
HW#6 (Project 1)

Answers for some questions

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Eigenfaces and Face Recognition

- Use PCA (SVD) for gray-scale face images
 - Find eigenfaces
 - Show face recognition performance



1. Collect face images

- ❑ Crop the same image size for face area
 - Image size: $32 \times 32 \Rightarrow 1024$ -D vector (F)
- ❑ At least 1024 gray images (N face images)
 - More than vector dimension
 - Different faces



2. Construct data matrix, A

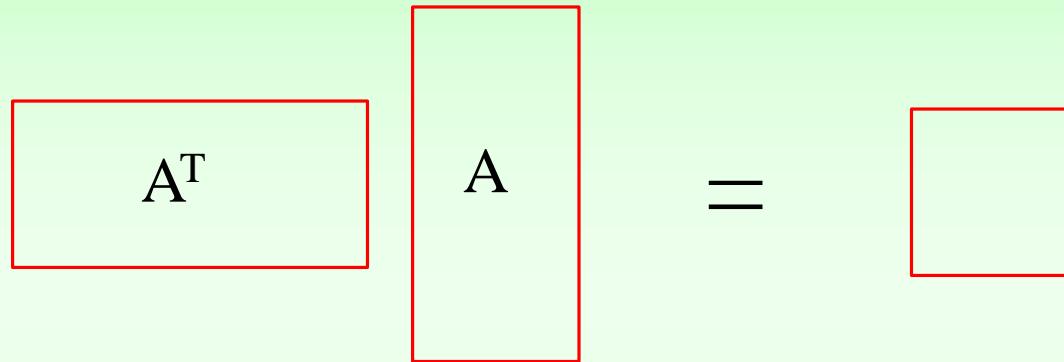
- Find the mean vector (M) of your collected image vectors (F's)
 - Make the vector space by including the origin
- Subtract each face vector with the mean vector
 - $F_k - M \Rightarrow a_k$
 - k : index of face image vector
- Make the data matrix, A with the column vector a_k

$$A = [a_1 \ a_2 \ \dots \ a_N]$$

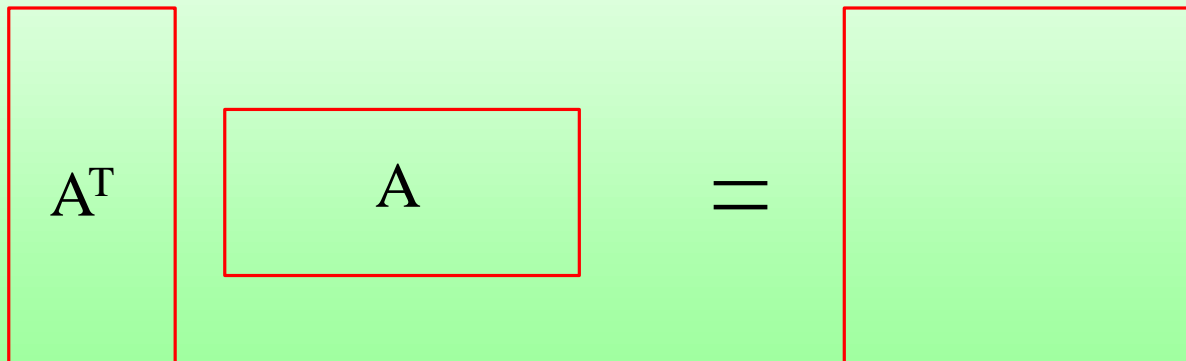


Two cases of $A^T A$

□ $N < 1024$



□ $N > 1024$



3. Apply SVD

- Apply SVD (PCA) to the covariance matrix
- Find some eigenvectors for the largest singular values.
 - Number of eigenfaces is your choice.
 - Dependent on your training face data



4. Test face recognition

□ Collect 10 different cropped face images

➤ 5 test images for one face

- Represent each face images using the eigenfaces
- Compare the coefficients $\{c_1, c_2, \dots, c_n\}$ for face recognition


$$- \mathbf{M} = c_1 \text{ [eigenface 1]} + c_2 \text{ [eigenface 2]} + c_3 \text{ [eigenface 3]} + \dots + c_n \text{ [eigenface n]}$$

Mean vector of collected face images



Find the Coefficients

□ inner product of eigenface vector and test face image vector

- Eigenfaces => orthonormal

$$\text{Test Face Image} - \mathbf{M} = c_1 \text{Eigenface}_1 + c_2 \text{Eigenface}_2 + c_3 \text{Eigenface}_3 + \dots + c_n \text{Eigenface}_n$$

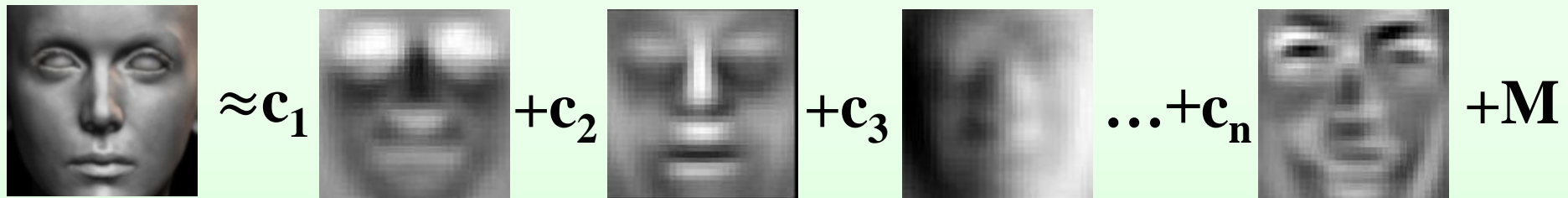
$$c_k = \left[\text{Test Face Image} - \mathbf{M} \right] \cdot \text{Eigenface}_k$$

(inner product of \mathbf{e}_k and test face image vector)



Generate face image using eigenfaces

- linear combination of eigenface vectors adding the mean vector


$$\text{Target Face} \approx c_1 \text{Eigenface}_1 + c_2 \text{Eigenface}_2 + c_3 \text{Eigenface}_3 + \dots + c_n \text{Eigenface}_n + M$$



Use Libraries for SVD

□ 파이썬, C++, Matlab....

- Input your collected face image vectors
- Output the eigenface vectors

□ In the ppt report

- Show your own eigenfaces with the mean vectors
- Face recognition test results
 - How to compare with the coefficients
 - How many eigenfaces to be used



Mid test (on-line)

□ Project #1

- SVD for Eigenfaces and face recognition
- Submission: 2020. 10. 21. (Wed)

□ Problems

- Linear algebra problems
- Submission: 2020. 10.25. (Sun)

