Face Recognition

using Linear Discriminant Analysis

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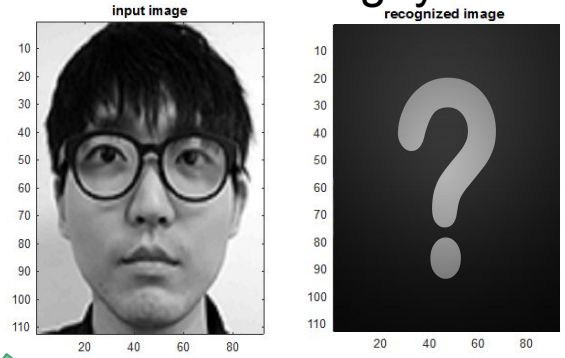
Outline

- Problem Statement
- Implemented algorithm
  - PCA
  - LDA
- Preliminary Result
- Evaluation / Conclusion
- Related work
- Q&A

Problem statement

Who is this guy?



human

computer

“This is Jun!”

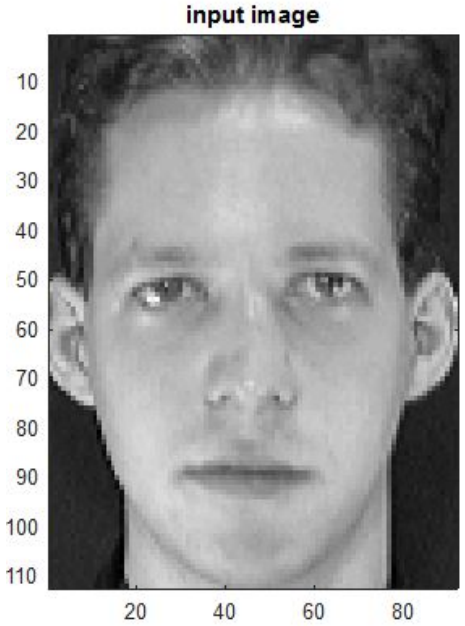
“I NEED DATA TO RECOGNIZE YOU!”

Face Recognition using Eigenfaces / Fisherfaces

- **Eigenfaces:** eigenvectors based on Principal Component Analysis
- **Goal:** compute a linear transformation that maps data from high dimensional space to lower dimensional subspace

- **Fisherfaces:** eigenvectors based on Linear Discriminant Analysis
- **Goal:** Dimensionality reduction!
- **Difference:** More capable of distinguishing image variation such as illumination or expression.

Face image can be represented as a linear combination of the eigenvectors:



PCA

coeff: -7.81 2.53 -3.31 -2.50

= 10^7*( +  +  +  + …)

LDA

coeff: 1.37 1.37 -1.38 0.5

= 10^7*( +  +  +  + …)

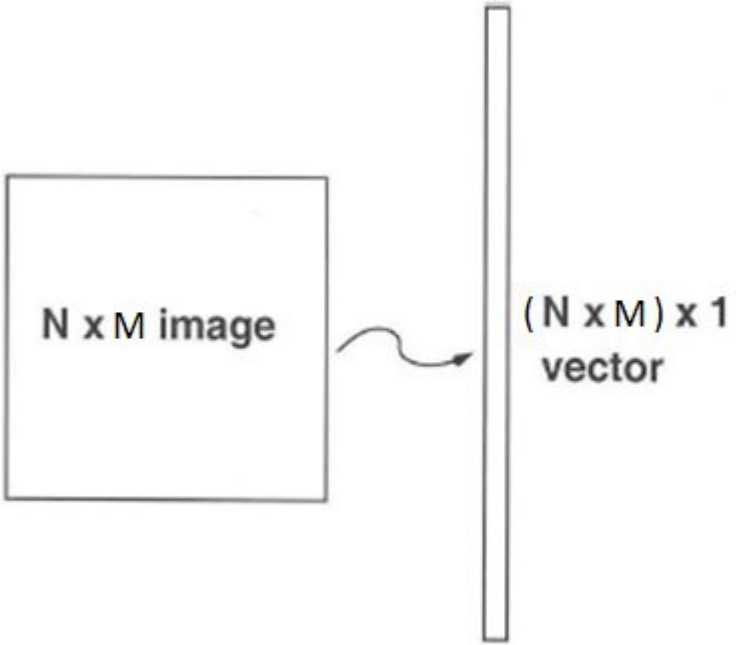
Implemented algorithm (preprocess)

Datasource: ORL
Total images: 420
Class: 42
Image size: 112x92

Convert images into column vector space (10304x420)

Split ratio:

- Train: 90% (10304x387)
- Test: 10% (10304x42)



Implemented algorithm (training steps)

Column vector size = 10304

train data

…

378

mean_face

subtract

$$\vec{f} - \vec{f}_{mean} = \sum_{i=1}^{k} w_i \vec{u}_i$$

mean-shifted

…

378

PCA

Compute the covariance matrix

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n\Phi_n^T = AA^T \quad (N^2 \text{x} N^2 \text{ matrix})$$

where $A = [\Phi_1\ \Phi_2 \cdots \Phi_M]$ $(N^2 \text{x} M \text{ matrix})$

Compute eigenvectors and eigenvalues

eigenfaces

…

Projection

Projecting centered images onto eigenspace

LDA

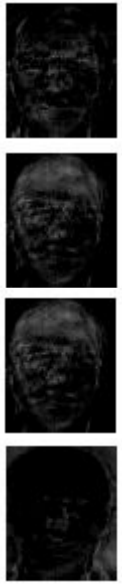
Calculate the mean for eigenspace

Calculate the between and within scatter matrix

$$S^{(V)} = S_w^{-1} S_b$$

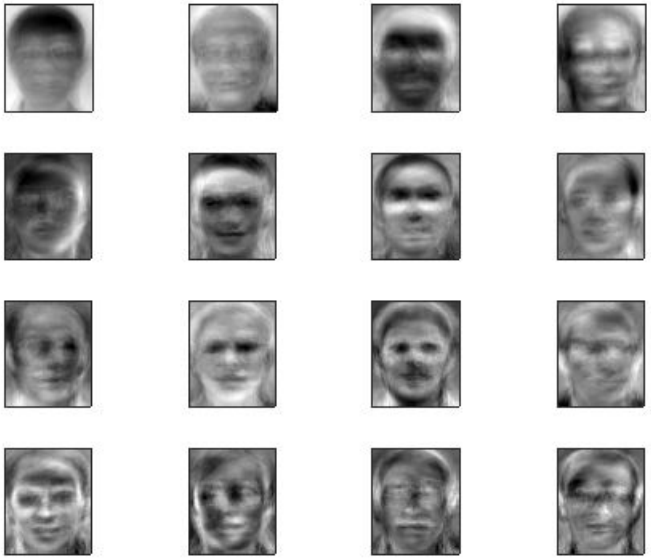
Compute eigenvectors and eigenvalues

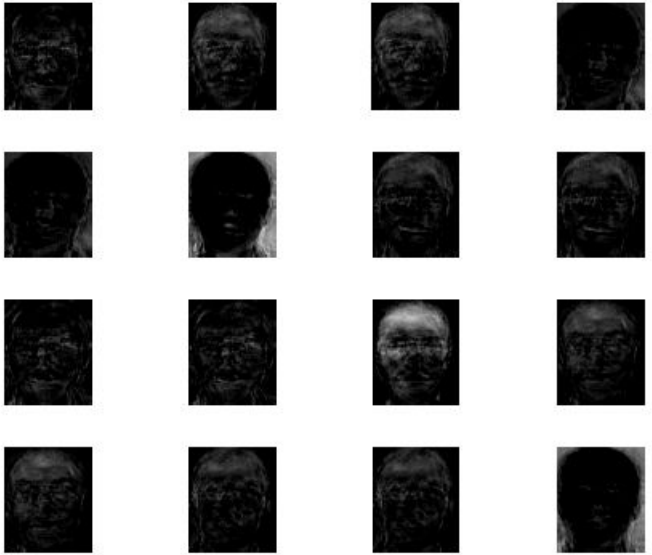
fisherfaces



…

The first 16 Eigenfaces ↔ Fisherfaces



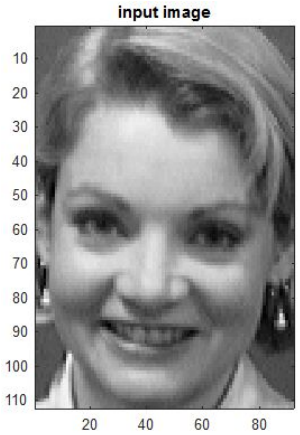


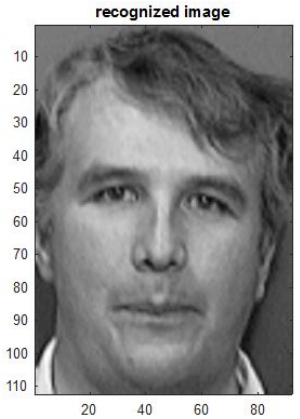
Recognition / evaluation method

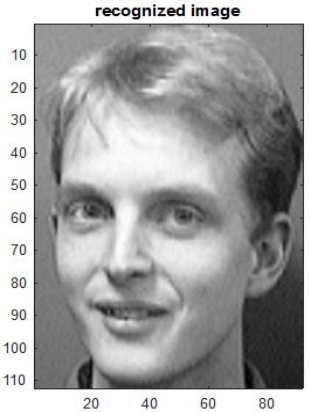
Step 1	Step 2	Step 3	Step 4	Step 5
Normalize a test image vector by subtracting mean-face	Project the test image vector onto eigenspaces	Calculate Euclidean distance between the test image vector and train image vectors	Find the nearest neighbor image and its class (ID)	Compare test image ID and class ID Compute recognition accuracy

Recognition result

	PCA (using eigenfaces)	LDA (using fisherfaces)
Similarity	0.805524	0.805524

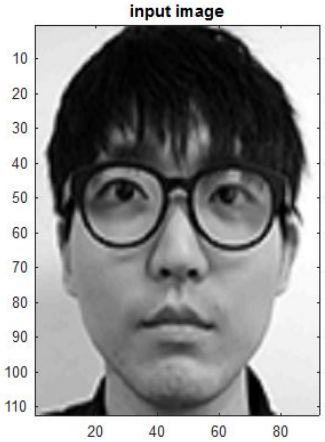


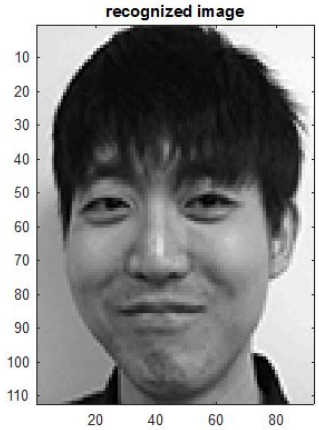


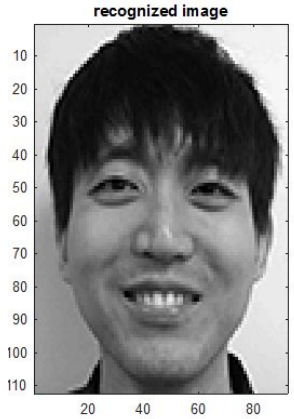


Recognition result with eyeglasses

	PCA (using eigenfaces)	LDA (using fisherfaces)
Similarity	0.753029	0.766363

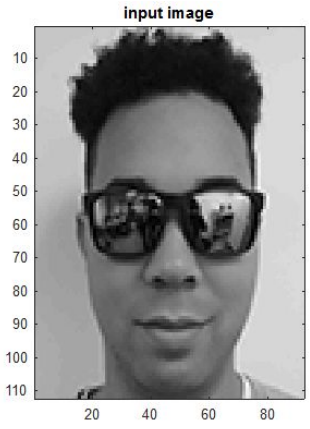


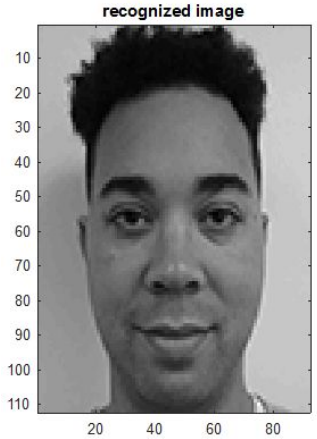


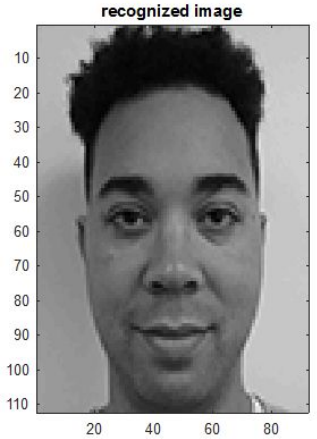


Recognition result with sunglasses

	PCA (using eigenfaces)	LDA (using fisherfaces)
Similarity	0.77896	0.77896







Recognition accuracy

	Recognition accuracy on 10% test data
PCA	95.23%
LDA	95.23%

Reference / Related Work

Discriminant analysis for recognition of humanface images	Kamran Etemad and Rama Chellappa
Eigenfaces vs. Fisherfaces: Recognition Using Class Specific Linear Projection	Peter N. Belhumeur, Joao P. Hespanha, and David J. Kriegman
Eigenfaces for Recognition	M. Turk, A. Pentland

Q&A