CommE 5052: Deep Learning for Computer Vision **Spring 2018**

Homework 1

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Problem 1: Bayes Decision Rule

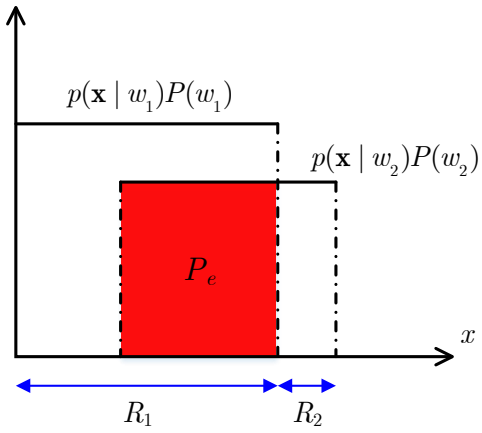


Figure 1: Figure 1

As shown in Figure 1, $R_1 = (0, 5)$ and $R_2 = (5, 6)$ and

$$P_e = \int_{R_1} p(\mathbf{x} \mid w_2)P(w_2)dx + \int_{R_2} p(\mathbf{x} \mid w_1)P(w_1)dx = \int_3^5 \frac{1}{12}dx = 1/6 \tag{1}$$

Problem 2: Classification

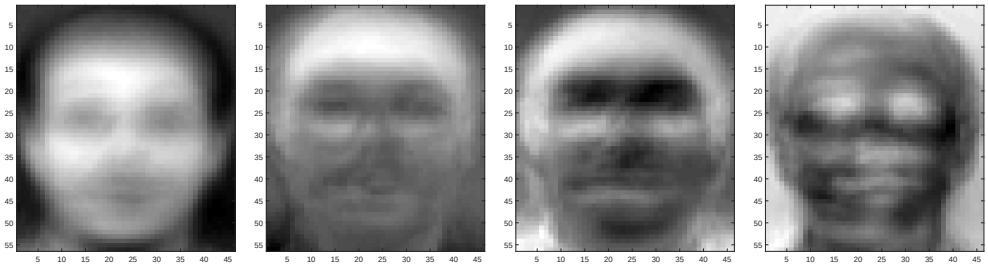
This solution is based on `Matlab`.

(a) As required, we performed PCA on the training set. The resulting mean face and the first three eigenfaces are illustrated on Figure 2.

(b) As required, we projected the image $\text{person}_1\_\text{image}_1$ onto the eigenspace and reconstruct this image using the first 3, 50, 100 and 239 eigenfaces. The MSE between the resulting image and the origin image equals to 659.4069 ($n = 3$), 213.2632 ($n = 50$), 81.9518 ($n = 100$) and 1.3598e-24 ($n = 239$) respectively (see Figure 4). Besides, we always plot the relationship between the MSE and the number of eigenfaces used for reconstruction, which is shown in Figure 4.

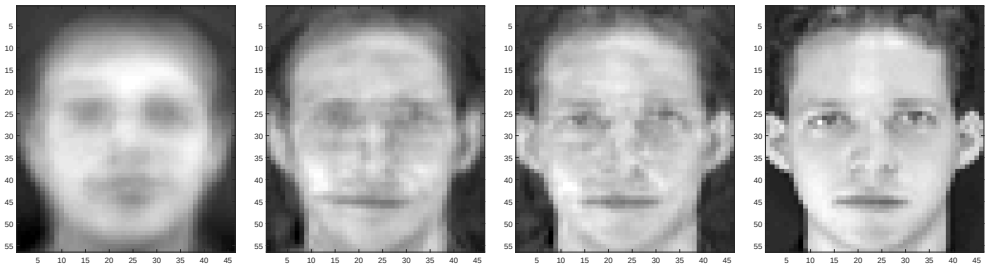
(c) We applied the k-nearest neighbors classifier (`fitcknn` for training and `predict` for test) to recognize test set images. We performed the 3-fold cross-validation to determine the best k and n. The average results are illustrated on Table 1. We can found

that when $k = 1$ and $n = 159$, the accuracy is the highest. Therefore, we choose $k = 1$ and $n = 159$ and the recognition rate is 92.5%. That means for 160 observations, about 148 is correctly recognized.



(a) Mean face (b) 1st eigenface (c) 2nd eigenface (d) 3rd eigenface

Figure 2: Results of problem 2(b).



(a) n=3 (b) n=50 (c) n=100 (d) n=239

Figure 3: Reconstruct image using eigenfaces.

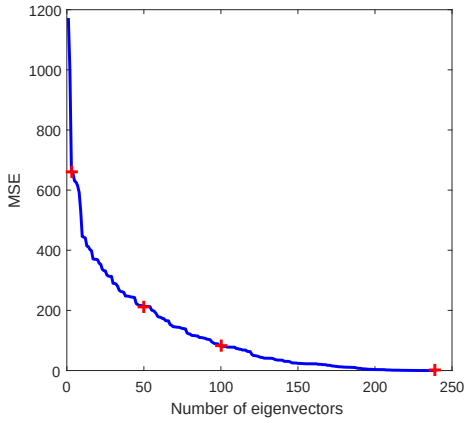


Figure 4: MSE w.r.t the number of eigenfaces used to reconstruction.

Table 1: Average results of 3-fold cross-validation.

	$n = 3$	$n = 50$	$n = 159$
$k = 1$	0.0583	0.3667	**0.6125**
$k = 3$	0.0542	0.2208	0.4375
$k = 5$	0.0333	0.1375	0.3875