

ECE 63700 Laboratory:

Eigen-decomposition of Images

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1 Introduction

No reports needed.

2 Multivariate Gaussian Distributions and Whitening

2.1 Scatter plots for W , \tilde{X} , and X

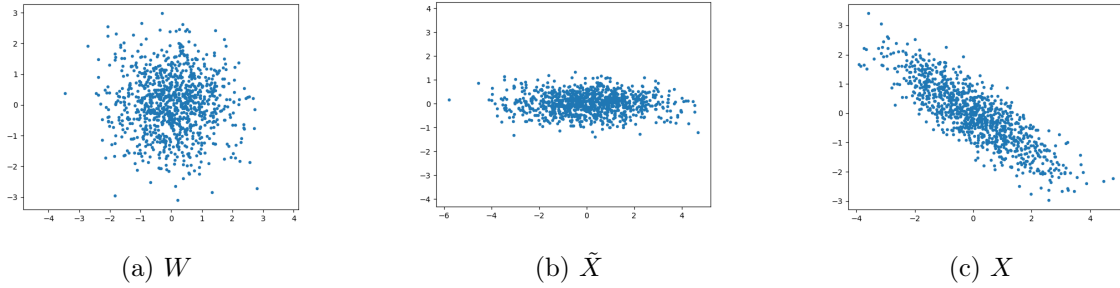


Figure 1: Scatter plots for W , \tilde{X} , and X

2.2 Covariance Estimation and Whitening

2.2.1 Theoretical value of the covariance matrix R_x

$$R_x = \begin{bmatrix} 2 & -1.2 \\ -1.2 & 1 \end{bmatrix}$$

2.2.2 Covariance estimate \hat{R}_x

$$\hat{R}_x = \begin{bmatrix} 2.0515 & -1.2521 \\ -1.2521 & 1.0444 \end{bmatrix}$$

2.2.3 Scatter plots for \tilde{X}_i and W_i

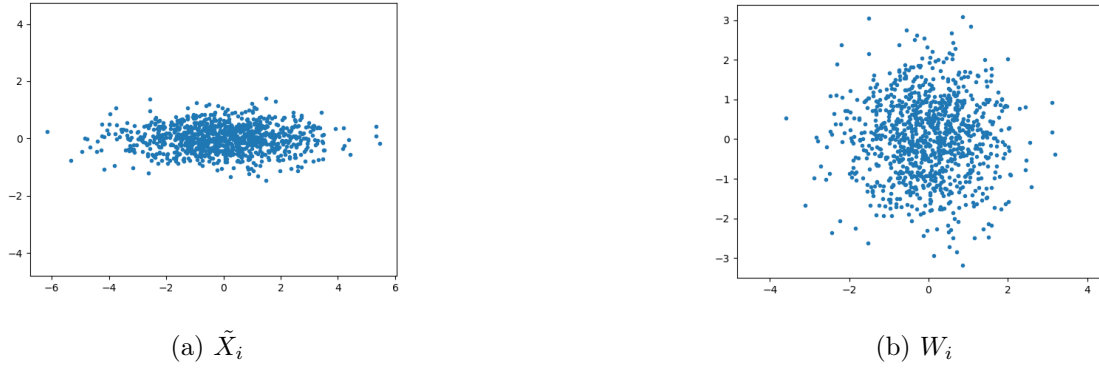


Figure 2: Scatter plots for \tilde{X}_i and W_i

2.2.4 Covariance estimate \hat{R}_W

$$\hat{R}_W = \begin{bmatrix} 1.0348 & -0.0224 \\ -0.0224 & 0.9924 \end{bmatrix}$$

3 Estimation of Eigenvectors and Eigenvalues Using the Singular Value Decomposition

No reports needed.

4 Eigenimages, PCA, and Data Reduction

4.1 First 12 eigenimages

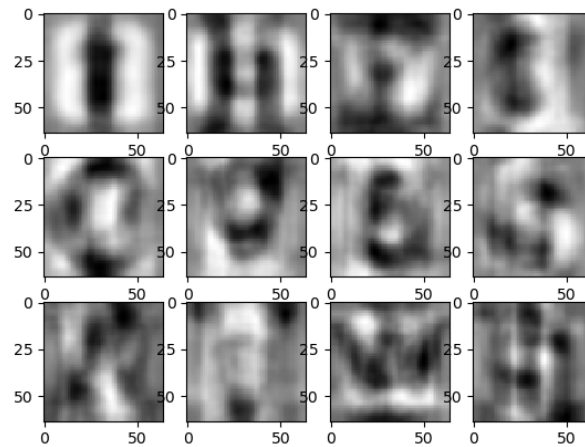


Figure 3: First 12 eigenimages

4.2 Projection Coefficients vs. Eigenvector Number

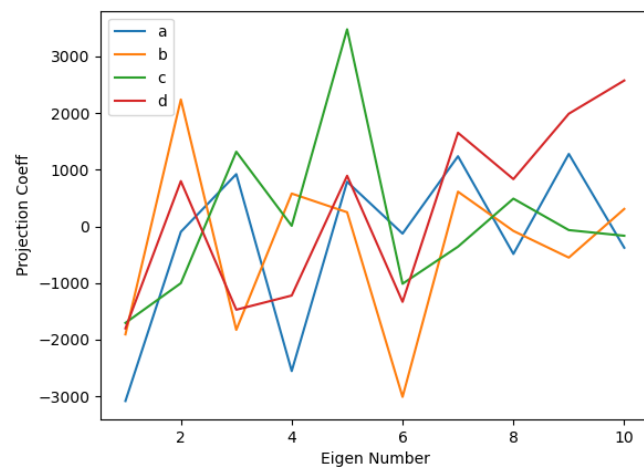


Figure 4: Projection Coefficients vs. Eigenvector Number

4.3 Original image, and the 6 resynthesized versions of 'a'



Figure 5: Original image of 'a'

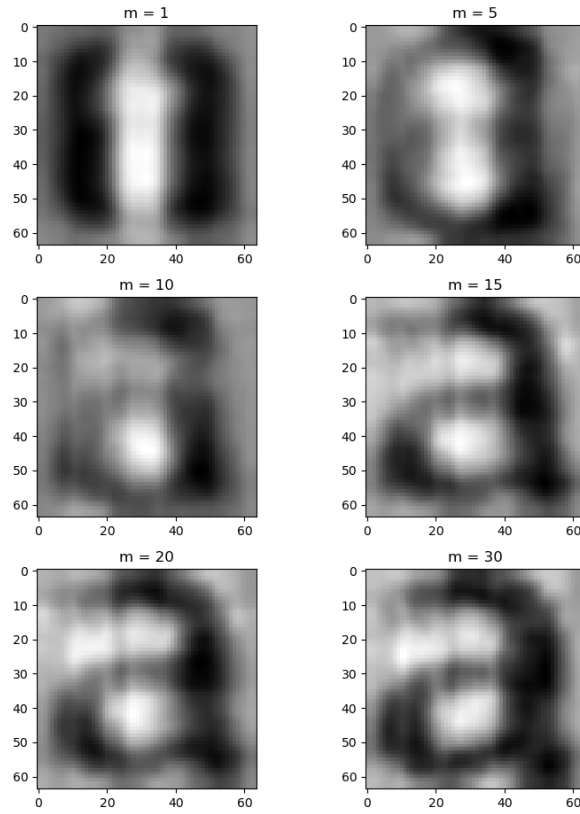


Figure 6: 6 resynthesized image of 'a'

5 Image Classification

5.1 Miss-classifications using R_k

Ground Truth	Classified as
d	a
j	y
l	i
n	v
p	e
q	a
u	a
y	v

5.2 Miss-classifications using different B_k

5.2.1 $B_k = \Lambda_k$

Ground Truth	Classified as
i	l
y	v

5.2.2 $B_k = R_{wc}$

Ground Truth	Classified as
g	q
y	v

5.2.3 $B_k = \Lambda$

Ground Truth	Classified as
f	t
y	v

5.2.4 $B_k = I$

Ground Truth	Classified as
f	t
g	q
y	v

5.3 Discussions

5.3.1 Which of the above classifiers worked the best in this experiment?

There are three classifiers that returns the best predictions: $B_k = \Lambda_k$, $B_k = R_{wc}$, and $B_k = \Lambda$. Only 2 out of 26 are mis-classified.

5.3.2 In constraining the covariance, what is the trade off between the accuracy of the data model and the accuracy of the estimates?

By constraining the covariance, the accuracy of the estimates will increase, but the accuracy of the data model will decrease.