



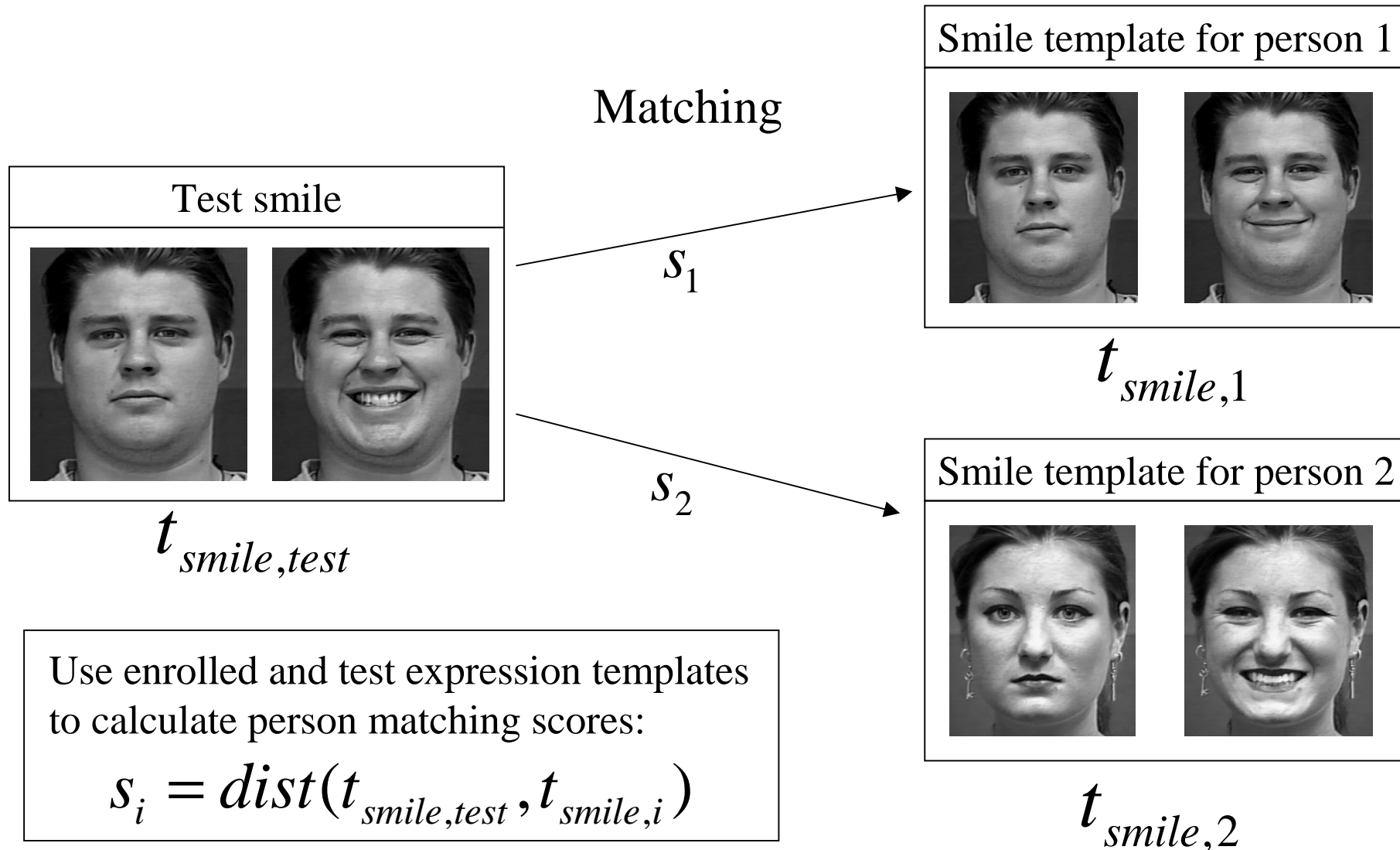
# **Facial Expression Biometrics Using Tracker Displacement Features**

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# Face Expression Biometrics





## Problem Statement

$i = test \Rightarrow s_i = dist(t_{smile,test}, t_{smile,i}) \sim S_{gen}$  - genuine scores

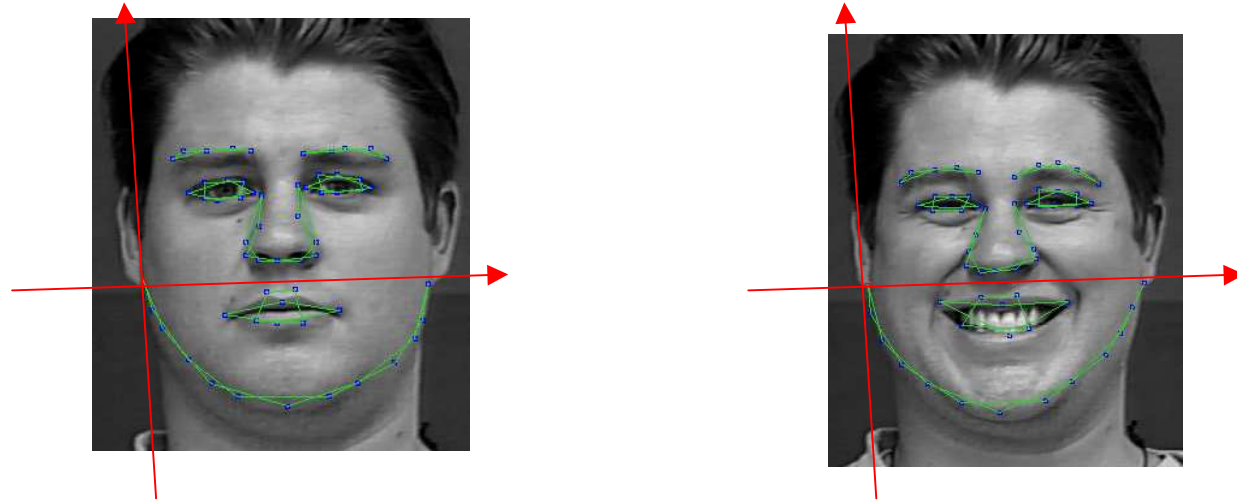
$i \neq test \Rightarrow s_i = dist(t_{smile,test}, t_{smile,i}) \sim S_{imp}$  - impostor scores

- How to find expression templates,  $t_{smile,i}$  ?
- How to calculate the distance between expression templates  
 -  $dist(t_{smile,test}, t_{smile,i})$  ?
- Are distributions of genuine and impostor scores,  $S_{gen}$ ,  $S_{gen}$  , different?



## Expression Templates

58 tracker  
points:



Normalized  
positions:

$$(x_1^1, y_1^1), \dots, (x_{58}^1, y_{58}^1)$$

$$(x_1^2, y_1^2), \dots, (x_{58}^2, y_{58}^2)$$

Expression template = displacements of tracker points:

$$t = \{t_1, \dots, t_{116}\} = \{x_1^2 - x_1^1, y_1^2 - y_1^1, \dots, x_{58}^2 - x_{58}^1, y_{58}^2 - y_{58}^1\}$$

Distance between expression templates:

$$\text{dist}(t^1, t^2) = \sqrt{(t_1^1 - t_1^2)^2 + \dots + (t_{116}^1 - t_{116}^2)^2}$$



## Experiments (Cohn-Kanade Database)

- Verifying the effectiveness of extracted displacement features for expression classification:
  - 456 pairs of images with same expression and different persons vs. 468 pairs of images of different expressions and different persons
- Verifying the effectiveness of extracted displacement features for biometric person matching:
  - 22 pairs of images with same expression of the same persons vs. 456 pairs of images with same expression and different persons

	Score Distribution 1	Score Distribution 2	Wilcoxon rank sum test
<b>Expression classification</b>	$\mu=0.8688$ $\sigma=0.2253$	$\mu=0.9813$ $\sigma=0.2143$	<b>p=5.55e-016</b> <b>Passed</b>
<b>Biometric person authentication</b>	$\mu=0.8078$ $\sigma=0.2394$	$\mu=0.8688$ $\sigma=0.2253$	<b>p=0.2234</b> <b>Not passed</b>



# Experiments with PCA Features

Expression classification:

Number of eigenvectors	Same Expression Matching Scores	Diff. Expression Matching Scores	Wilcoxon rank sum test
20	$\mu=0.79$ $\sigma=0.24$	$\mu=0.92$ $\sigma=0.23$	$p=3.9e-017$
10	$\mu=0.70$ $\sigma=0.25$	$\mu=0.84$ $\sigma=0.24$	$p=8.3e-021$
5	$\mu=0.57$ $\sigma=0.27$	$\mu=0.74$ $\sigma=0.25$	$p=5.1e-025$
2	$\mu=0.44$ $\sigma=0.28$	$\mu=0.47$ $\sigma=0.24$	$p=0.004$

Biometric person authentication:

Number of eigenvectors	Same Person Matching Scores	Diff. Persons Matching Scores	Wilcoxon rank sum test
20	$\mu=0.72$ $\sigma=0.27$	$\mu=0.79$ $\sigma=0.24$	$p=0.191$
10	$\mu=0.63$ $\sigma=0.25$	$\mu=0.70$ $\sigma=0.25$	$p=0.113$
5	$\mu=0.50$ $\sigma=0.24$	$\mu=0.57$ $\sigma=0.27$	$p=0.147$
2	$\mu=0.37$ $\sigma=0.23$	$\mu=0.44$ $\sigma=0.28$	$p=0.189$



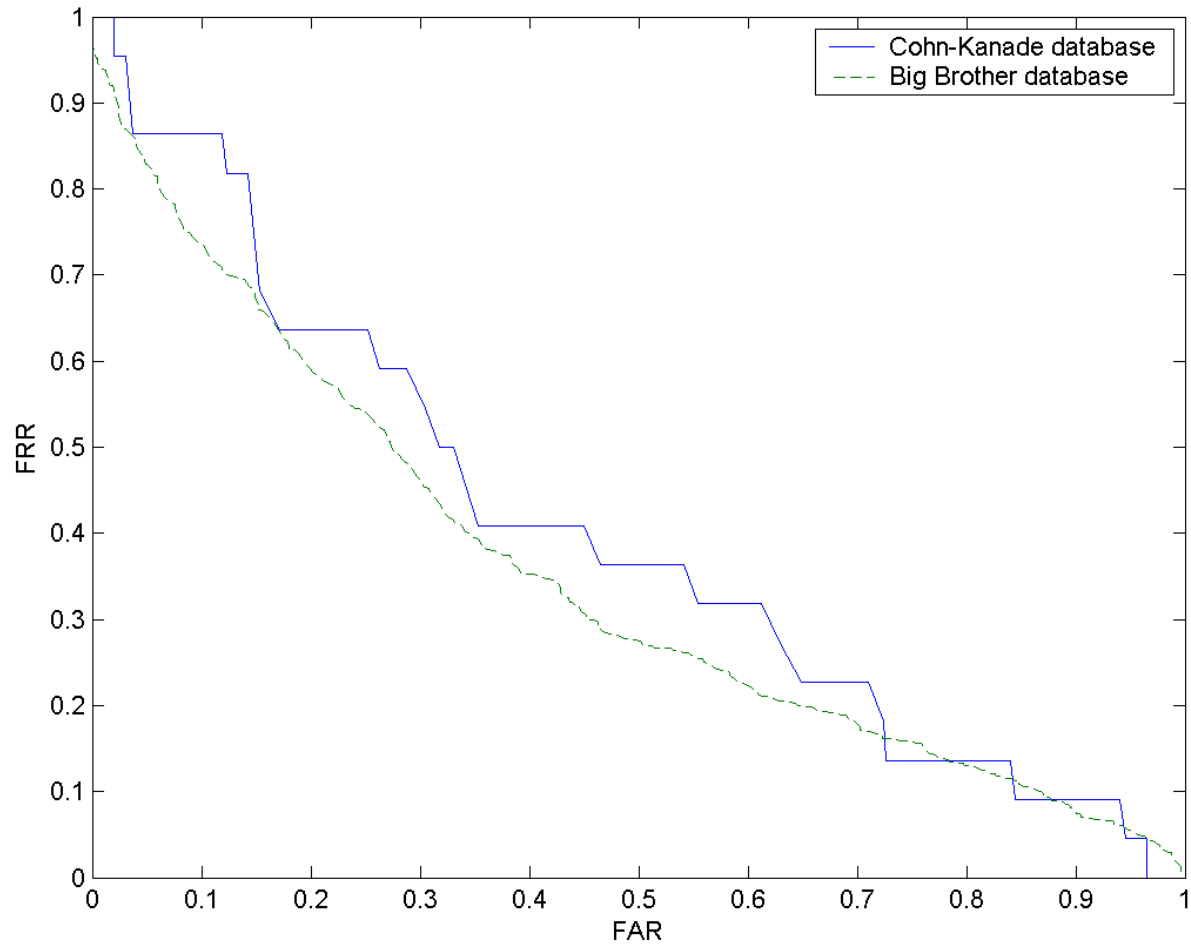
## Experiments (Big Brother Database)

- Verifying the effectiveness of extracted displacement features for biometric person matching:
  - 724 pairs of images with same expression of the same persons vs.
  - 1014 pairs of images with same expression and different persons

	Score Distribution 1	Score Distribution 2	Wilcoxon rank sum test
<b>Biometric person authentication</b>	$\mu=2.5733$ $\sigma=1.8032$	$\mu=3.2252$ $\sigma=1.6661$	$p=2.67e-26$ Passed



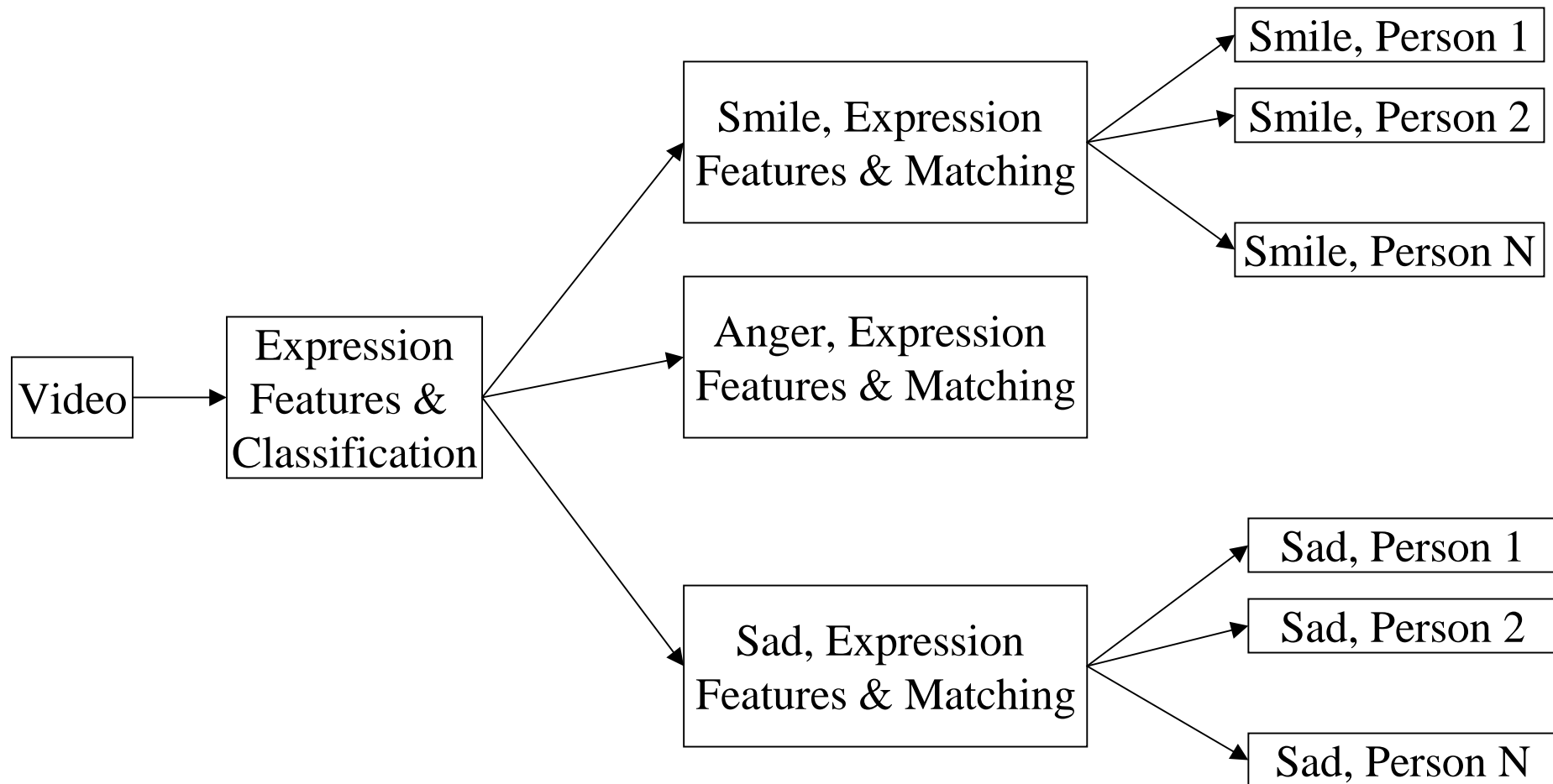
# ROC curves







# Automating Expression Biometrics





**Thank you!**

Questions?