



# Benchmark for Multimodal Authentication



*Project 12*

*Final Presentation*

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# Team



## § Project leaders:

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## § Team members:

- ú C. Roche (UCD-NUI)
- ú M. Tirel (University of Rennes)
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# Background

§ Standard strategies to identify multimedia signals:

- ú Tailored: Feature Extraction Methods

- ú General purpose: Robust Hashing (aka Perceptual Hashing, Fingerprinting)

§ Usually reliant on one single modality (image, audio)

# Multimodal Approaches

§ Monomodal methods. Two types:

- ú Generic signals: images/audio
- ú Specific signals: face images, fingerprint images

§ Multimodal methods

- ú Combinations of two or more types of standard monomodal methods
- ú Multimodality affords higher performance



# The Need for Benchmarking

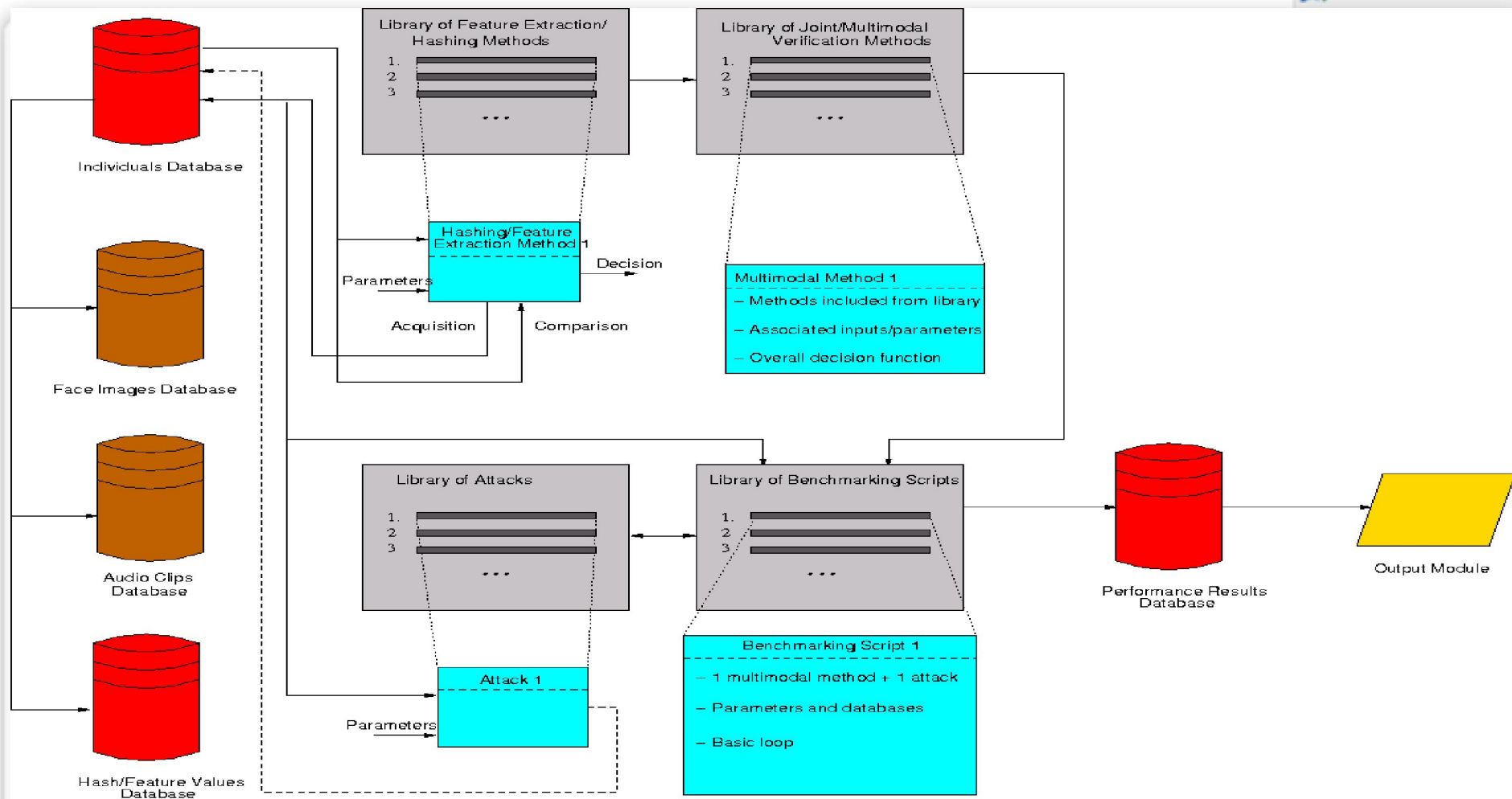
## § Issues

- ú What is the gain provided by multimodality?
- ú What are the best multimodal combinations of monomodal methods?
- ú How do they perform in different scenarios?

## § Benchmarking

- ú Helps to easily *define* multimodal approaches
- ú Helps to routinely test & compare the performance of these approaches
- ú Analytic comparisons are sometimes difficult

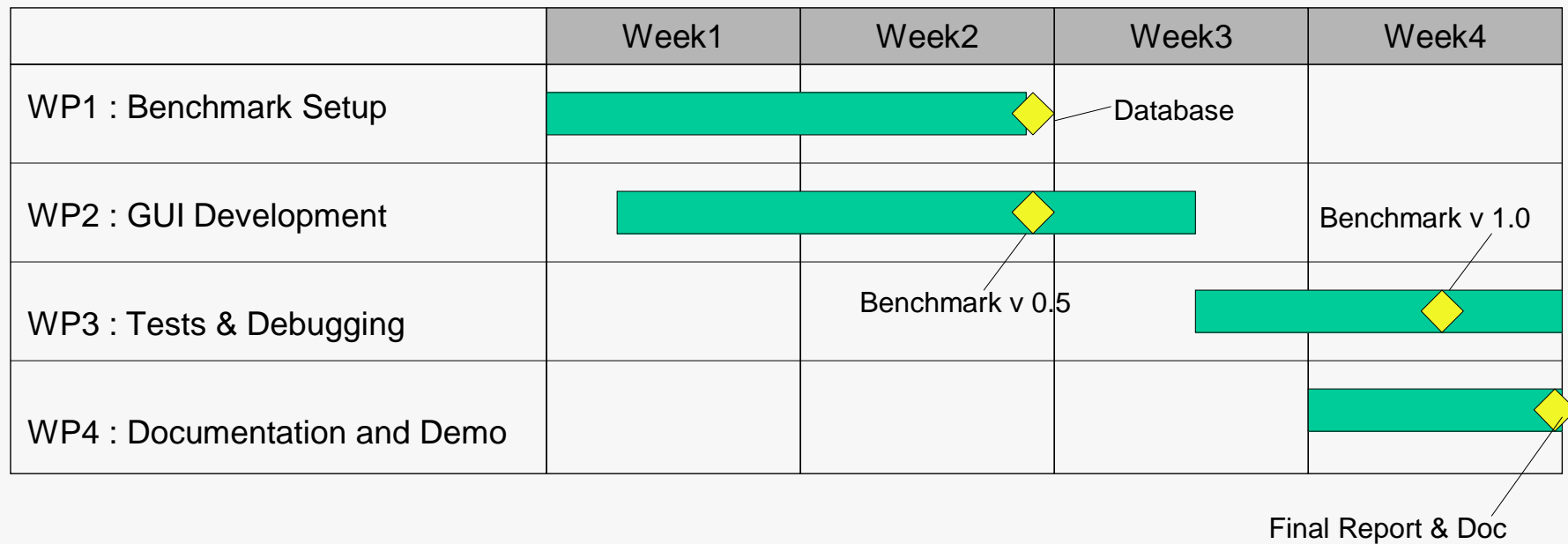
# Benchmark Structure





# Project Schedule

## § 5 Workpackages, 4 Milestones





# Changes from Original Plan

§ New modality added to benchmark

- ú Hand images

§ Initial database not suited to project: decision taken to collect new database

- ú Face images ( $-90^\circ, -45^\circ, 0^\circ, 45^\circ, 90^\circ$ ), 2 left hand images, video, speech, hand gestures

- ú Data also collected for Project #6

- ú 92 individuals included



# Multimodal Database

eNTERFACE '07

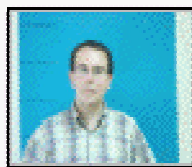
The SIMILAR NoE  
Summer Workshop  
on Multimodal Interfaces



hand-  
subject20-1.jpg



hand-  
subject20-2.jpg



subject20-1.JPG



subject20-2.JPG



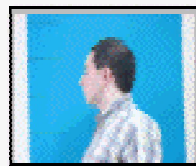
subject20-3.JPG



subject20-4.JPG



subject20-5.JPG



subject20-6.JPG



# Benchmark Implementation

## § Architecture:

ú MySQL database

ú Matlab source code

- GUI
- robust hashing/feature extraction methods
- attacks

ú Advantages:

- fast implementation
- flexibility and extendability
- interfaceable with other languages (Mex files)

ú Disadvantages:

- execution speed

# Benchmark Methods

## § Initial monomodal methods:

### ú image hashing:

- iterative geometric hashing
- NMF-NMF-SQ
- PRSQ

### ú feature extraction:

- hand feature extraction

### ú audio hashing:

- Microsoft method
- Bo aziçi method
- Philips method



# Benchmark Attacks

## § Attacks

### ú Image

- additive noise
- random bending
- print scan
- rotate and crop
- contrast enhancement
- simple chimeric

### ú Audio

- additive noise
- delay
- pitch bending



# Sample Benchmark Windows

**mainWindows**

Multimodal Authentication Benchmark

Open Connection

Database of Individuals

Library of Monomodal Methods

Library of Attack Methods

Library of Multimodal Methods

Library of Scripts

Close Connection

**addMonoFct**

Add a new Monomodal Method

Name :

Modality :

Hash Name :

Edit parameter

Comp Name :

Edit parameter



# Sample Benchmark Windows

The image displays two overlapping windows from a benchmark application. The left window, titled 'individualsList', shows a list of names with 'Andrew Braust' selected. Below the list are 'Add', 'Remove', and 'Edit' buttons, and a '<-- Back' button at the bottom. The right window, titled 'individual', shows the profile for 'Andrew Braust'. It includes a 'Files' dropdown menu set to 'all', a list of files ('audio\_subject81.wav', 'face\_subject81-1.jpg', 'hand\_subject81-1.jpg'), and 'Add file' and 'Remove' buttons. Below the file list is a hand image and 'Play sound' and 'Stop sound' buttons. A '<-- Back' button is at the bottom right.

**individualsList**

Individuals

- Albert Ali Salah
- Alexey Carpov
- Alexis Moimet
- Ali Demir
- Ana Andres
- Andrew Braust**
- Arman Savran
- Aydin Akyol
- Baris Bahar
- Ben Scholiten
- Burak Acar
- Byunqjun Kwon
- Caglayan Dicle
- Cem Keskin
- Christian Muhl
- Cliona Roche
- Cristian Canton-Ferrer
- Cumhur Erkut

Add Remove Edit

<-- Back

**individual**

Andrew Braust

Files : all

- audio\_subject81.wav
- face\_subject81-1.jpg
- hand\_subject81-1.jpg**

Add file

Remove

Play sound

Stop sound

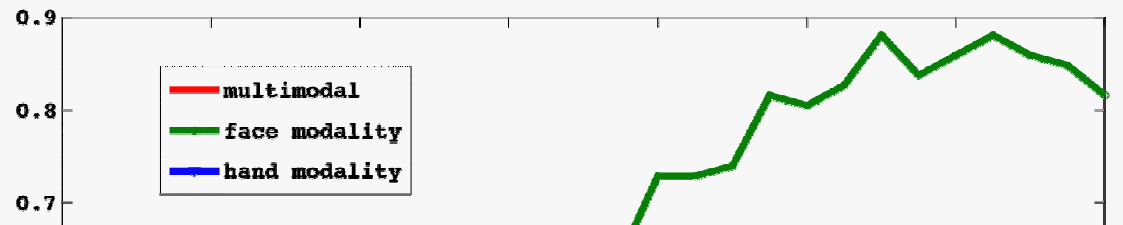
<-- Back



# Sample Benchmark Windows

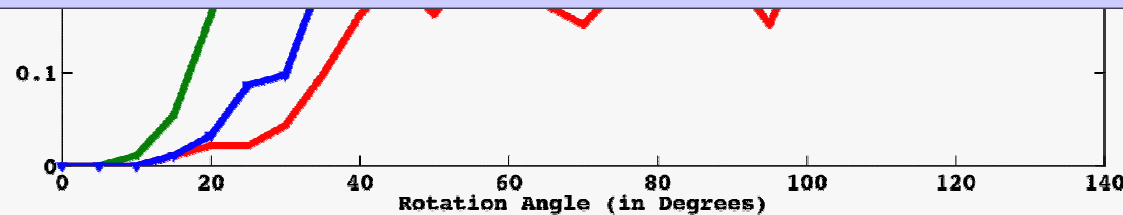
The image shows two side-by-side software windows. The left window, titled 'multimodal', has a header 'Library of Multimodal Methods'. It contains a list box with 'gaussian' and 'hand\_face02'. Below the list are 'Add' and 'Remove' buttons. A 'Details' section is open, showing the following text: 'Method name : gaussian', 'Monomodal Method n°1 : geometric02\_face', 'Weight1 = 0.5', 'Attack Method n°1 : noise\_face', 'Monomodal Method n°2 : geometric02\_hand', 'Weight2 = 0.5', and 'Attack Method n°2 : noise\_hand'. At the bottom is a '<-- Back' button. The right window, titled 'script', has a header 'Library of Scripts'. It features a 'Templates :' dropdown menu with a value of 'I', an 'add template' button, and a 'Multimodal Methods :' dropdown menu. Below these is a 'Generate new Script' button. A list box contains 'gaussianscript' and 'simulation02'. To the right of the list are three buttons: 'Run Script', 'Plot Results', and 'Create Report'. At the bottom is a 'Remove Script' button and a '<-- Back' button.

# Some Results



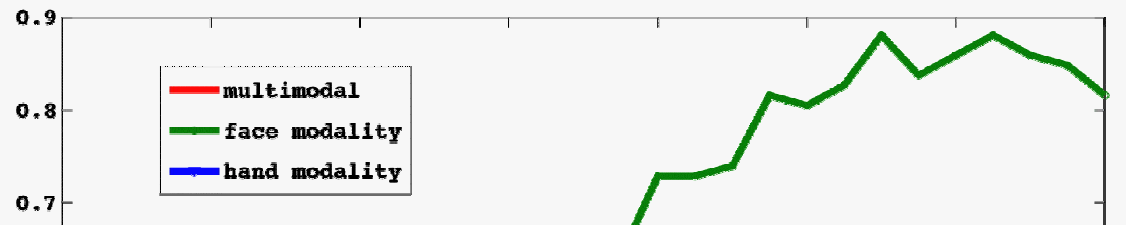
## Two Monomodal Methods

Face Image : Iterative Geometric Image Hash A  
Hand Image : Iterative Geometric Image Hash B

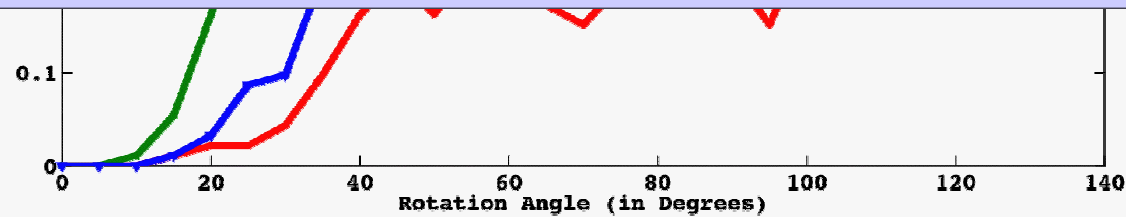




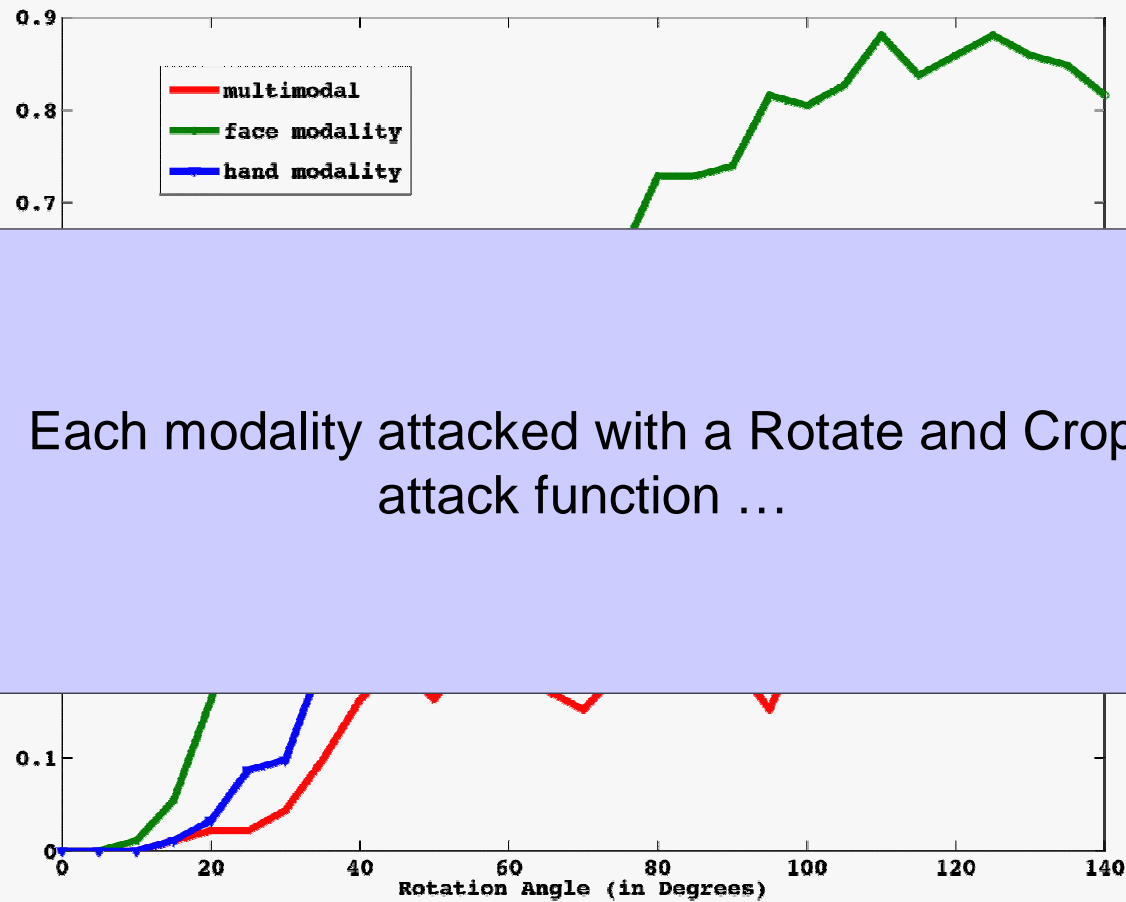
# Some Results



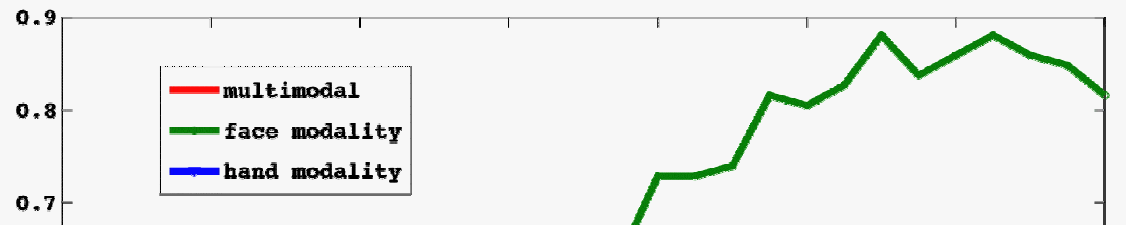
Combined with equal Importance Weighting...



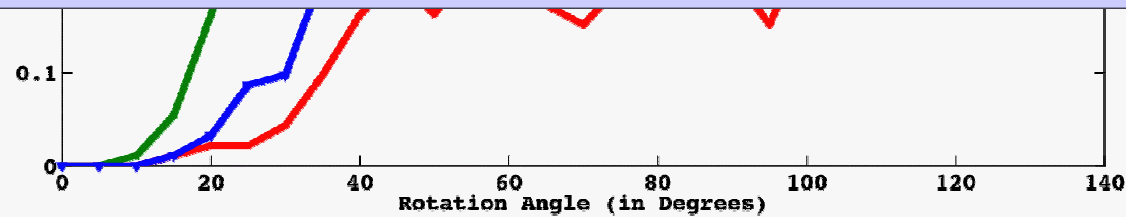
# Some Results



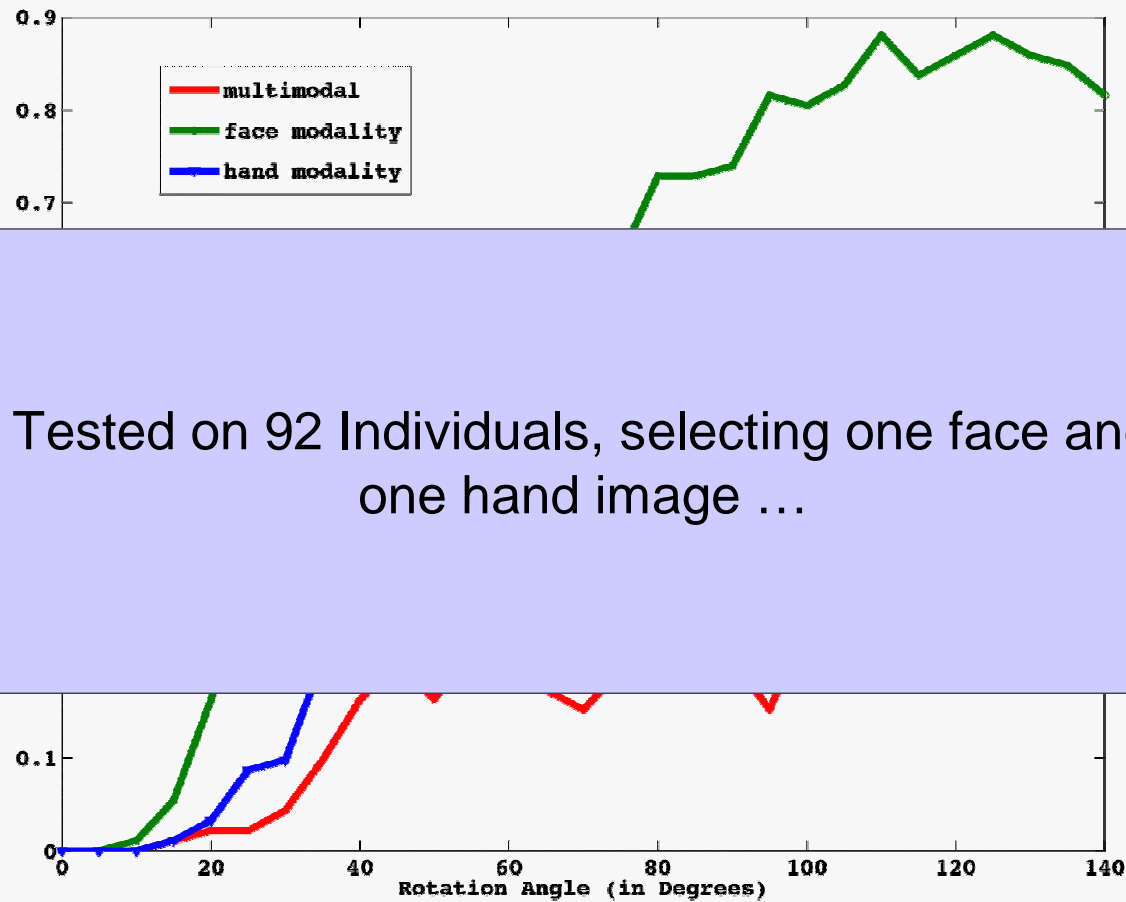
# Some Results



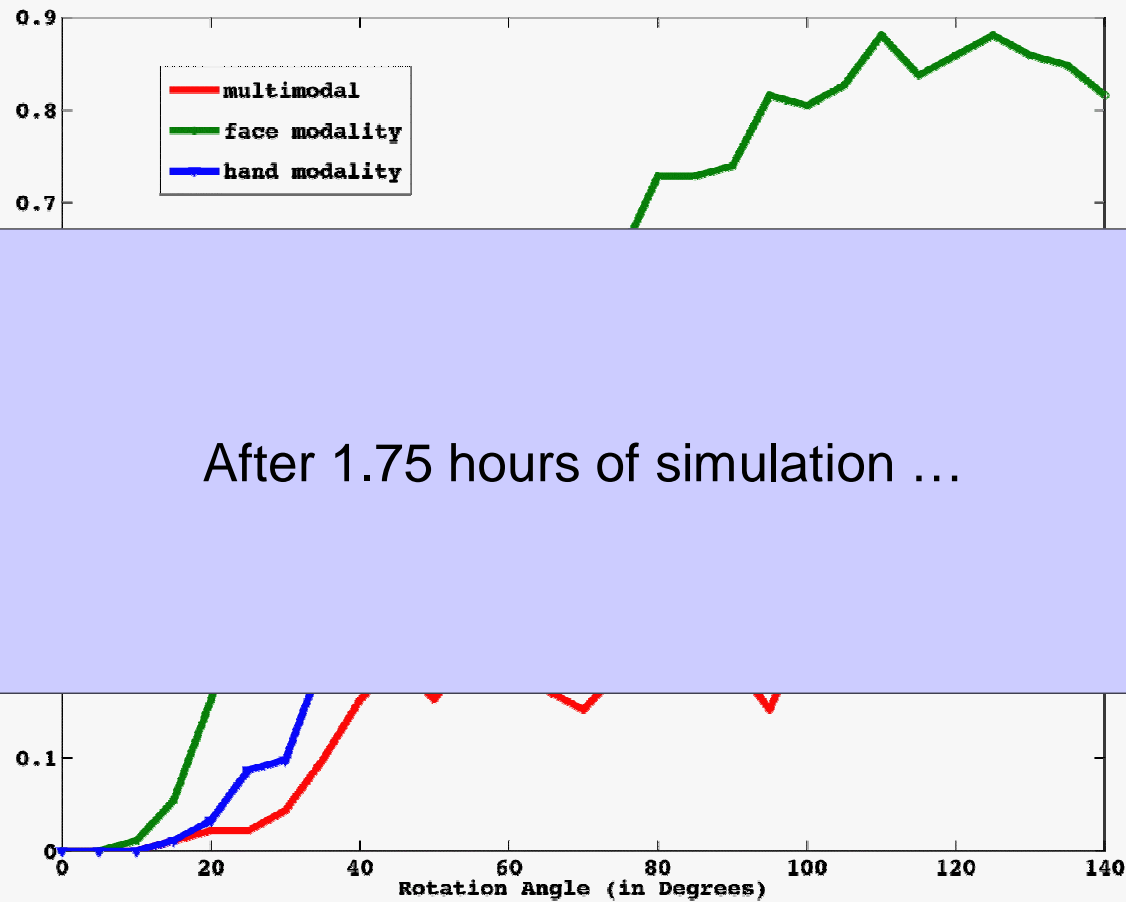
Varying the angle of Rotation ...



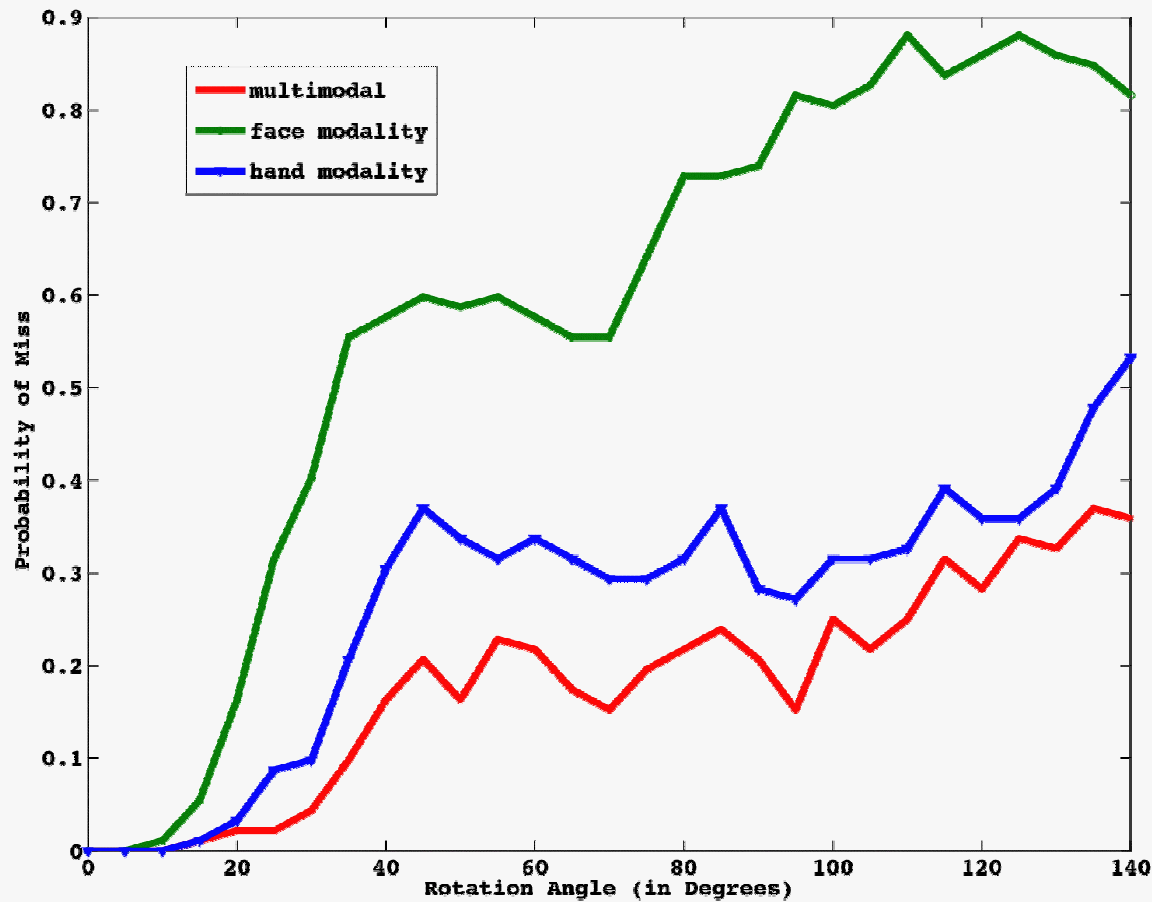
# Some Results



# Some Results



# Some Results



# Future Work

## § Computational burden

- ú Loop-intensive benchmarking: monomodal functions and attacks need optimization
- ú Remote use of database will distribute computational load

## § Addition of new scripts & functions

## § Reliability of decision issues

- ú Monomodal methods are combined taking into account the reliability of their decisions
- ú Research is needed in this area for many methods



# Future Work

## § Certification Procedure

- ú Fixed set of attacks (dependent on modality)
- ú Fixed set of scripts
- ú Systematic ranking of methods.





§ Thank you