

Face Template Reconstruction from Match Scores

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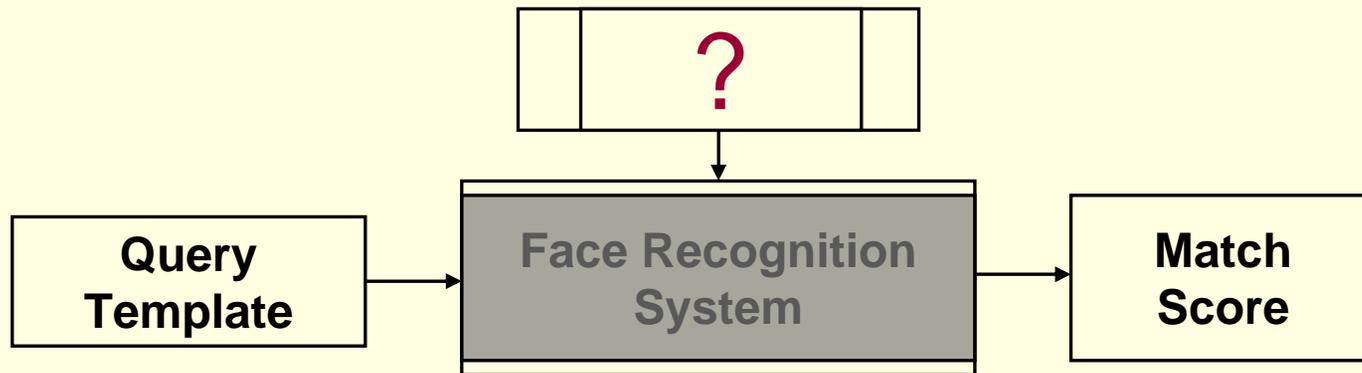
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Outline

- Introduction
- Proposed Scheme
- Experiment and Results
- Conclusion

Objective

“To reconstruct the target templates from observed match scores”



- The Recognition system is considered as a black box and we do not perform any reverse engineering methods.
- All the target images are completely unknown

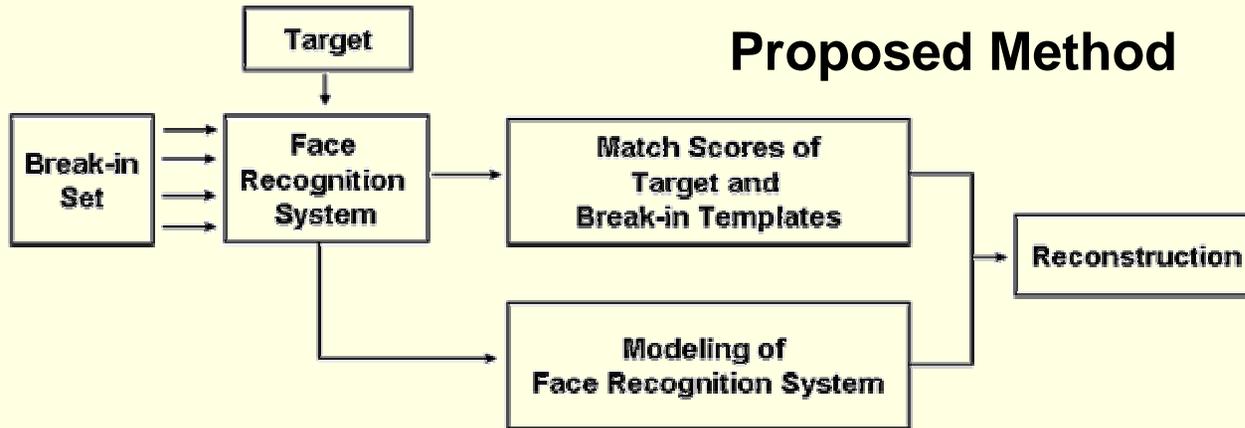
Reconstruction of templates

Major Steps

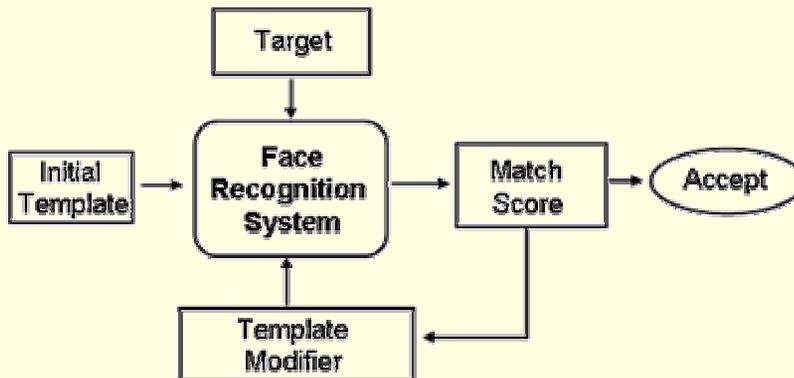
1. Model the recognition system through an affine transformation of image space
2. Embed the target template in affine space
3. Reconstruction of target template.

Comparison to Hill-Climbing Approach

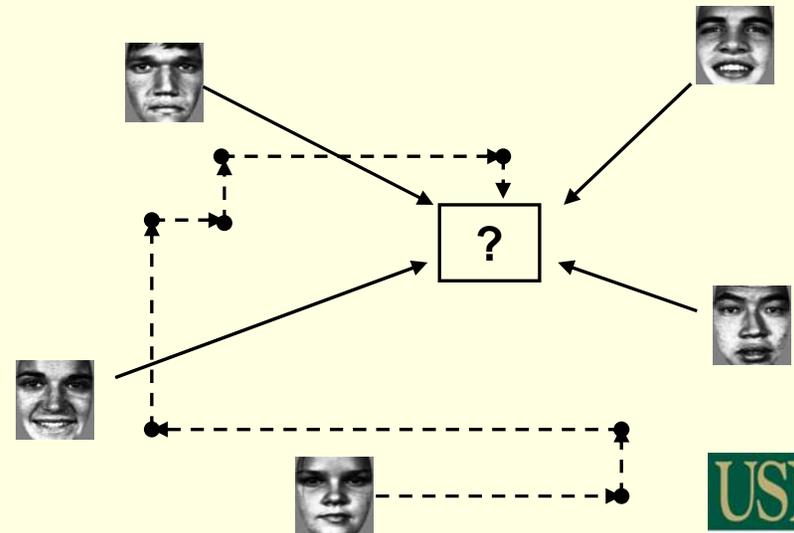
Proposed Method



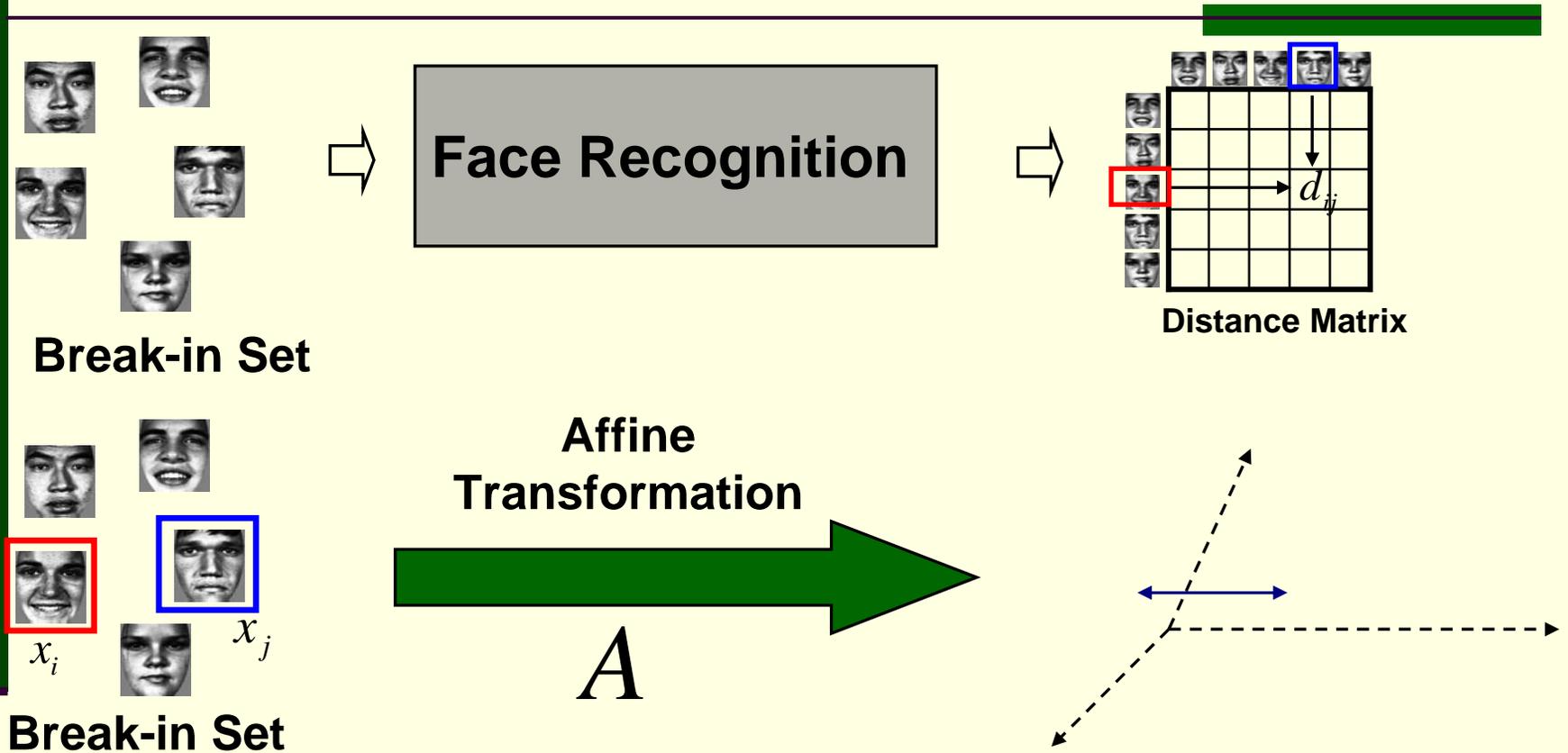
Hill Climbing Approach



Graphical Comparison



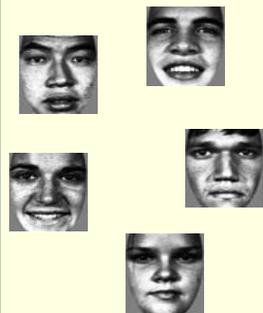
Modeling Recognition Algorithm



1. Create an Independent set of images “**Break-in set**”
2. Compute the distance matrix D using the recognition system
3. Using the same break-in set design an affine transformation s. t.

$$d_{ij}^2 - \|Ax_i - Ax_j\|^2 \cong 0$$

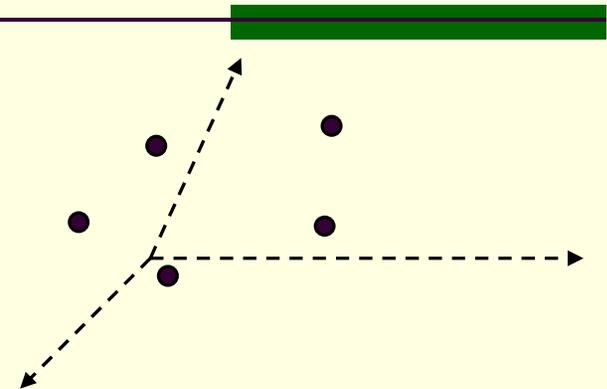
Modeling Recognition Algorithm



Affine Transformation



$$A = A_{nr} A_r$$



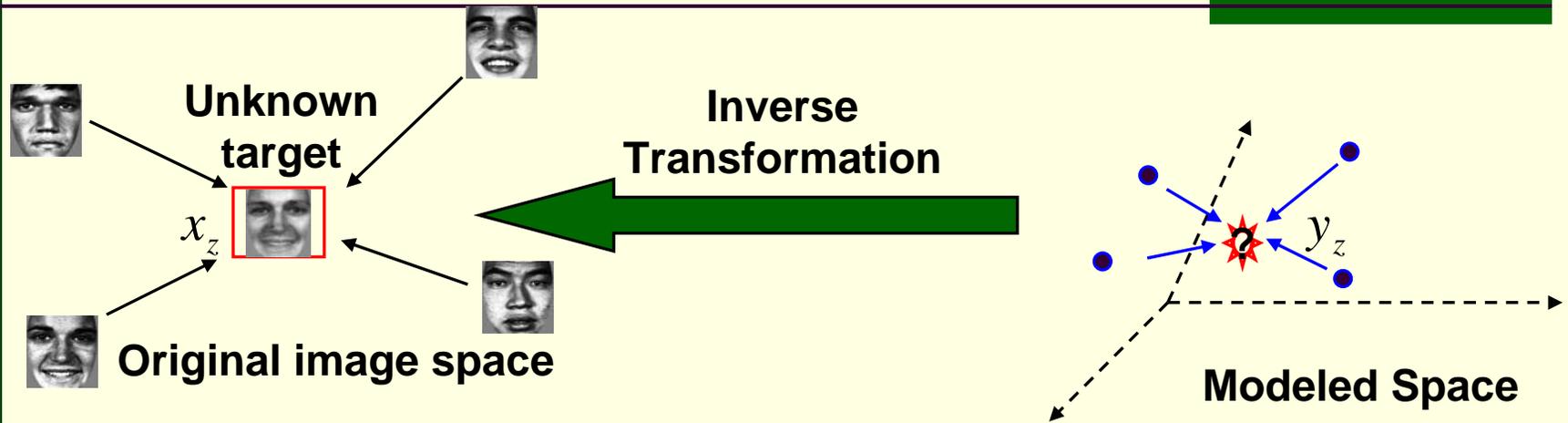
A_r

- a rigid transformation
- independent of the recognition algorithm
- derived from the orthonormal subspace analysis e.g. PCA of images in break-in set

A_{nr}

- a non-rigid transformation
- depends on the specific recognition algorithm
- approximate the recognition algorithm through sheer and stretching of the image space
- derived using classical MDS

Embedding & Reconstruction



Embedding

- Observe the distance from selected templates from break-in set to unknown target x_z
- Calculate the co-ordinate of the unknown target in transformed space y_z

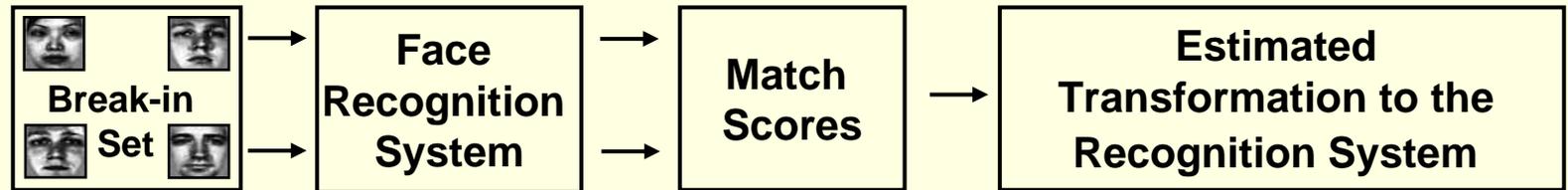
Reconstruction

- Use Invert transformation to reconstruct the unknown target template in original affine space

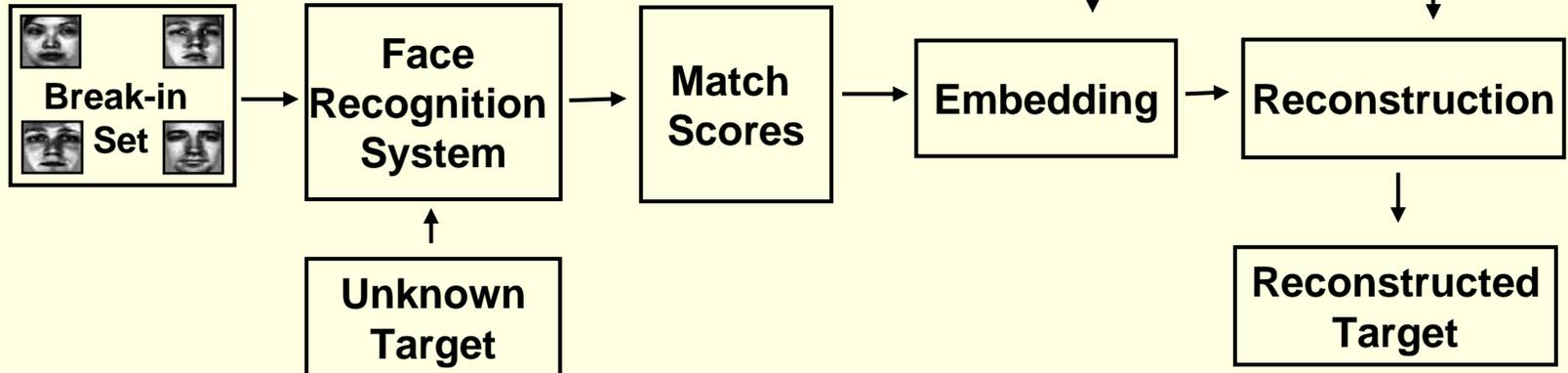
$$x_z = A_r^T A_{nr}^\Psi y_z$$

Outline of Proposed Scheme

Modeling



Embedding & Reconstruction



Dataset & Recognition Algorithms

■ Database

- Break-in set : 600 FERET images (150 subjects)
- Target Set
 - 100 FRGC Subjects
 - 100 FERET Subjects (all different from break-in set)

■ Algorithm

- FRGC baseline algorithm (template based)
- Bayesian intrapersonal/extrapersonal classifier (template based)
- Commercial Face Recognition System (feature based)

All algorithms are set to operate at 1% False Acceptance Rate and 99% True Acceptance Rate* with 100 enrollments on both the target sets.

* Except Bayesian Method on FRGC target set

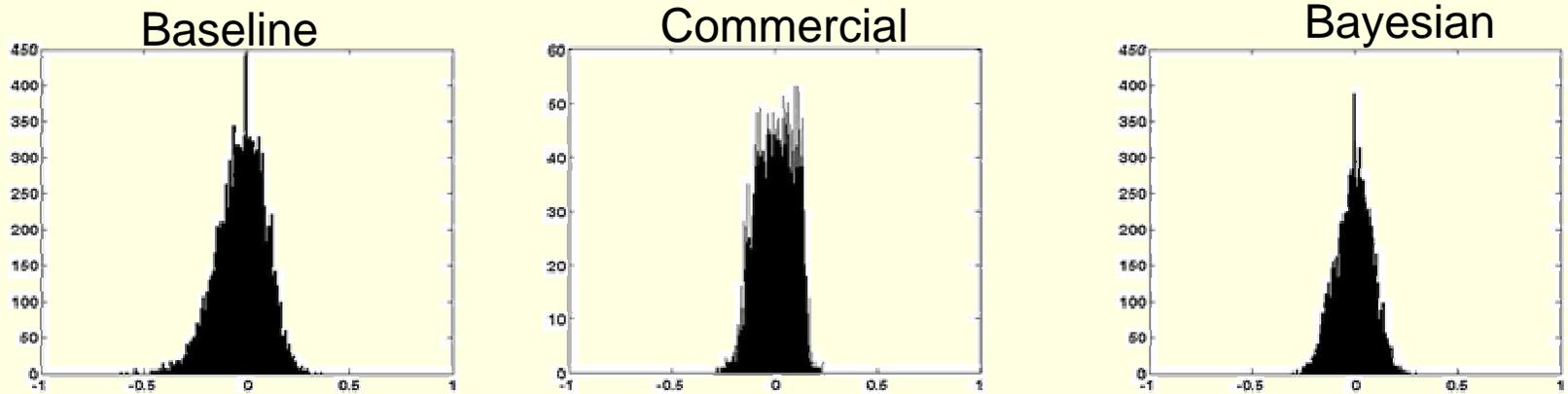
Results

■ Modeling Error

$$Error = \frac{d_{ij}^2 - \delta_{ij}^2}{d_{ij}^2}$$

d_{ij} Original distance computed by the recognition algorithm

δ_{ij} Euclidean distance in model space

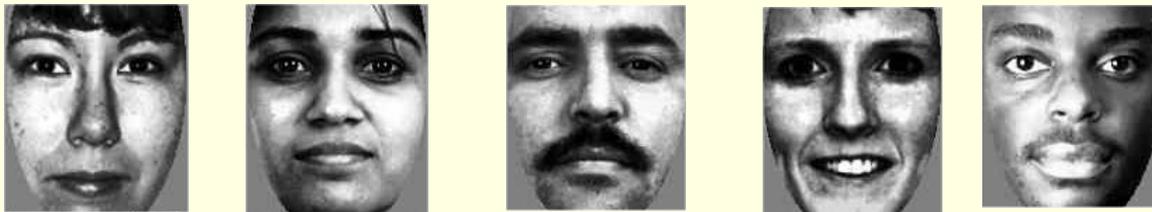


Error distribution has zero Mean in all three cases

Results (Contd.)

■ Reconstructed FERET Target Templates

Original



Reconstructed



Baseline



Commercial



Bayesian

Results (Contd.)

■ Reconstructed FRGC Target Templates

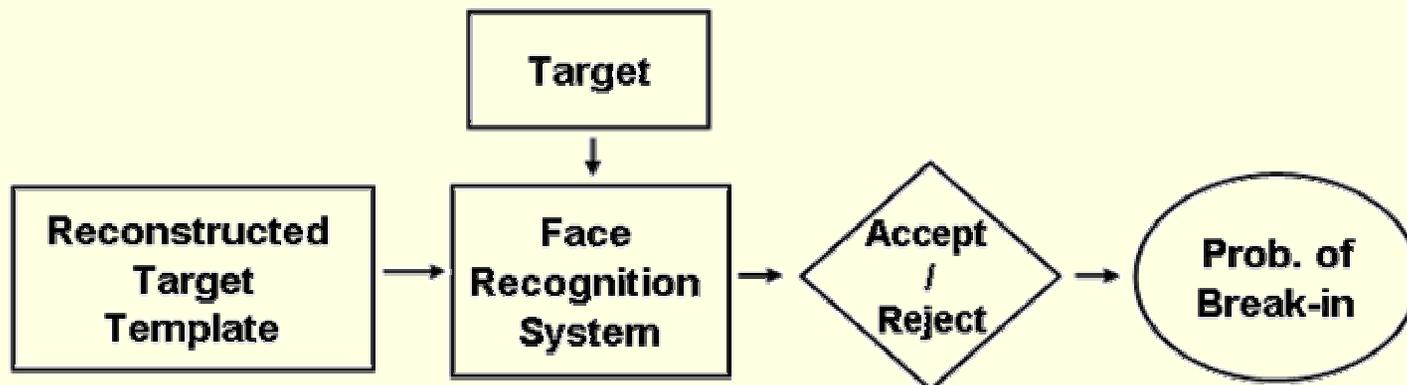


Results (Contd.)

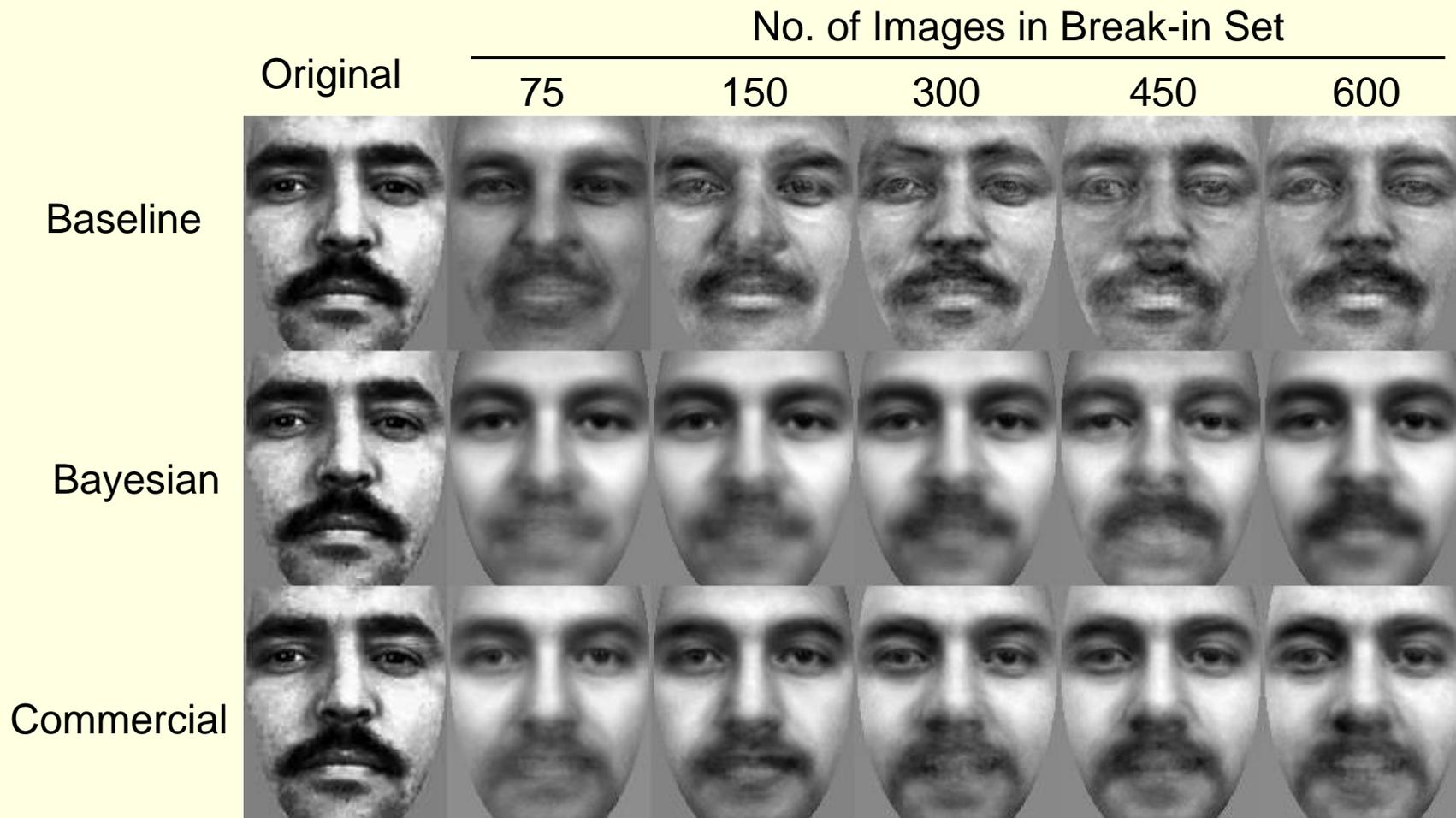
- We reconstruct the target sets using five different break-in set with 75, 150, 300, 450 and 600 images

Probability of Break-in

“Probability of breaking into a face recognition system by randomly selecting an enrolled account”

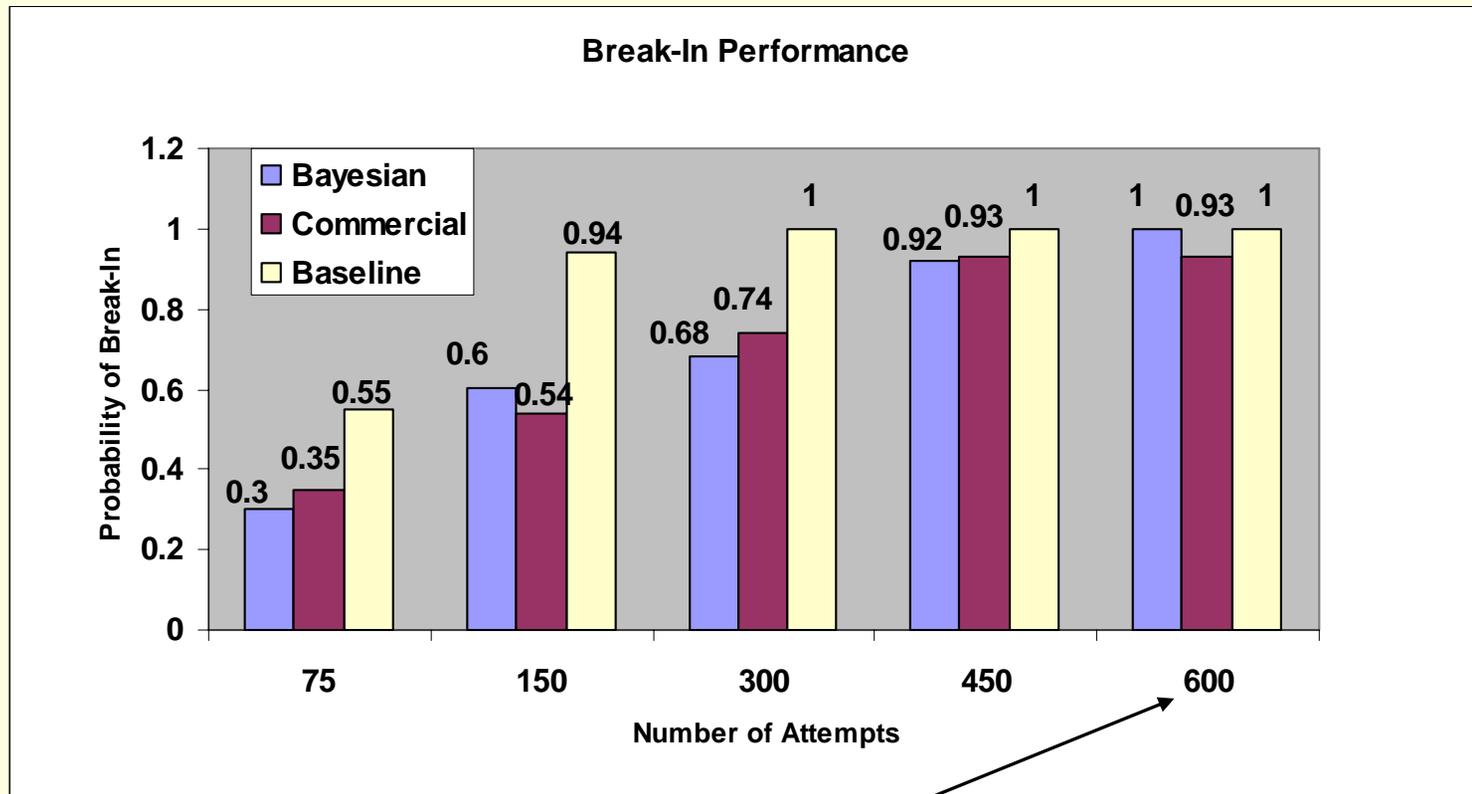


Results (Contd.)



Results (Contd.)

Probability of Break-in on FERET Set

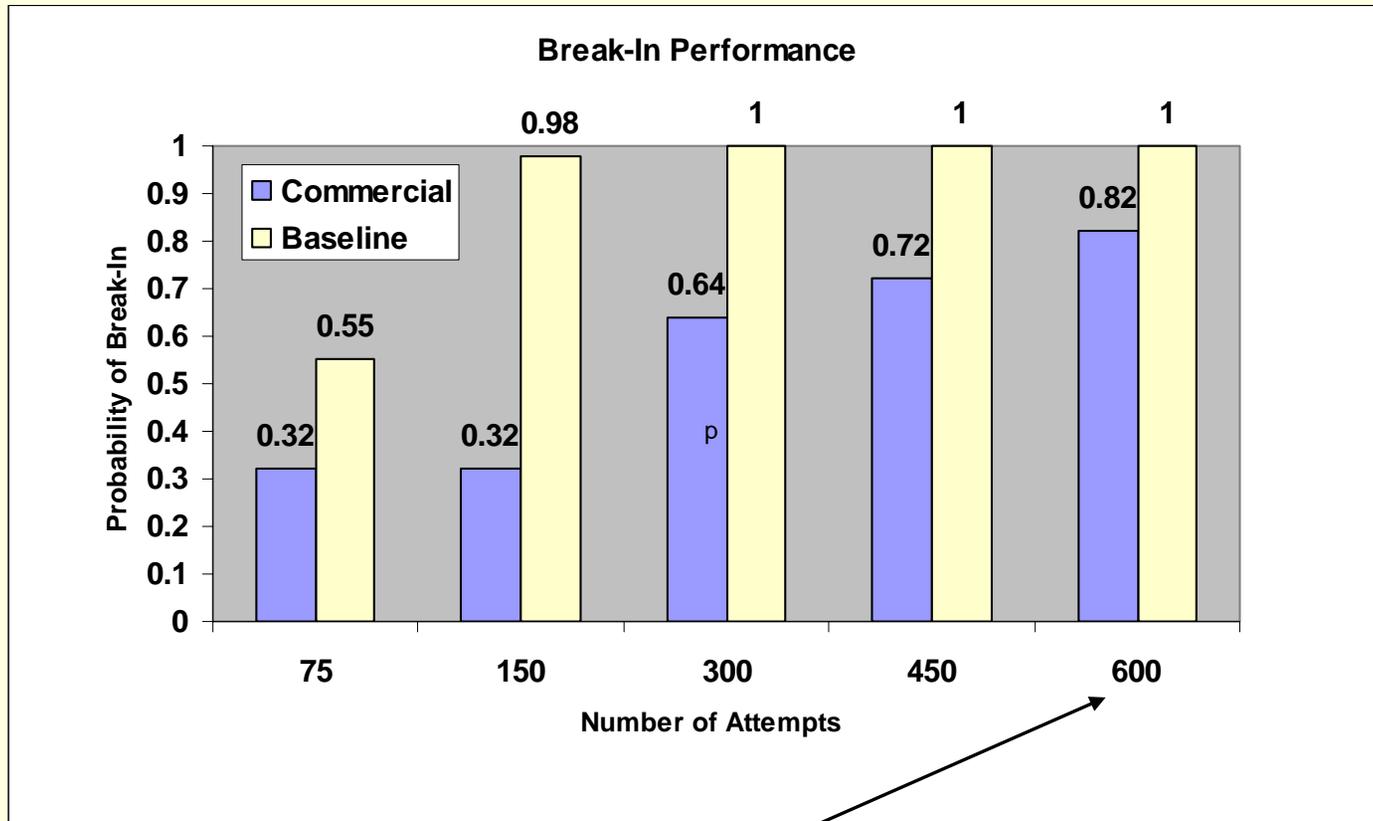


Bayesian & Baseline 100%

Commercial 94%

Results (Contd.)

Probability of Break-in on FRGC Set

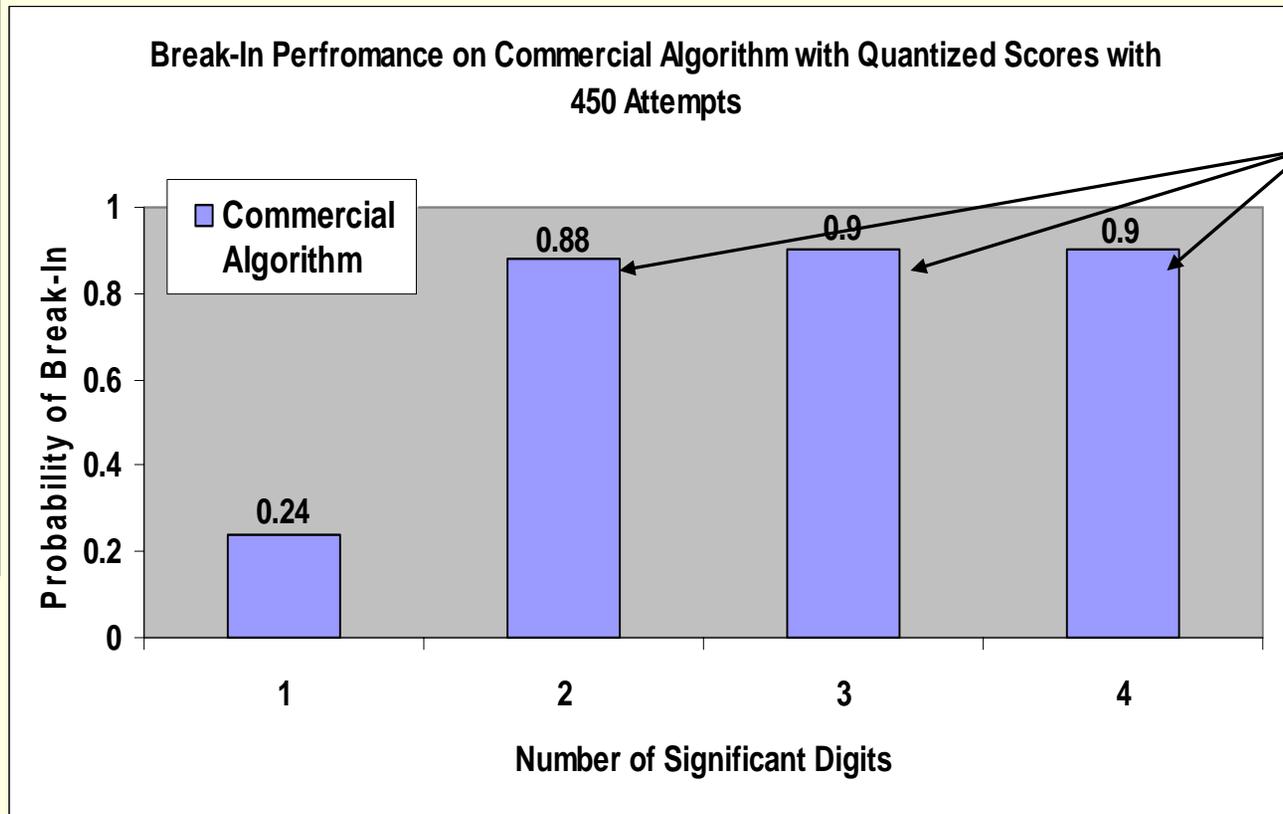


Baseline 100%

Commercial 82%

Results (Contd.)

■ Quantization of Match Scores



Performance remain unchanged for quantization up to 2nd most significant digit

Commercial Algorithm

Conclusion

- The proposed template reconstruction scheme uses an affine transformation to model the underlying recognition algorithm
- It is non-iterative
- Uses distinct face images to be matched with target template
- Requires less number of matching compared to Hill-Climbing Approach
- Robust to Score Quantization

Questions

Thank You