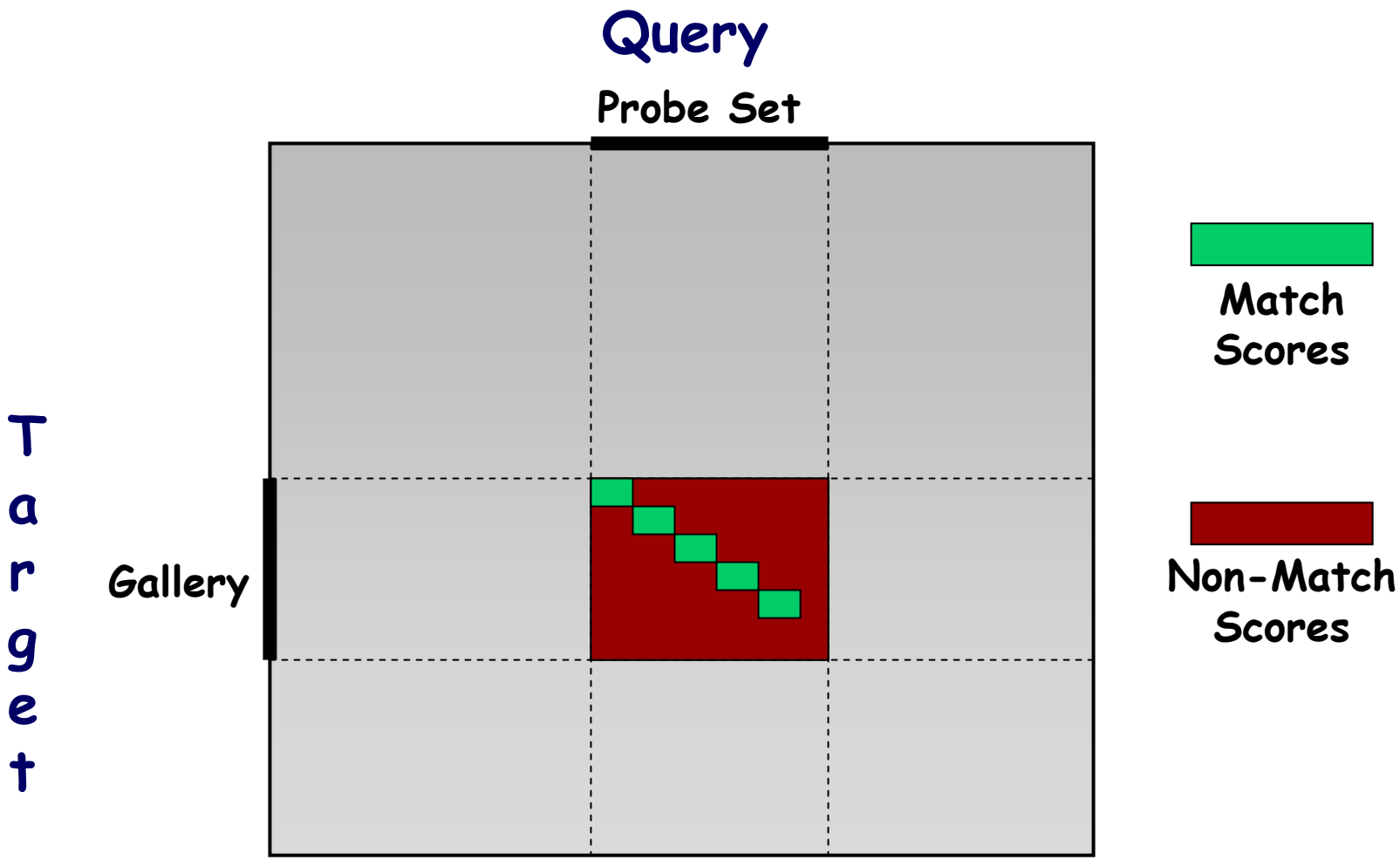
5 Images per Person



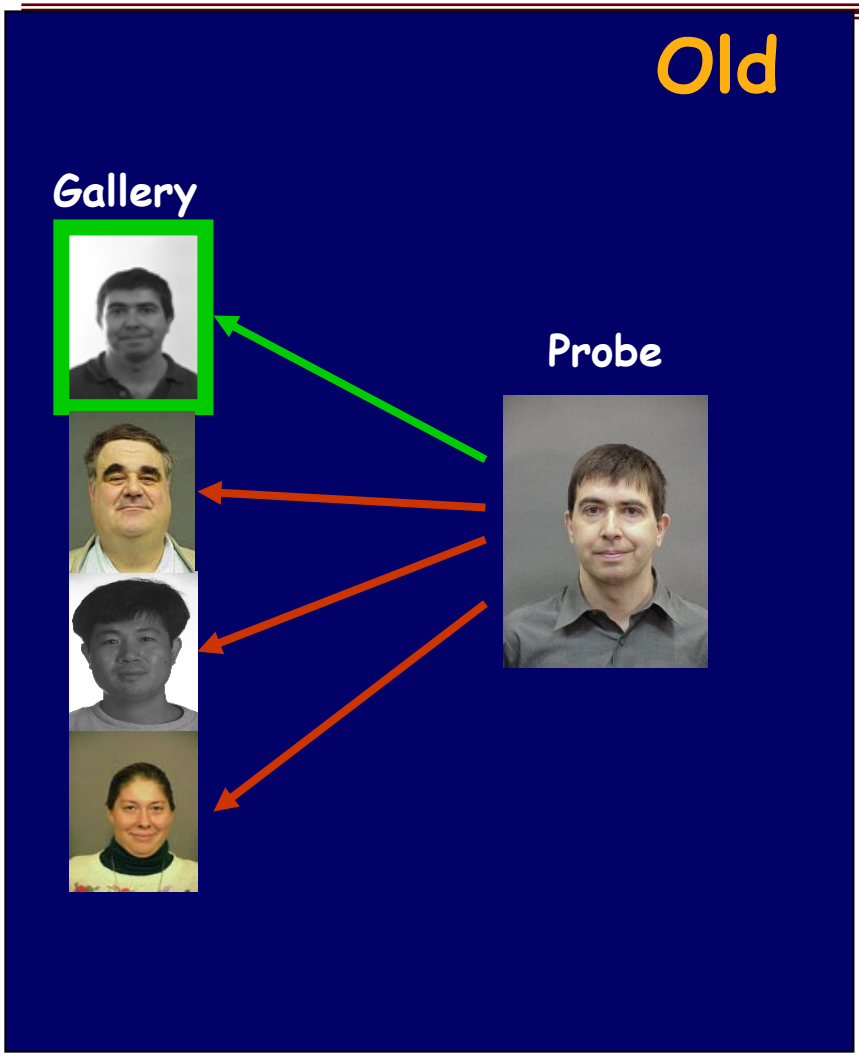
5 People

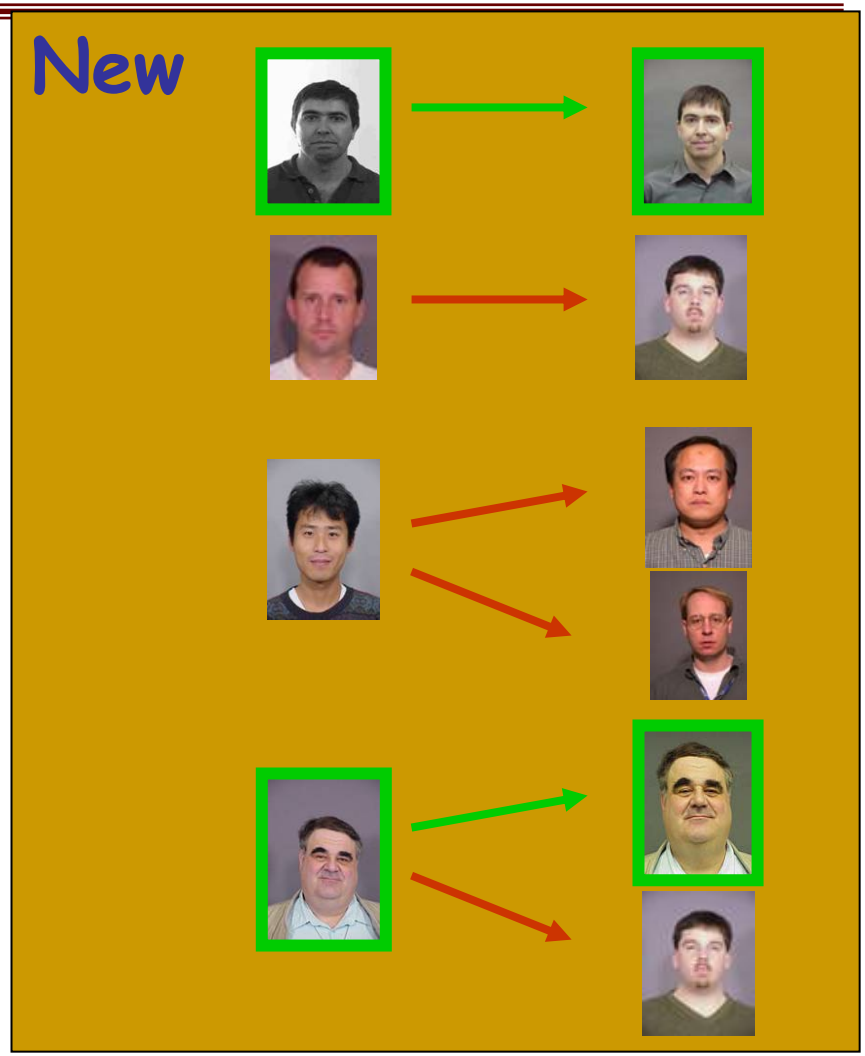
6 • 5 • 5 = 150 Match Scores

FERET & FRVT Verification Protocol

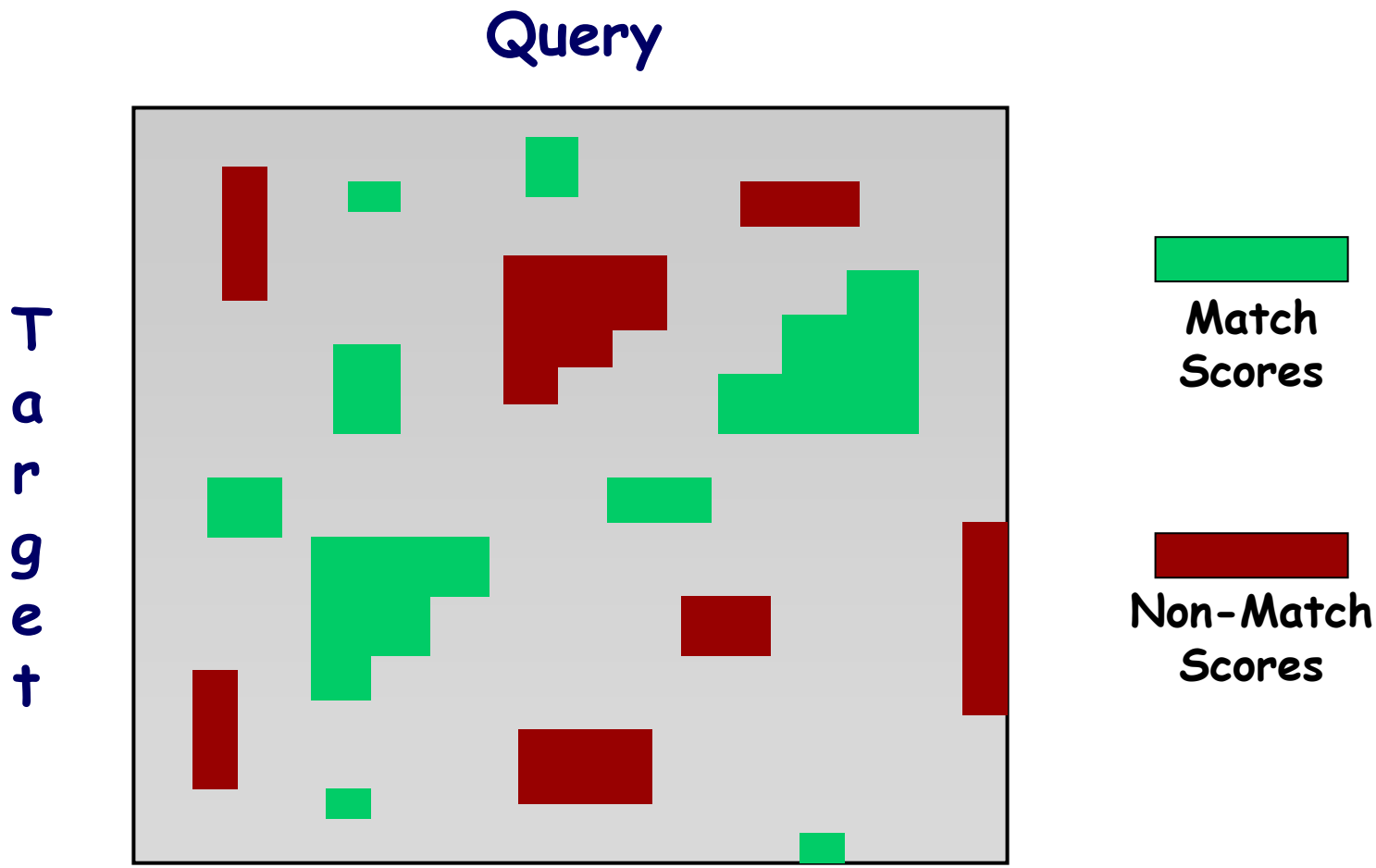


Old vs New Method



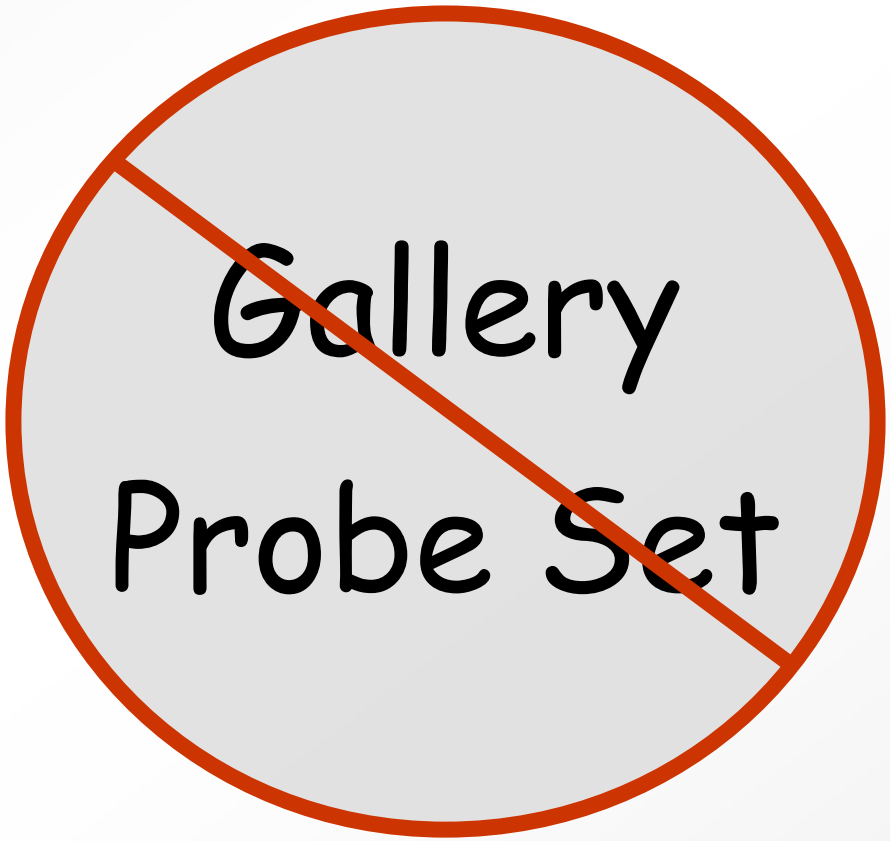


Generalized Verification Protocol

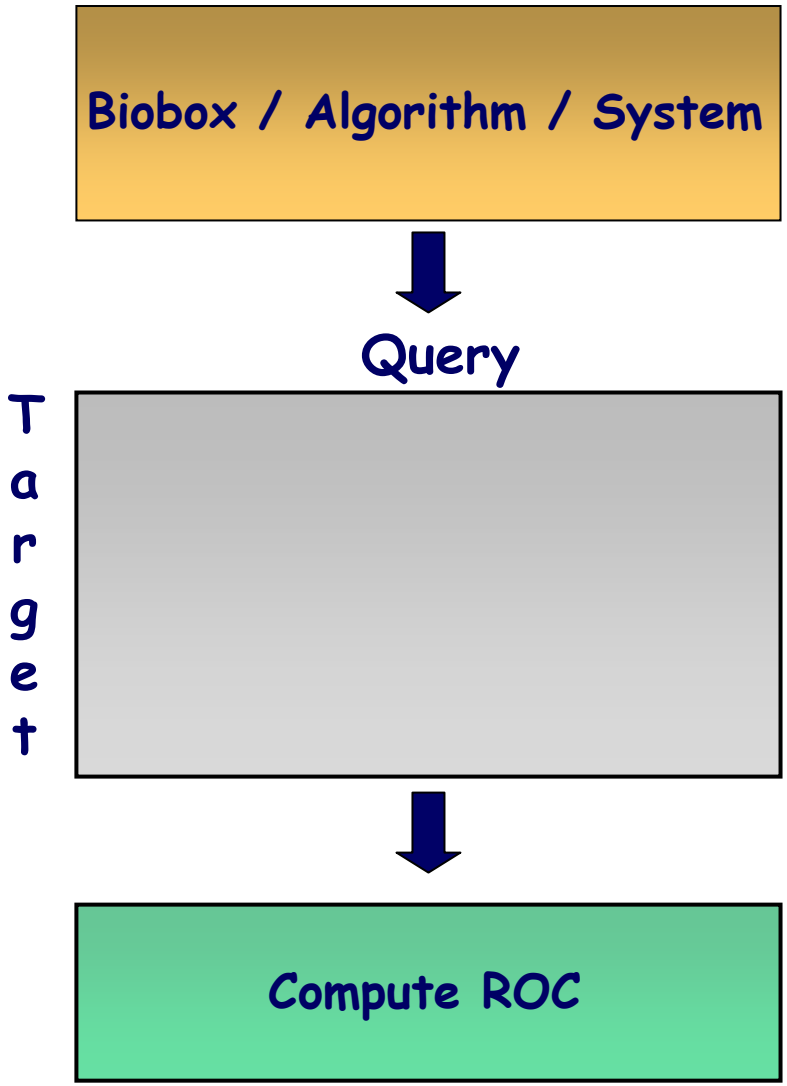


Generalized Verification Protocol

- Only for verification—NO identification



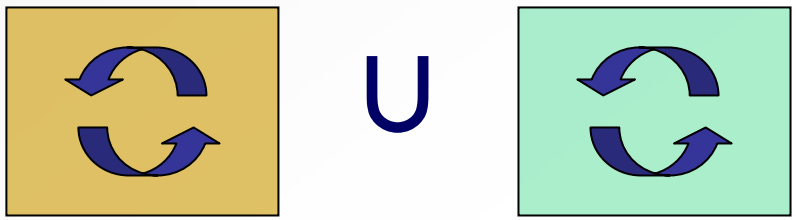
Similarity Matrix



Target / Query
Similarity Matrix

Three ROCs

ROC I - Within Semesters

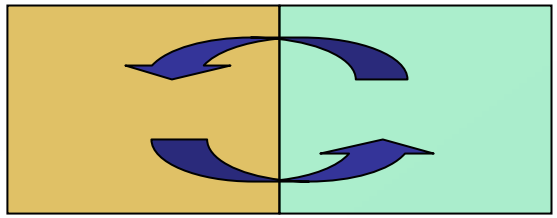


ROC I

Exp 1: 173k

Exp 3: 11k

ROC II – Within Year

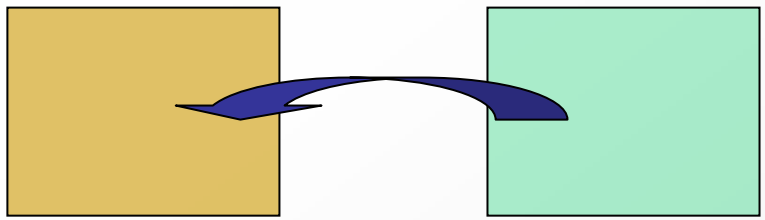


ROC II

Exp 1: 346k

Exp 3: 22k

ROC III – Between Semesters



ROC III

Exp 1: 173k

Exp 3: 11k

Similarity Score Normalization

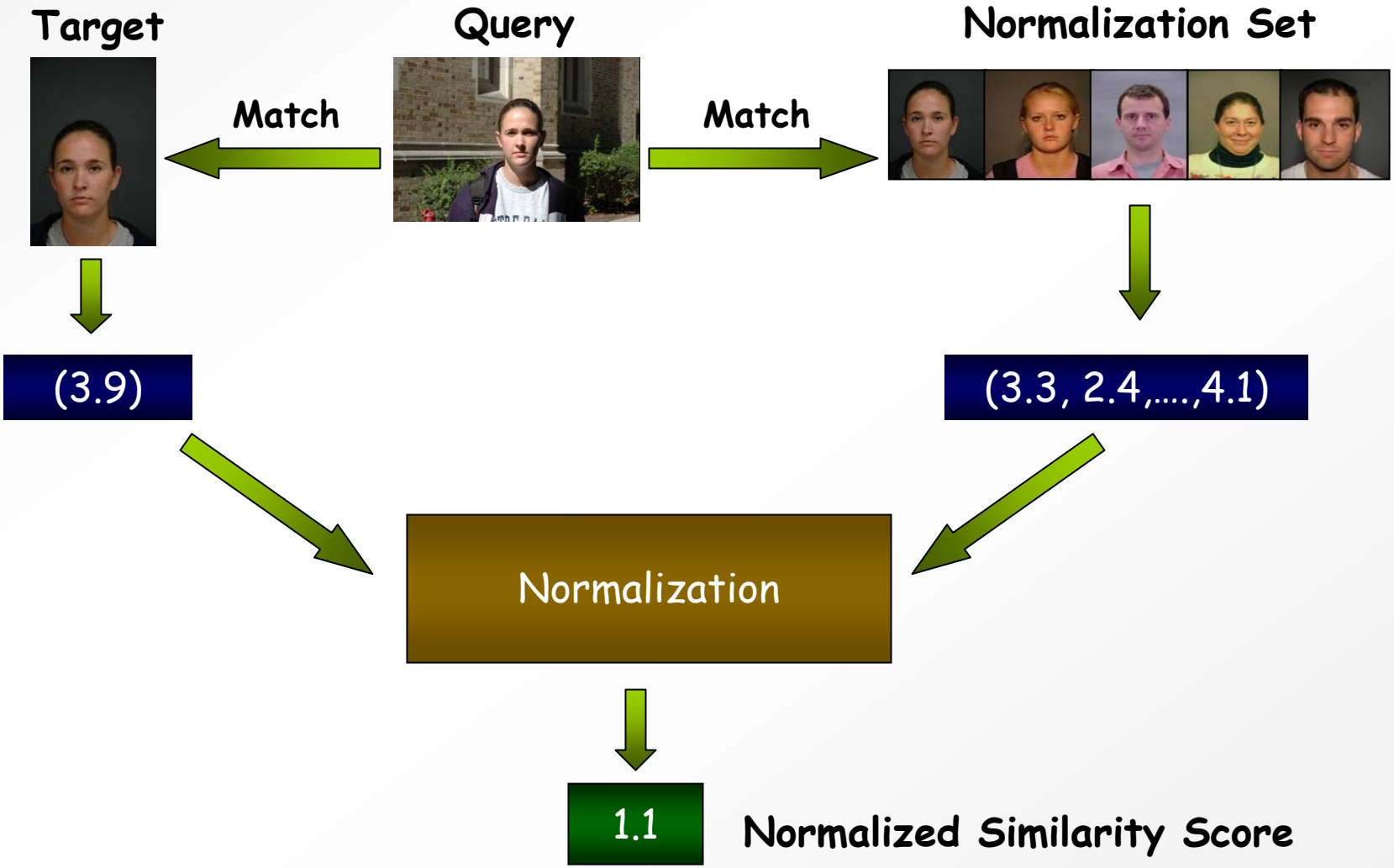
- Post processing similarity scores
- Can improve verification performance

Classical Similarity Score Normalization

Generalized Verification Protocol

How do I normalize?

Normalization Set



Baseline Performance

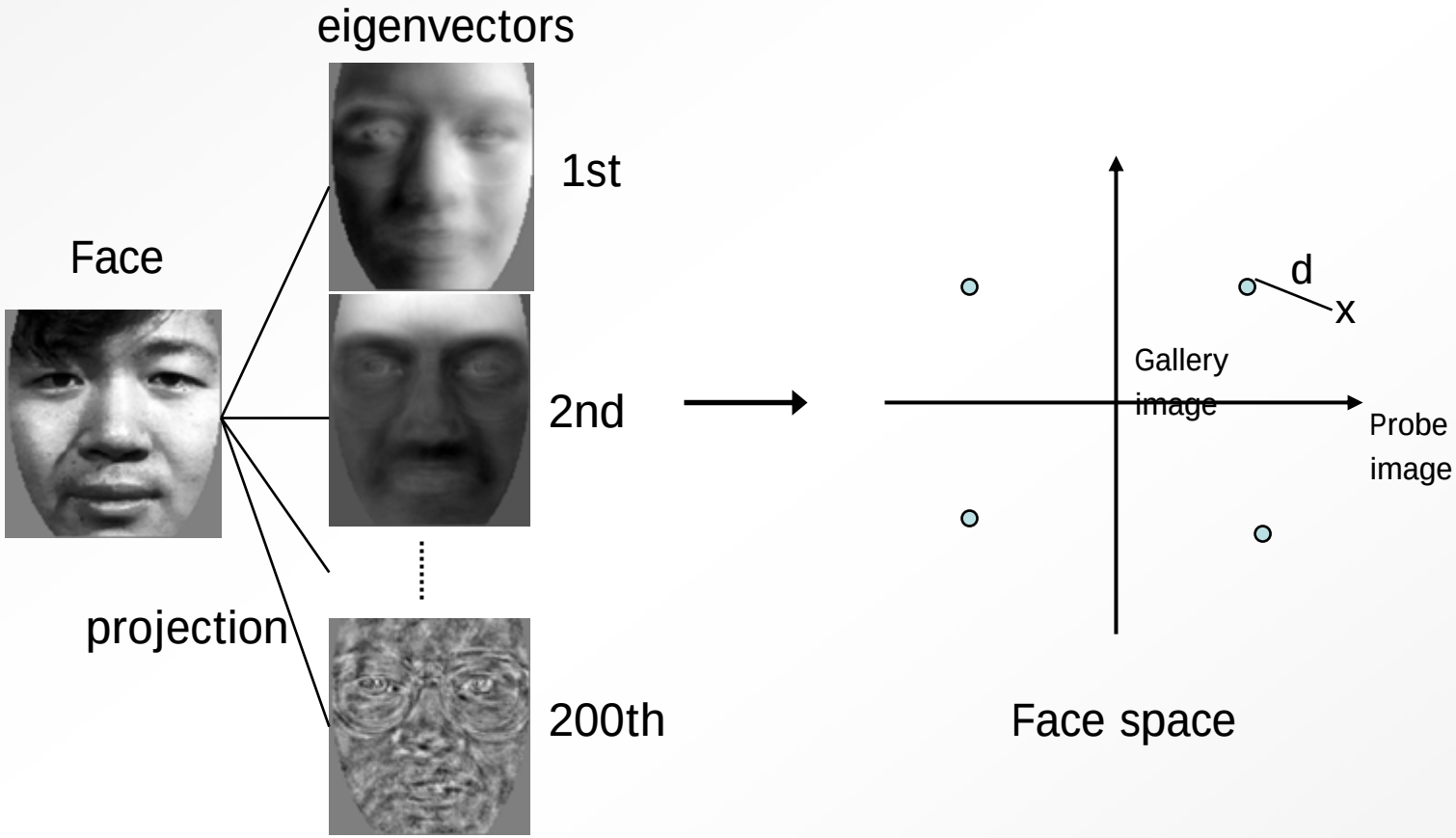
FRGC Core Experiments

- Exp 1: Controlled indoor still versus indoor still
- Exp 2: Indoor multi-still versus indoor multi-still
- Exp 3: 3D versus 3D
- Exp 4: Controlled indoor still versus uncontrolled still
- Exp 5: 3D versus controlled single still
- Exp 6: 3D versus uncontrolled single still

Size of ver2.0 Experiments

Exp.	Target set size	Query set size	No. Sim Scores (million)
1	16,028	16,028	257
2	4,007	4,007	16
3	4,007	4,007	16
4	16,028	8,014	128
5	4,007	16,028	64
6	4,007	8,014	32

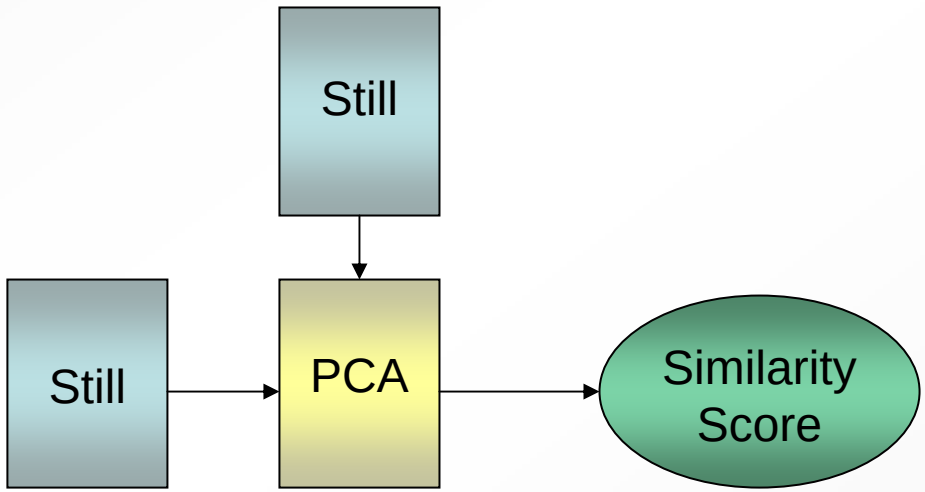
Baseline algorithm—PCA



- Whiten Cosine distance for classifier

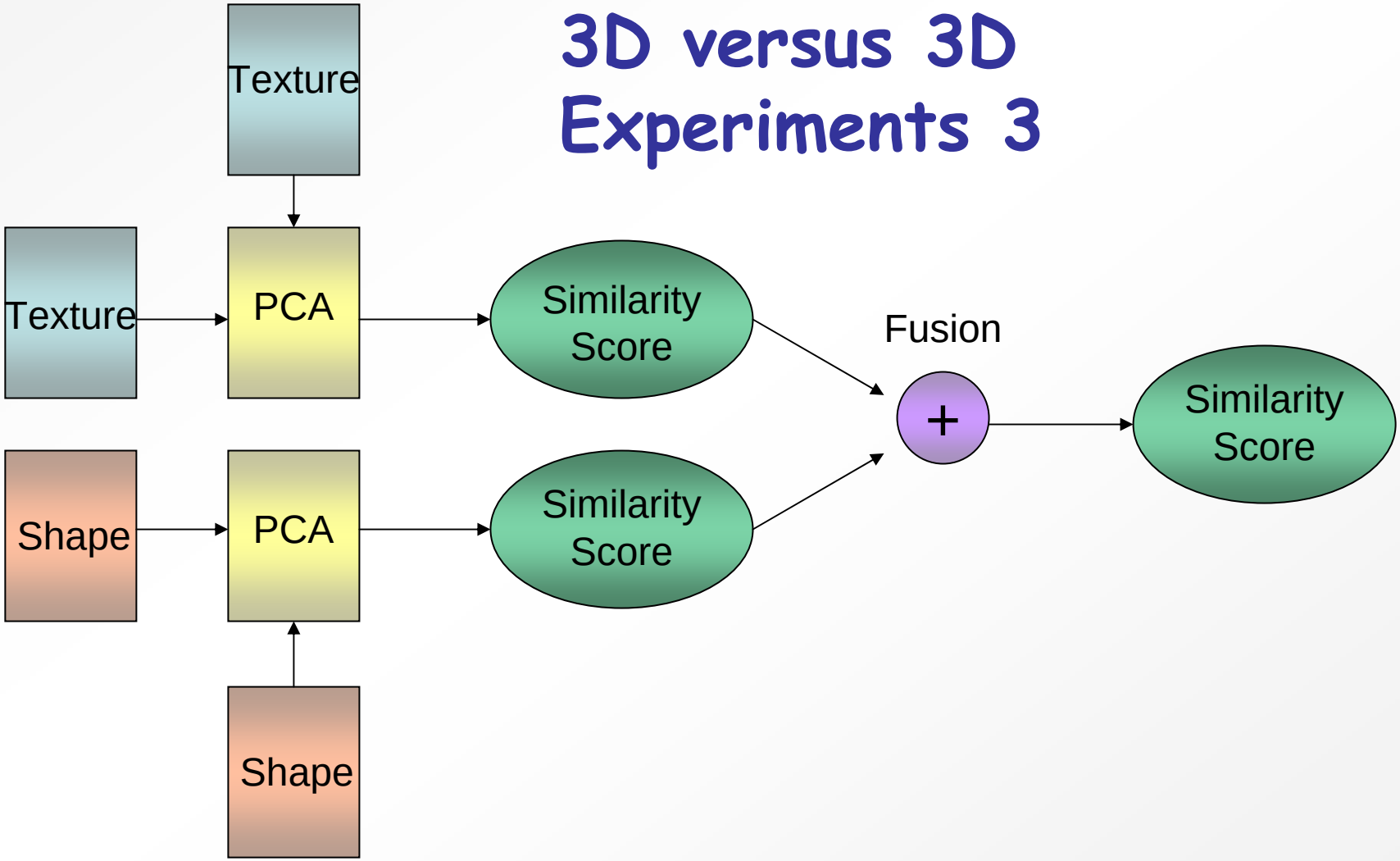
Baseline Algorithms

Still versus Still Experiments 1 and 4

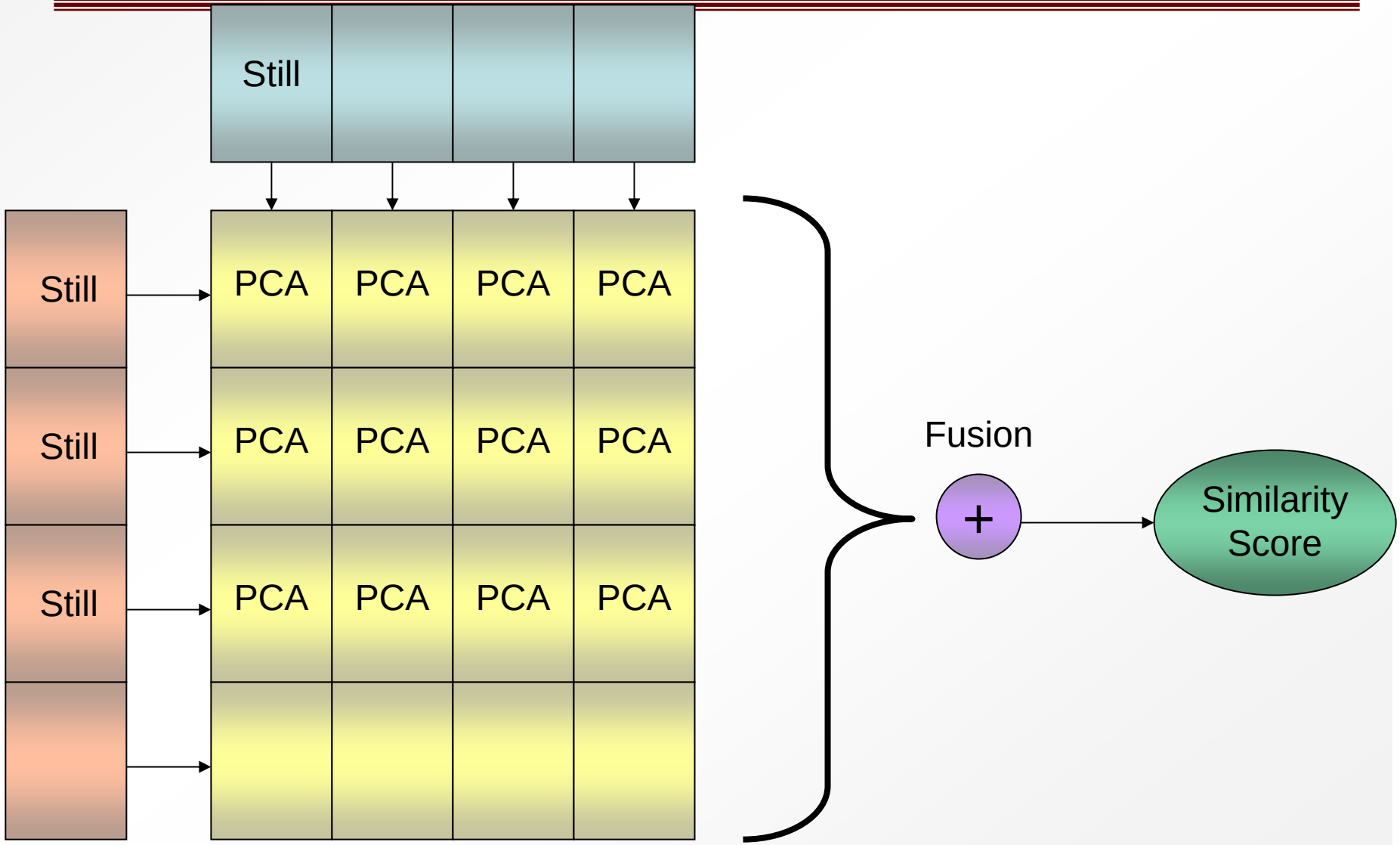


Baseline Algorithm

3D versus 3D Experiments 3



Multi-still versus Multi-still Experiment 2



Results of FRGC ver2.0 Challenge Problem

Participation

- Results received from ver1.0a by deadline
  - 10 Participants
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- Results received from ver2.0 by deadline
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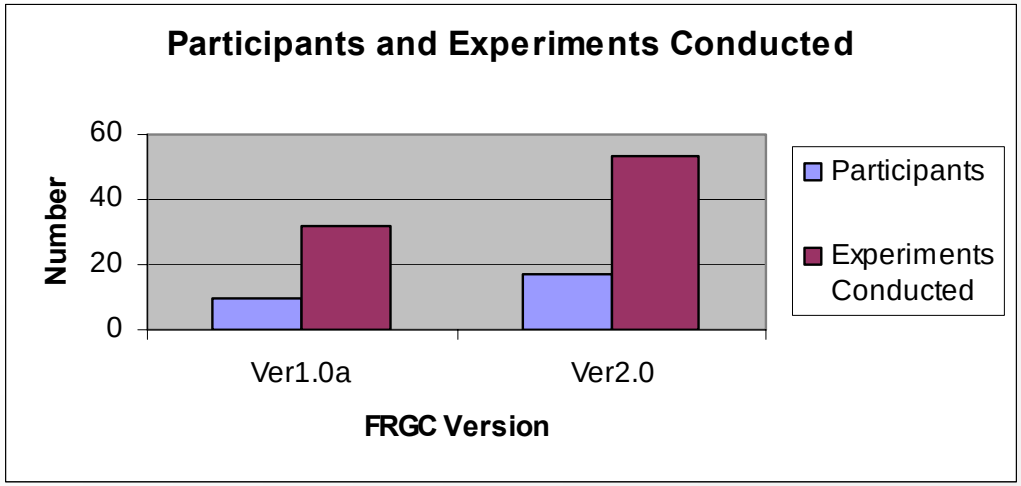
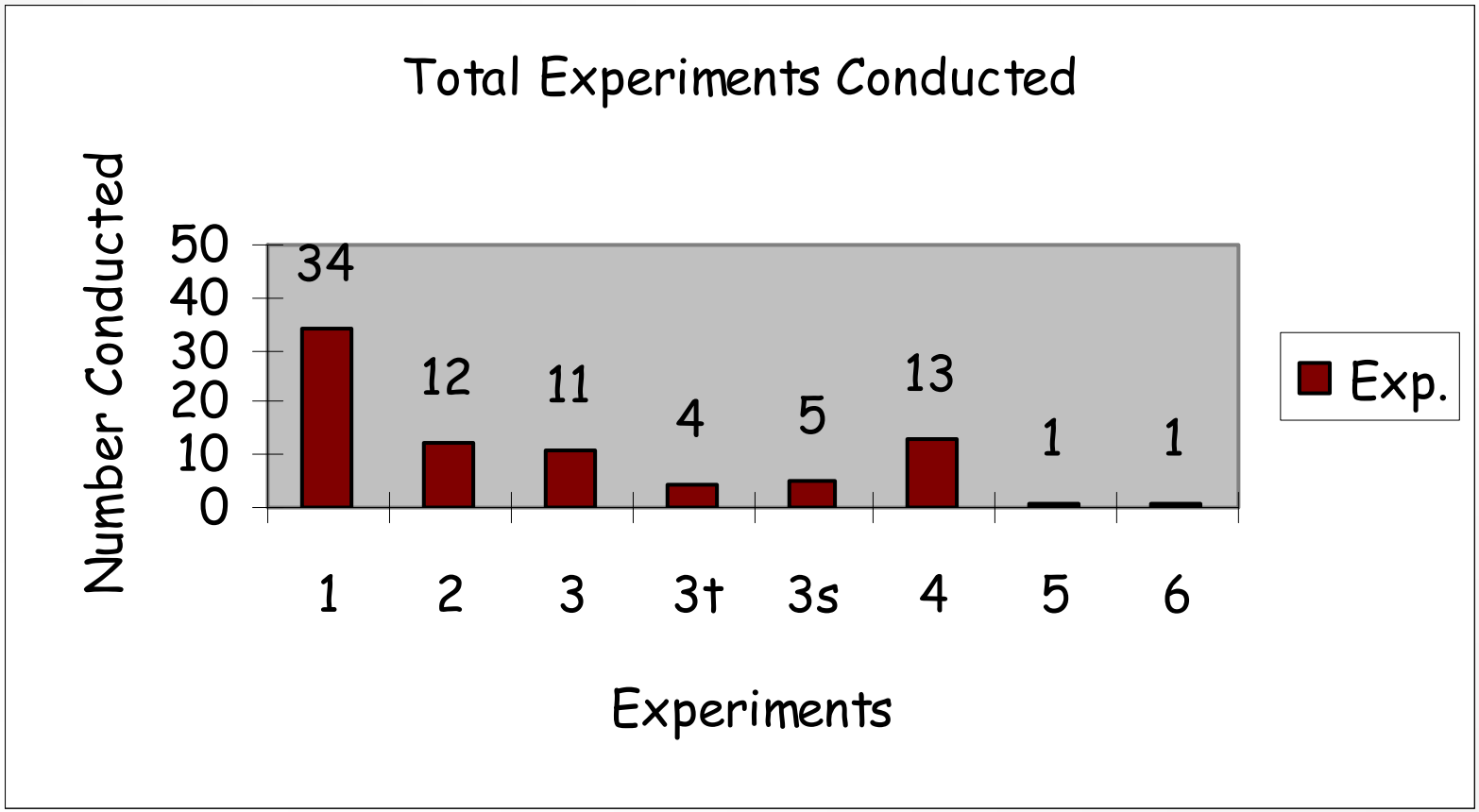
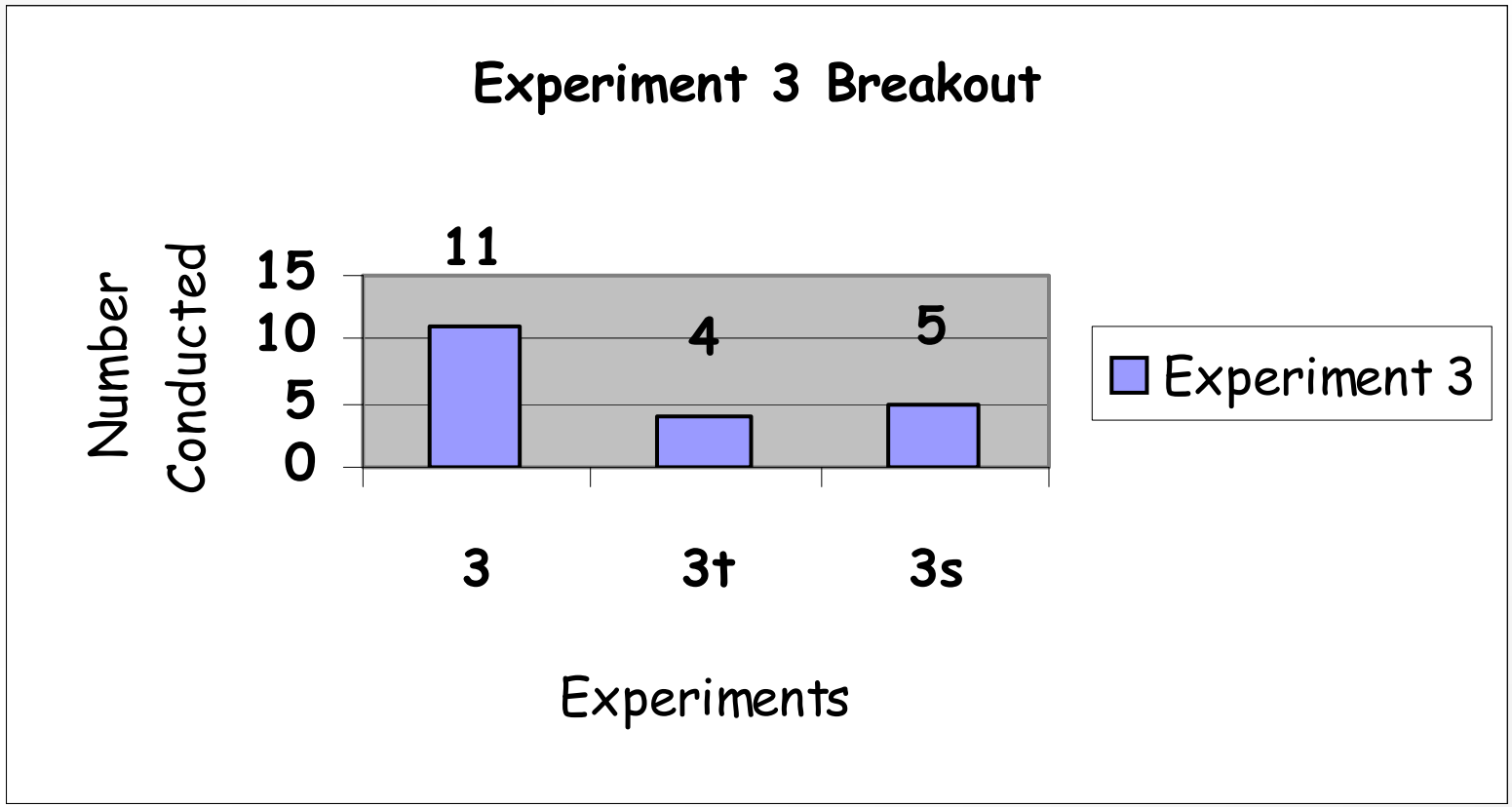


Ver2.0 Experiments

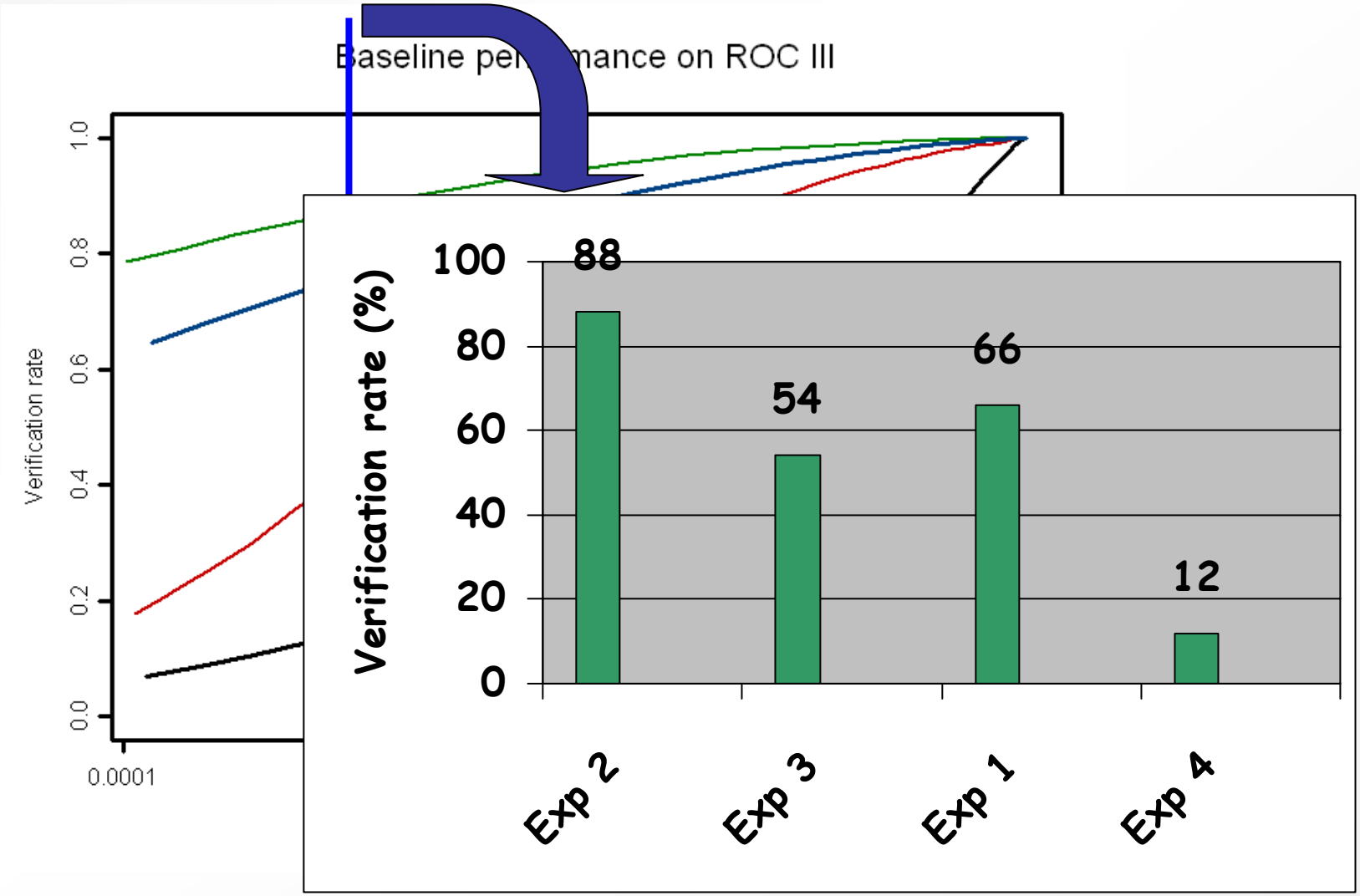


Grand Total Experiments Conducted: 53

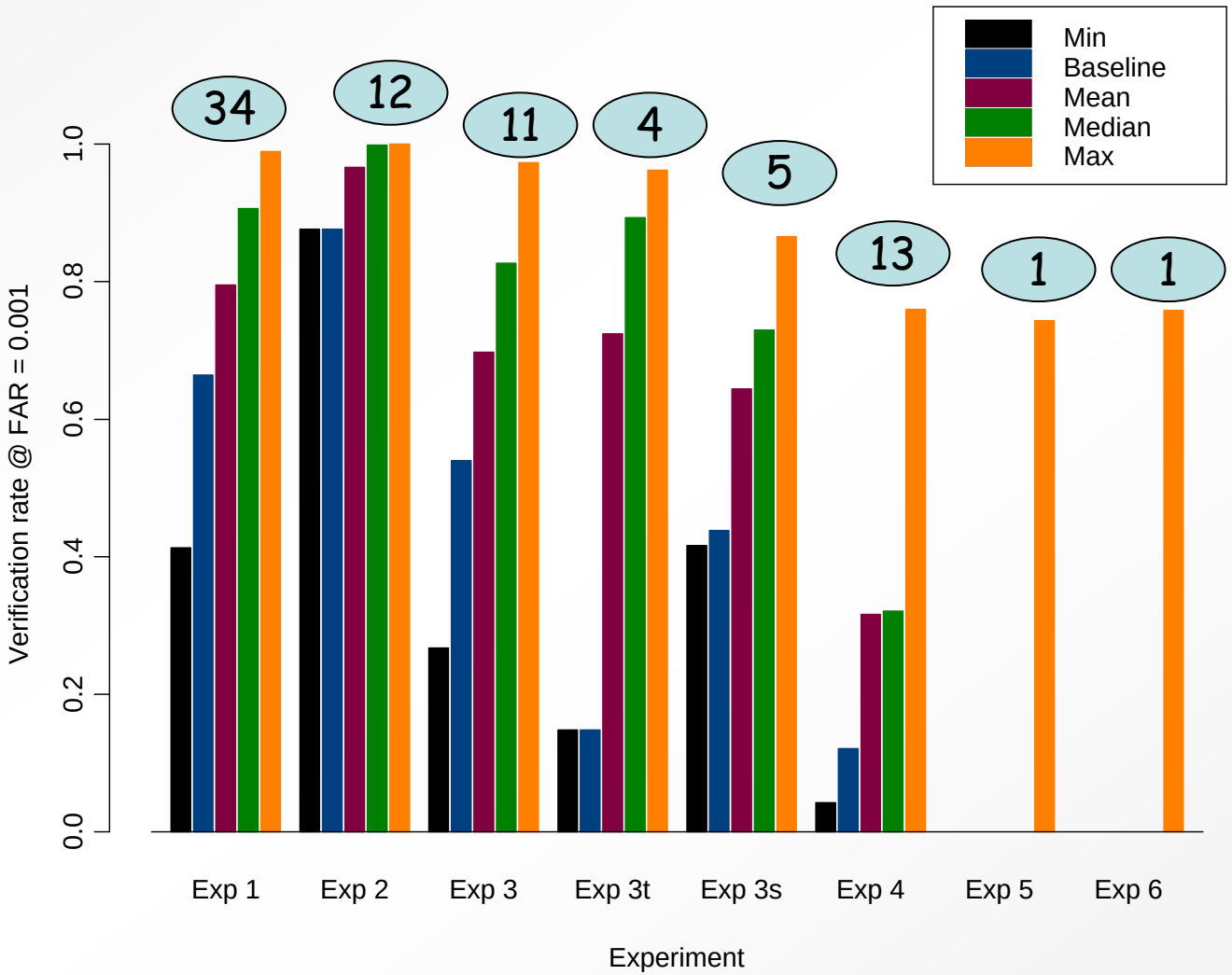
Breakout for Exp. 3



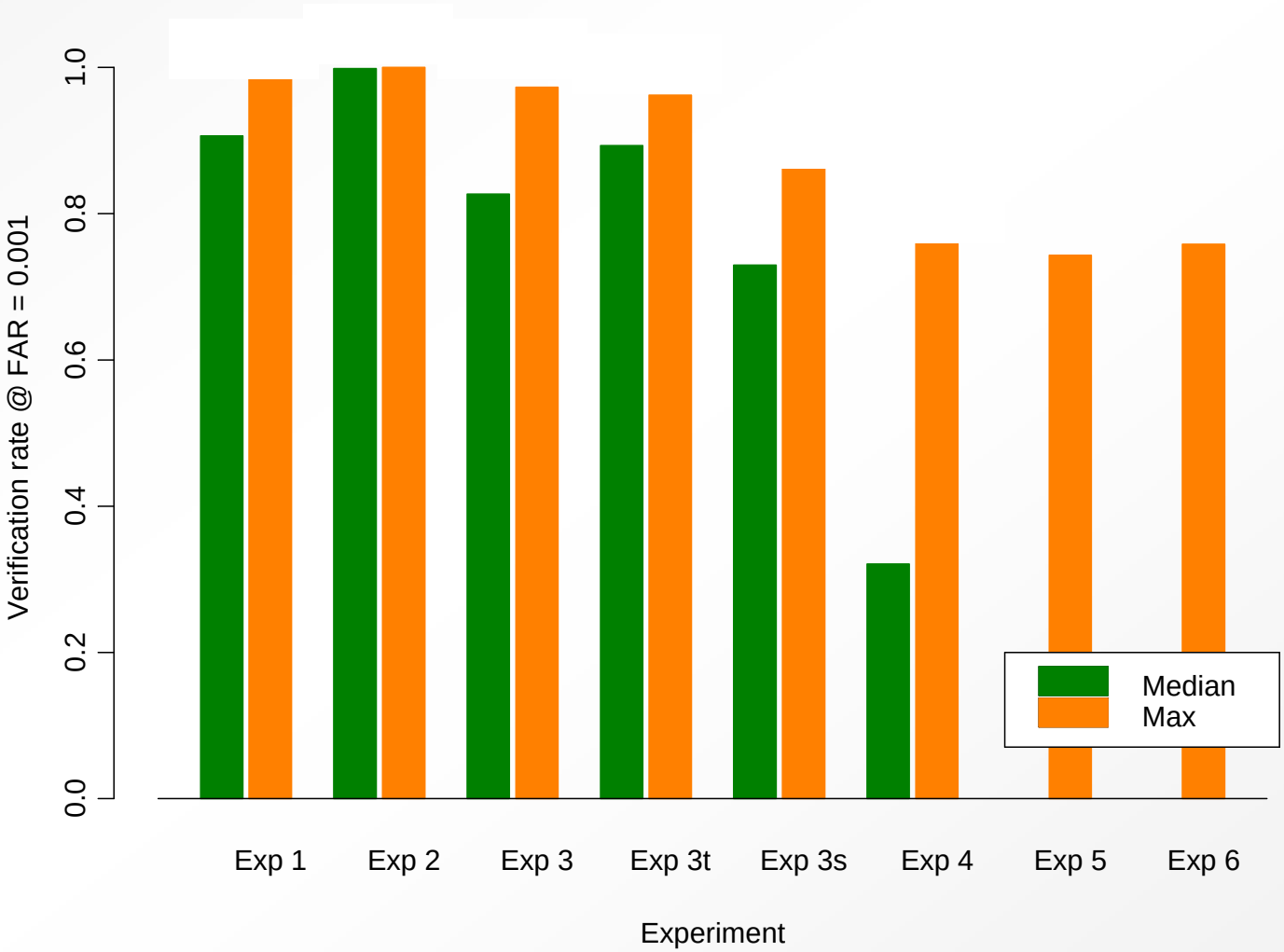
Ver2.0 Baseline FAR = 0.1%



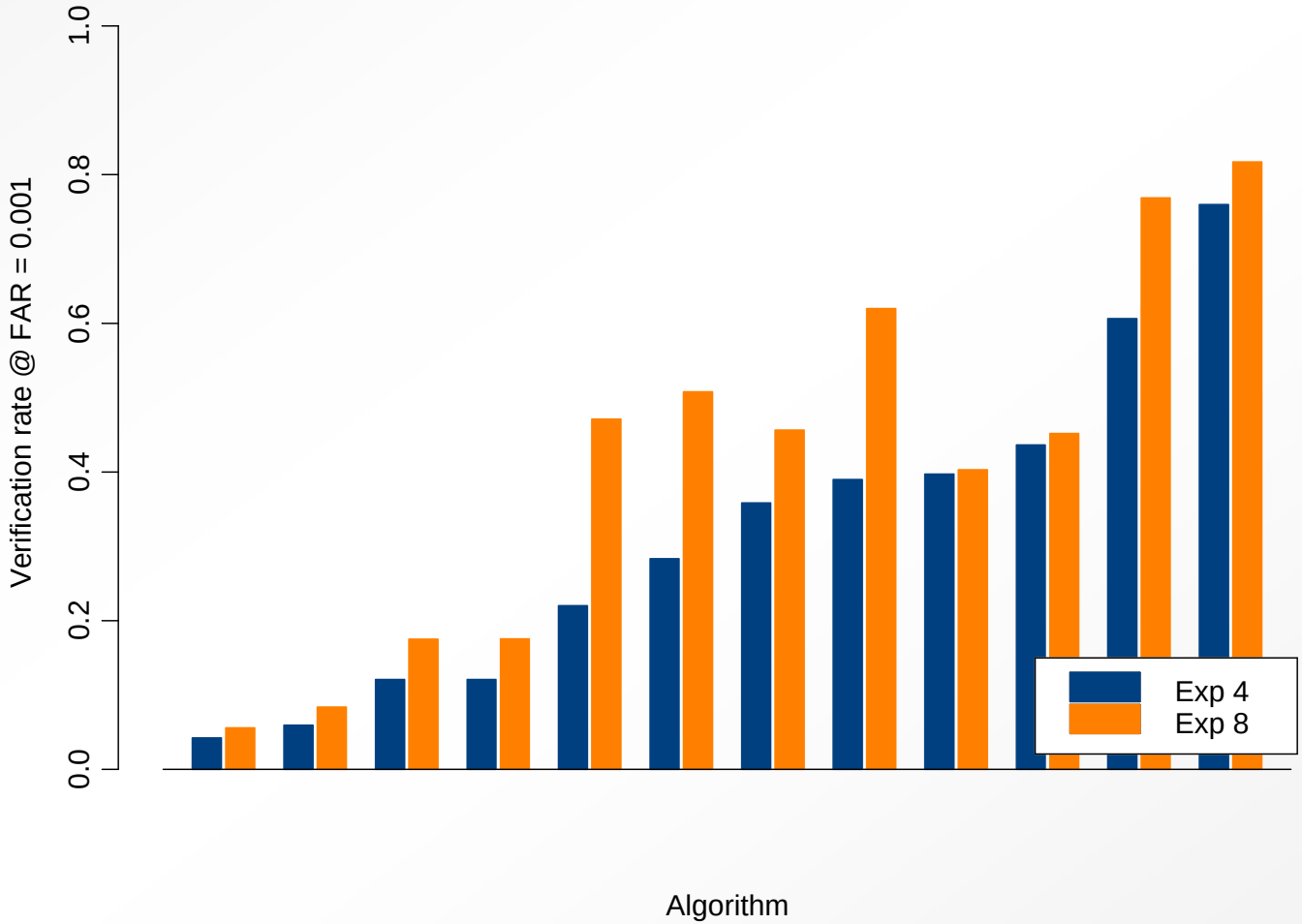
Experimental Results Summary



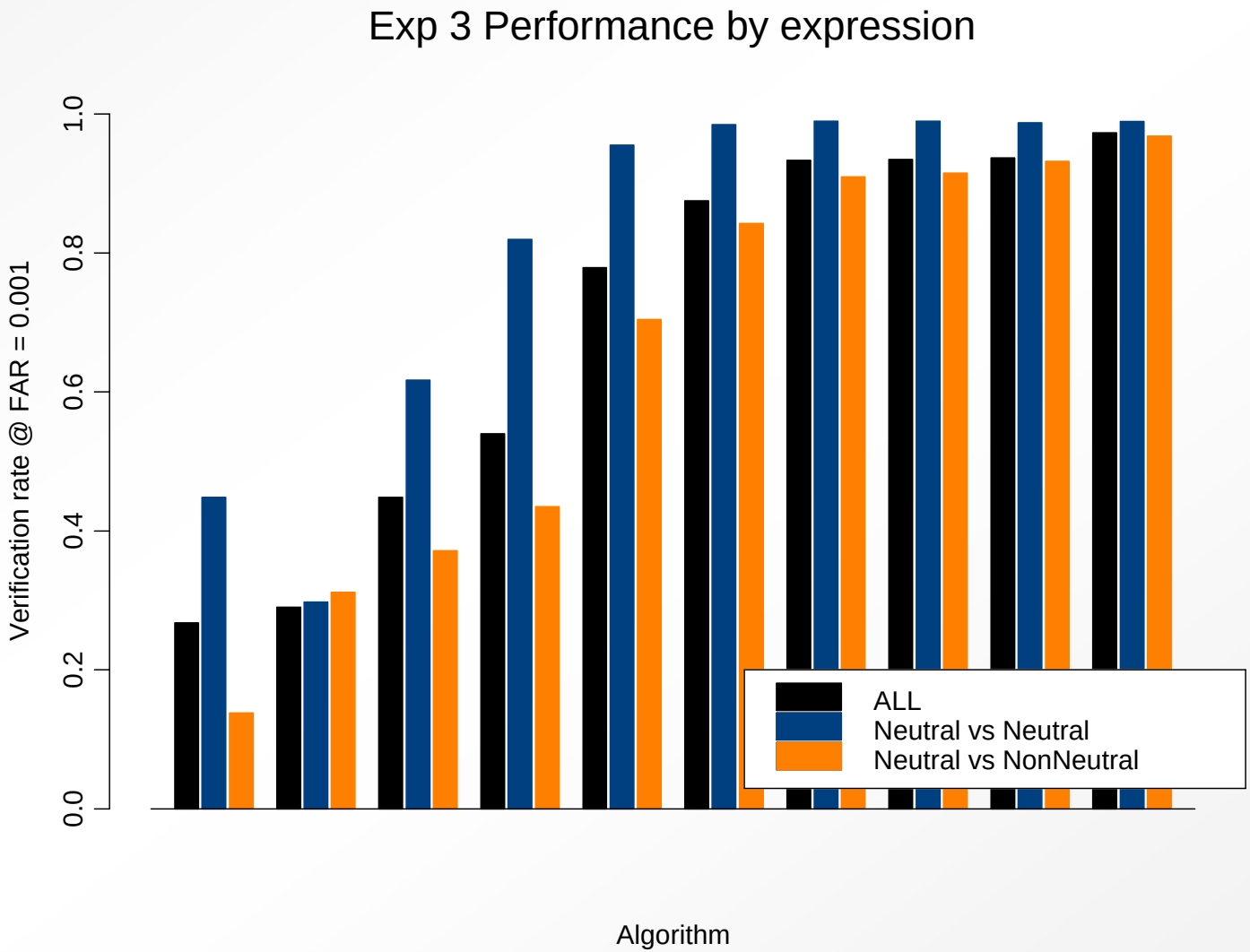
Results Summary



Experiments 4 and 8

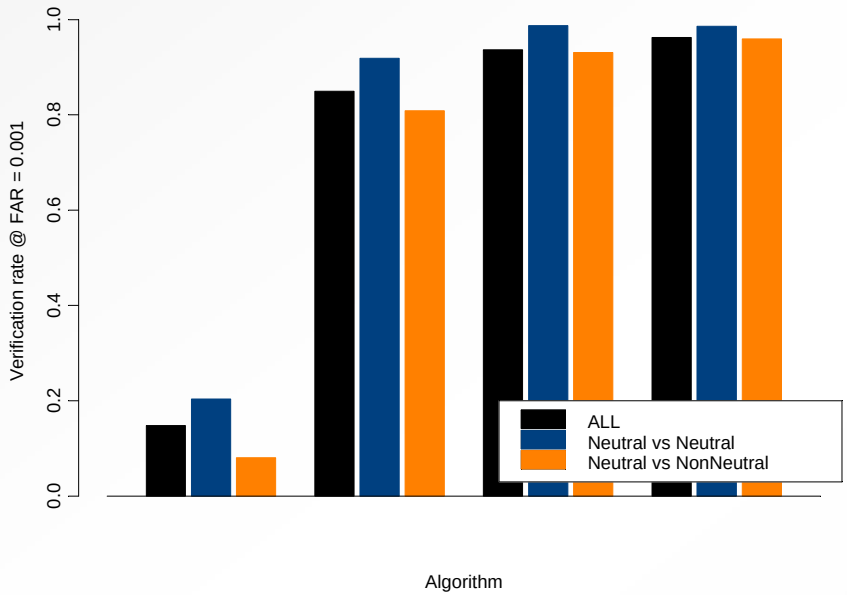


Effect of Expression on Exp 3

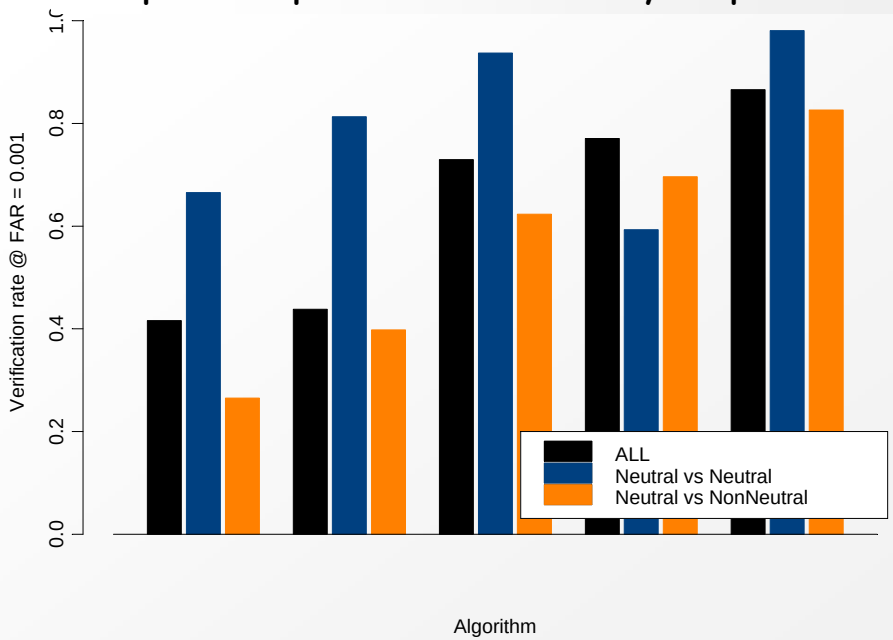


Effect of Expression on Exp 3

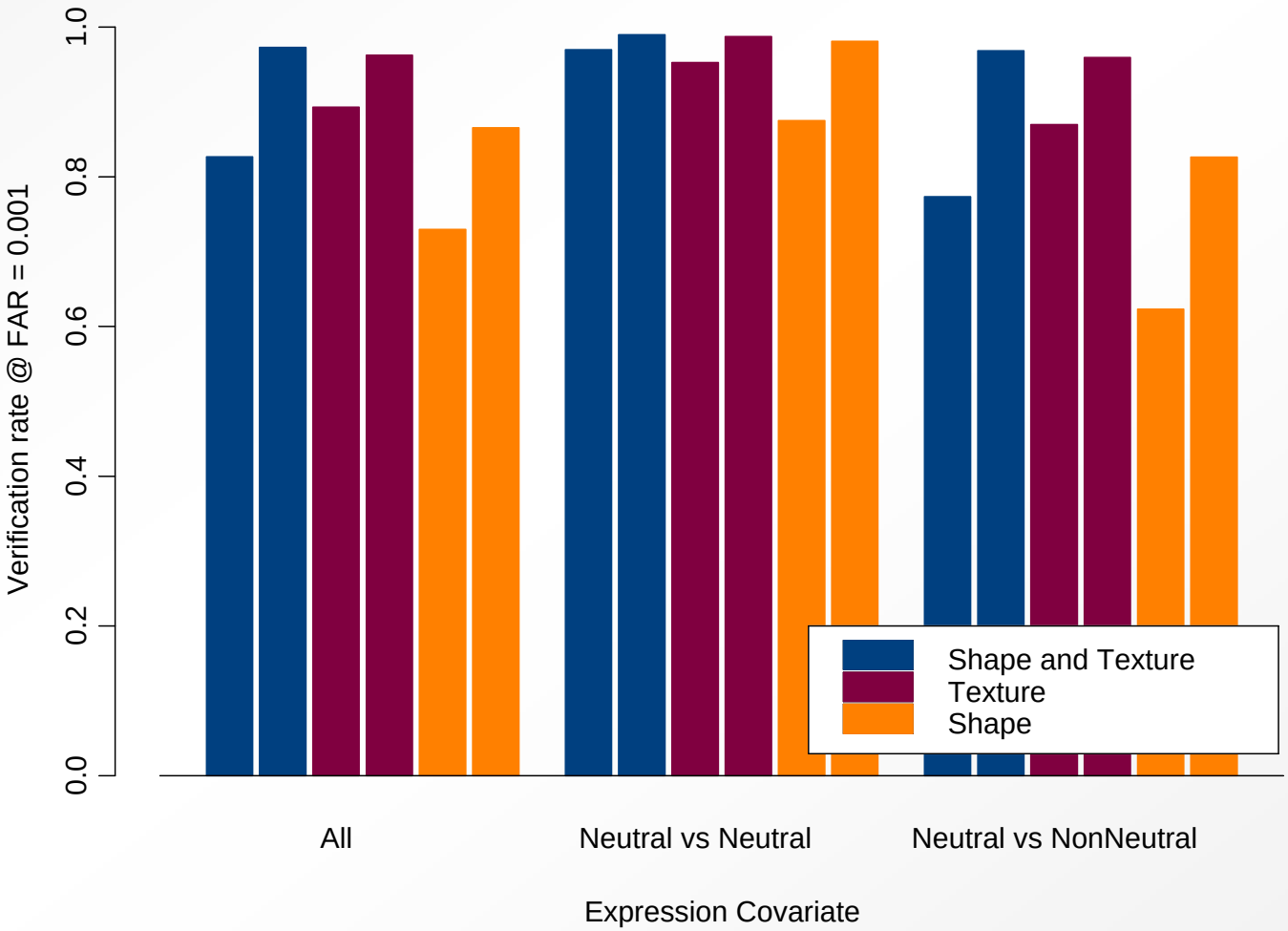
Exp 3 Texture Performance by Expression



Exp 3 Shape Performance by Expression



Summary of Expression



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.

Database of FRGC Results

- Enroll in FRGC archive when your paper is submitted or posted
  - Optional: check with sponsor(s)

Tentative Database Contents

- Figure and Graph Archive
  - Data used to plot figures and graphs
    - Points on a ROC and bar plot
  - Plotting instructions

Tentative Contents (Cont.)

- Similarity Score Archive
  - Similarity matrices
  - Signature sets
  - Mask matrices
  - Code for scoring
  - Limited access?
    - New results sent to authors
    - Scoring code contributed to archive
    - Full documentation of new results

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 August '05

Introduction

FRVT 2005

- **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

Software Development Kit (SDK) Test

- Sequestered data
- Independent evaluation
- Evaluation modes module
- Starts in the August/September 2005 time-frame

Test Types

- **FERET**
  - Proctored Test
- **FRVT 2000 & 2002**
  - System brought to Government
- **FRVT 2005**
  - SDK Test

SDK Test

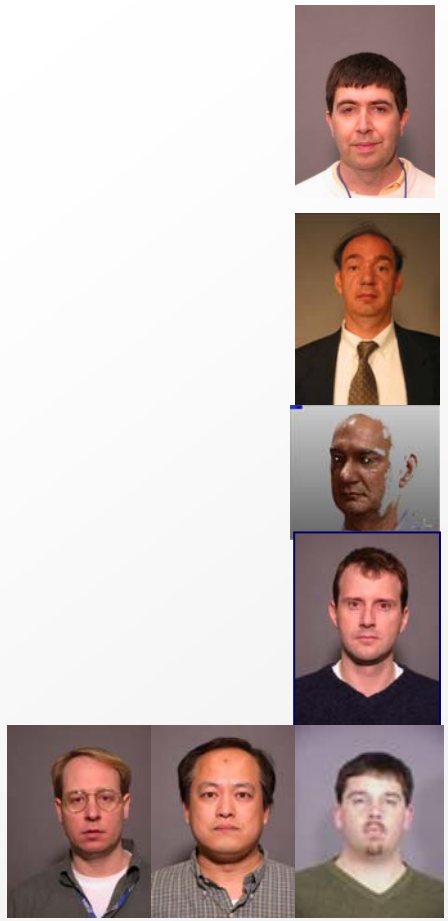
- Deliver software SDK with correct API
- API based on evolving ISO standard
- Consulting with Patrick Grother, NIST
- Tentative Platforms
  - Windows
  - Linux

SDK Components

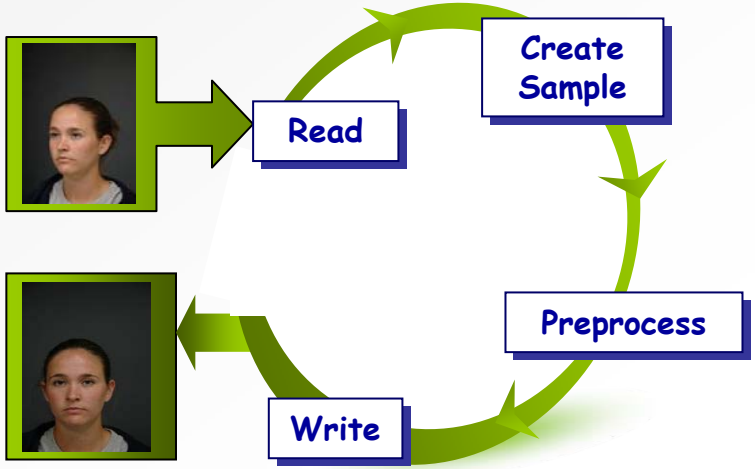
- Read recordings (files)
- Create samples
- Preprocess samples
- Write preprocessed samples
- Create templates
- Match templates
- Similarity score normalization
- Write similarity scores

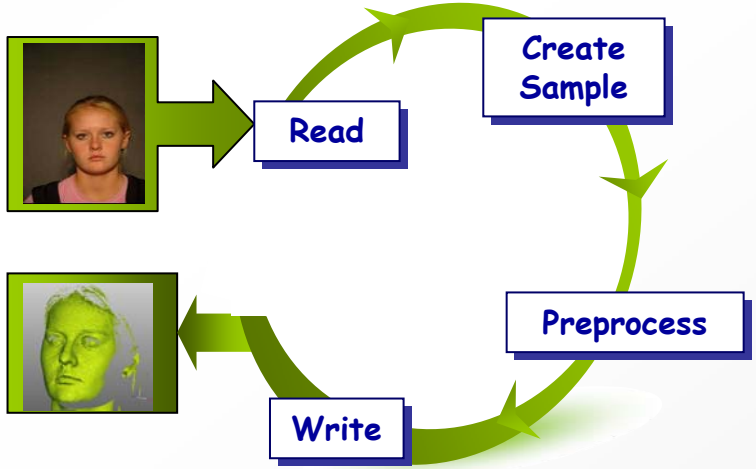
Preprocessing Experiment

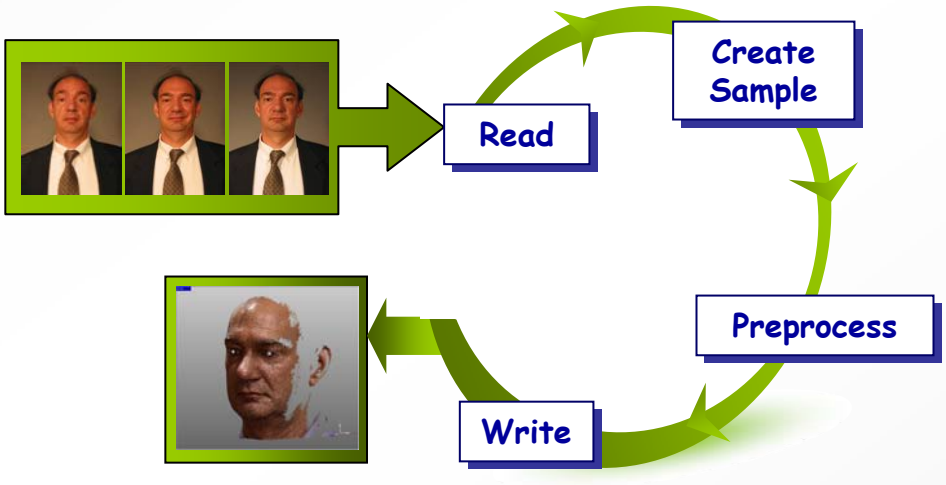
- Read recordings
- Create samples
- Preprocess samples
- Write preprocessed samples

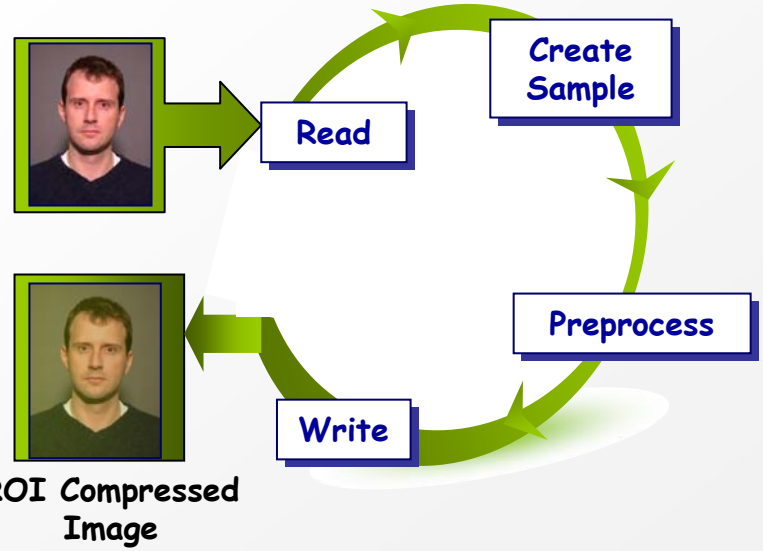


Preprocessing Example





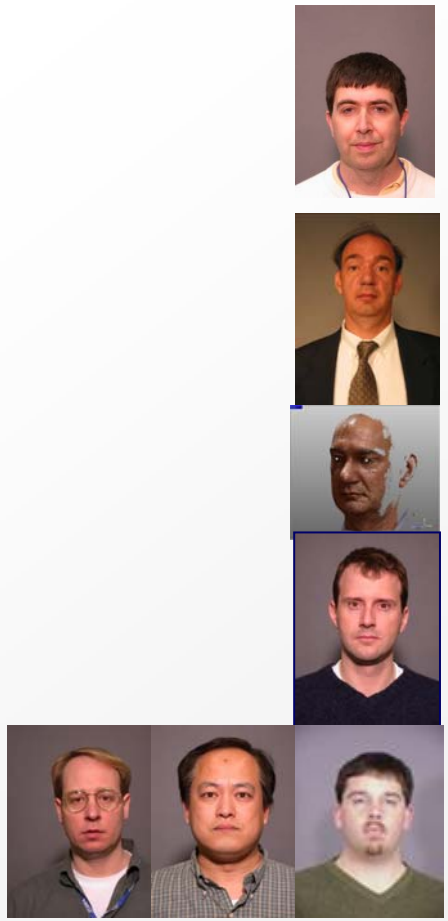




ROI Compressed Image

Recognition Experiment

- Read recordings
- Create sample
- Create templates
- Match templates
- Similarity score normalization
- Write similarity scores



Recognition Experiment

Read Recordings

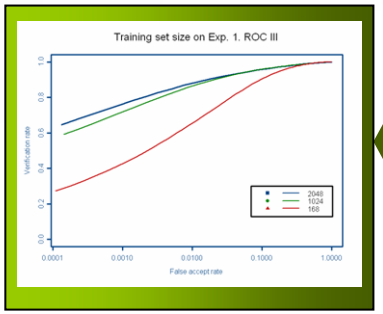
Create Sample

Create Templates

Match Templates

Similarity Score Normalization

Write Similarity Scores



FRVT 2005

- SDK specifications
  - Detailed specifications forthcoming
- Example implementation
- SDK concerns
  - Time to complete experiments
  - Especially for 3D algorithms

FRVT 2005

- There will be surprises....
- NOT a test on Notre Dame data

Summary

FRVT 2005

- FRVT 2005
  - Independent government evaluation of face recognition systems
  - Measure progress since FRVT 2002
  - Conduct comparison across modalities
  - Compare performance with FRGC Goals
  - August/September 2005 time frame

Next Steps

- March/April 2005
  - Planned release of v2.X
  -
- April 2005
  - Planned release of SDK
- 10 April 2005
  - Deadline for submission of IEEE Workshop papers on FRGC experiments
- 10 June 2005
  - Final papers due for IEEE Workshop
- 21 June 2005
  - IEEE Workshop, San Diego, CA
- August 2005
  - Submission of results from FRGC ver2.X
  - End of FRGC
- August/September 2005
  - Start of FRVT 2005

Reminder

- Permission to post today's presentations on the bbs website
  - We need your permission to post your presentations
  - Please send your permission or the revised version of your presentations via email to Cathy Schott at cschott@schafertmd.com