Homework 4

Collaborators:
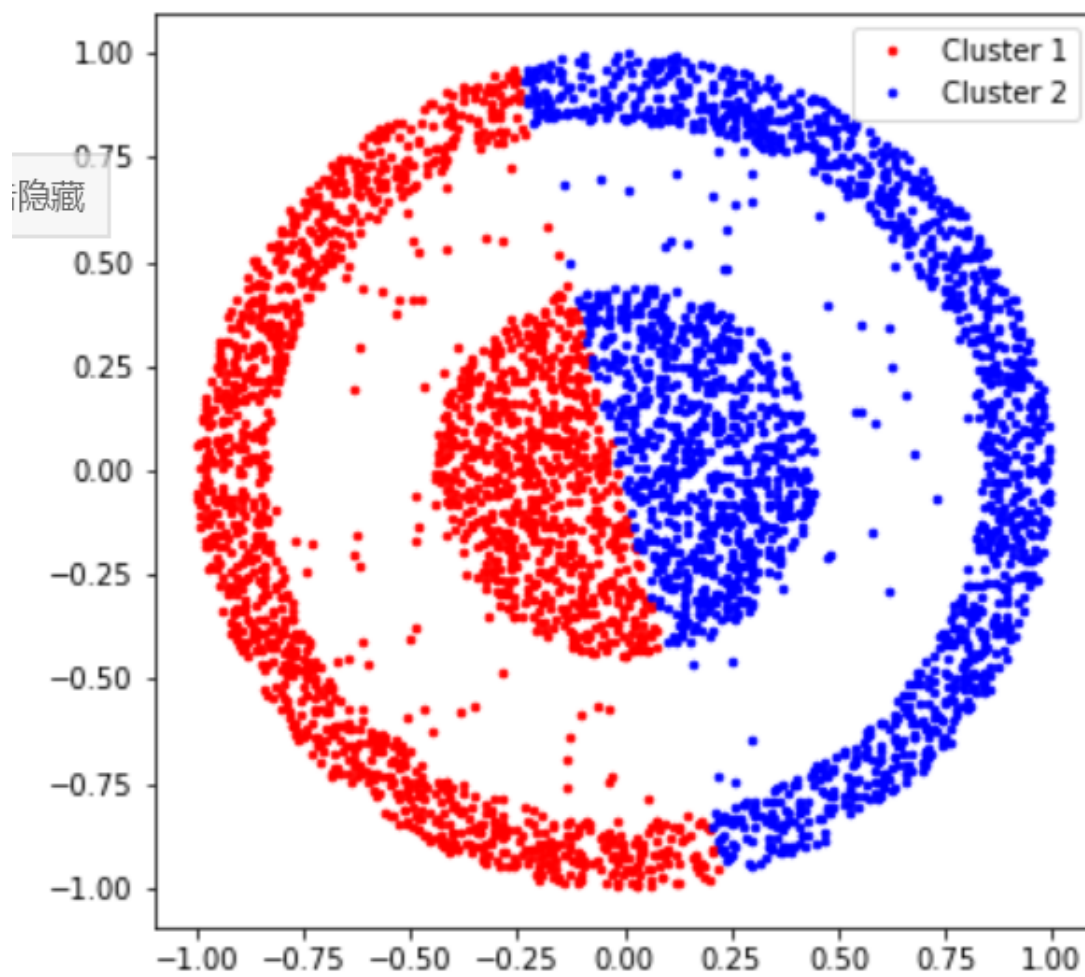
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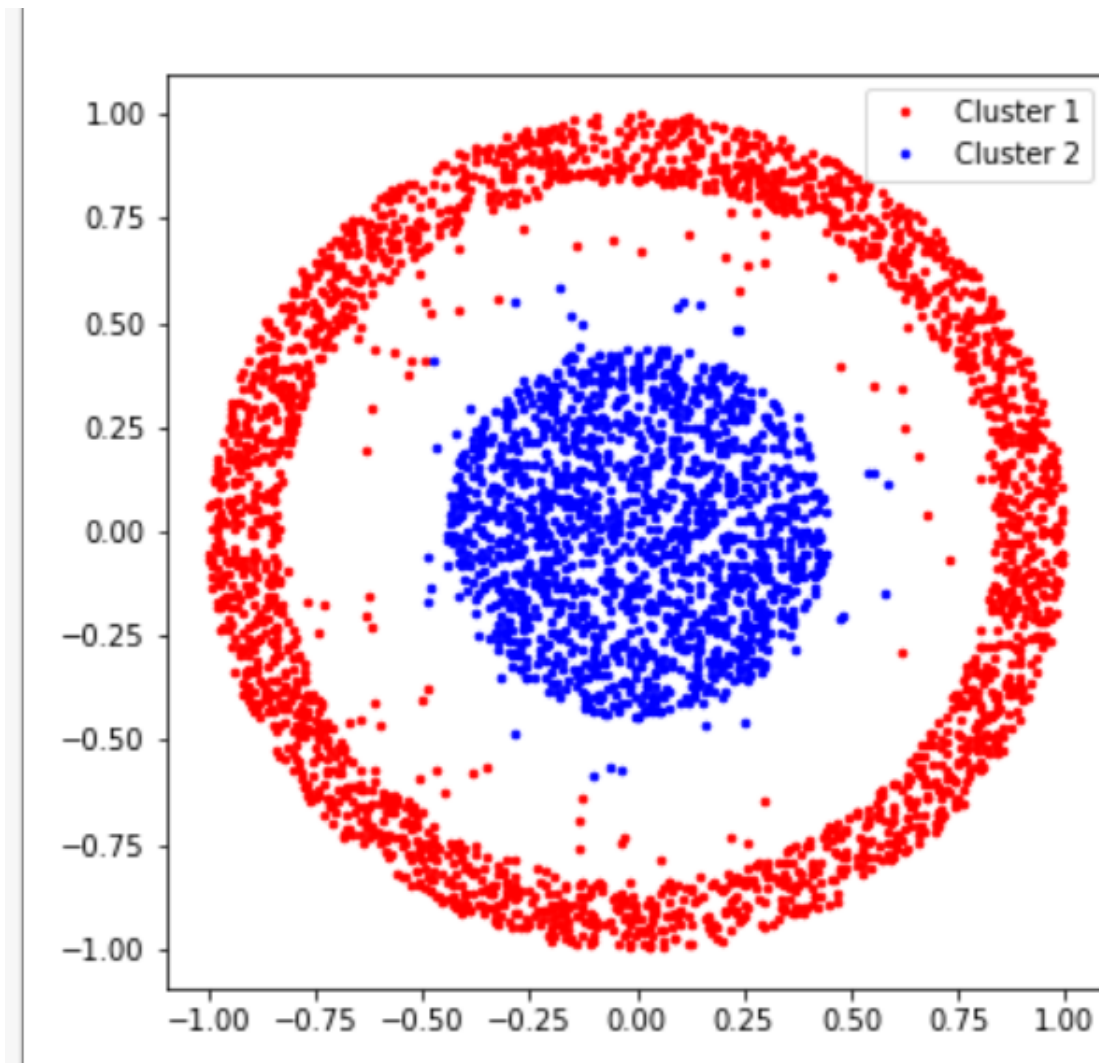**Problem 4-1. Spectral Clustering**

In this problem, we will try a dimensionality reduction based clustering algorithm Spectral Clustering.

   (a) We will first experiment Spectral Clustering on synthesis data

   Answer:

Figure 1: kmeans
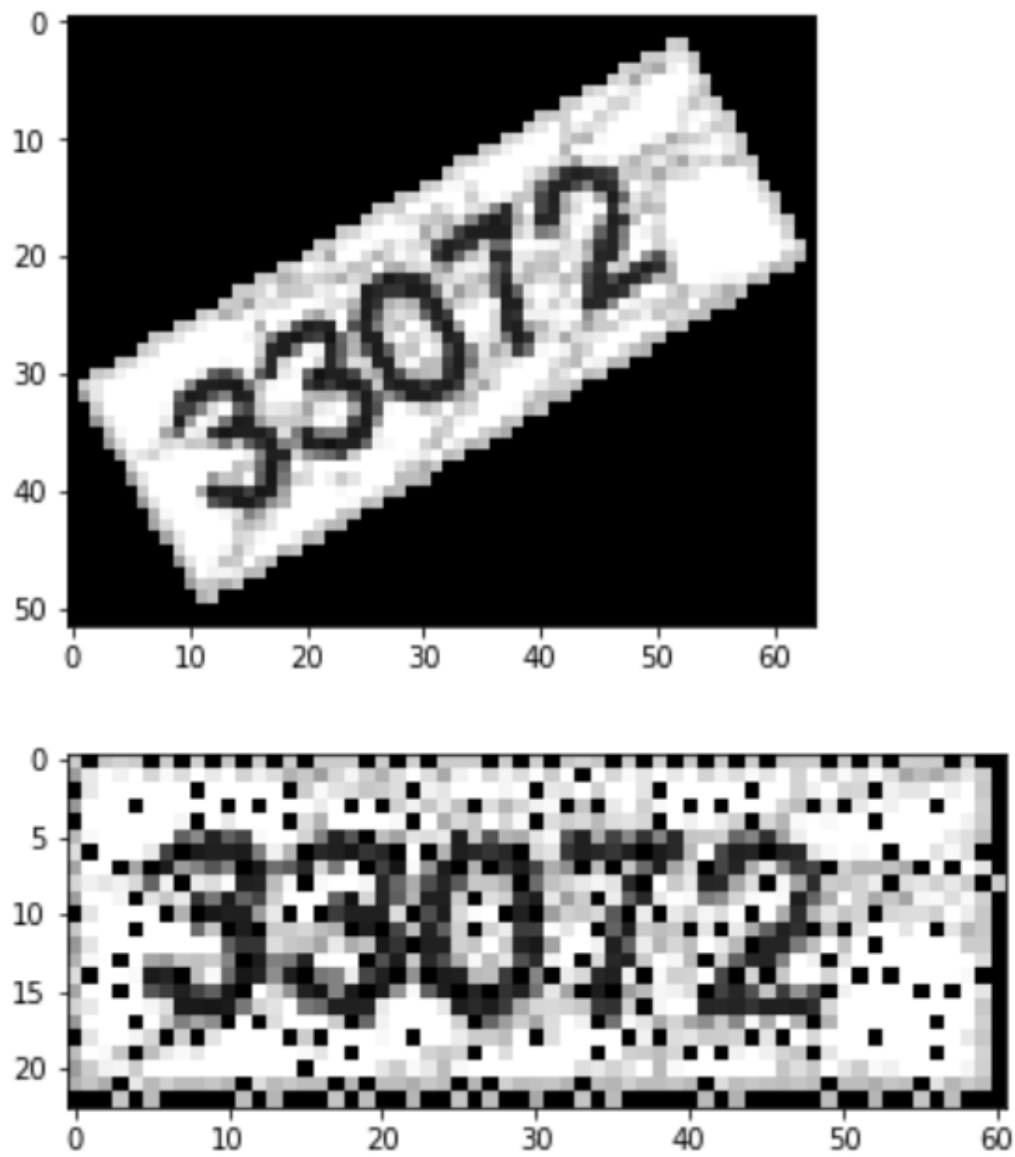
Figure 2: spectral clustering

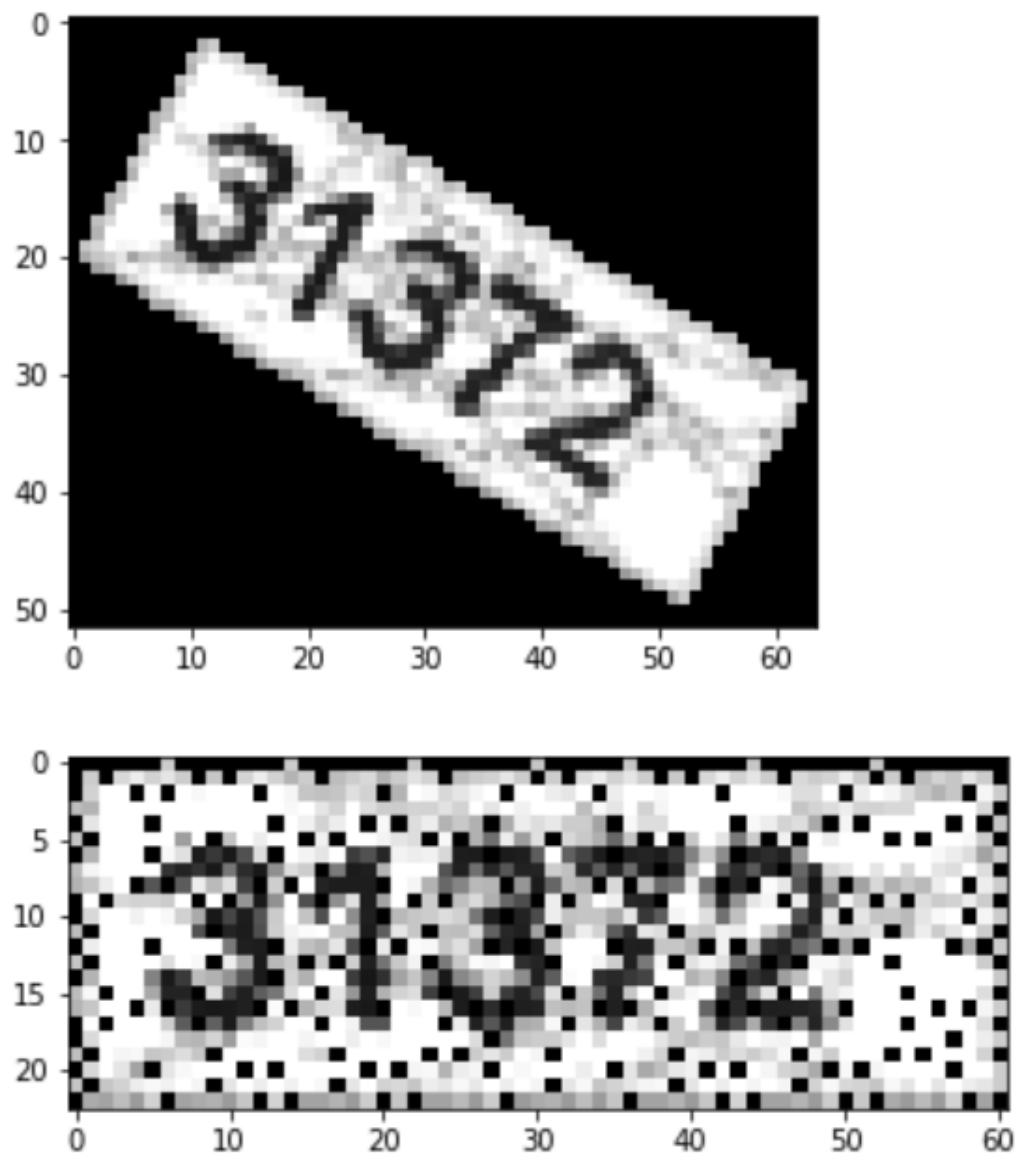**(b)** Now let us try Spectral Clustering on real-world data.

Answer:

Problem 4-2. **Principal Component Analysis** Let us deepen our understanding of PCA by the following problems.

(a) Your task is to implement *hack_pca.m* to recover the rotated CAPTCHA image using PCA.
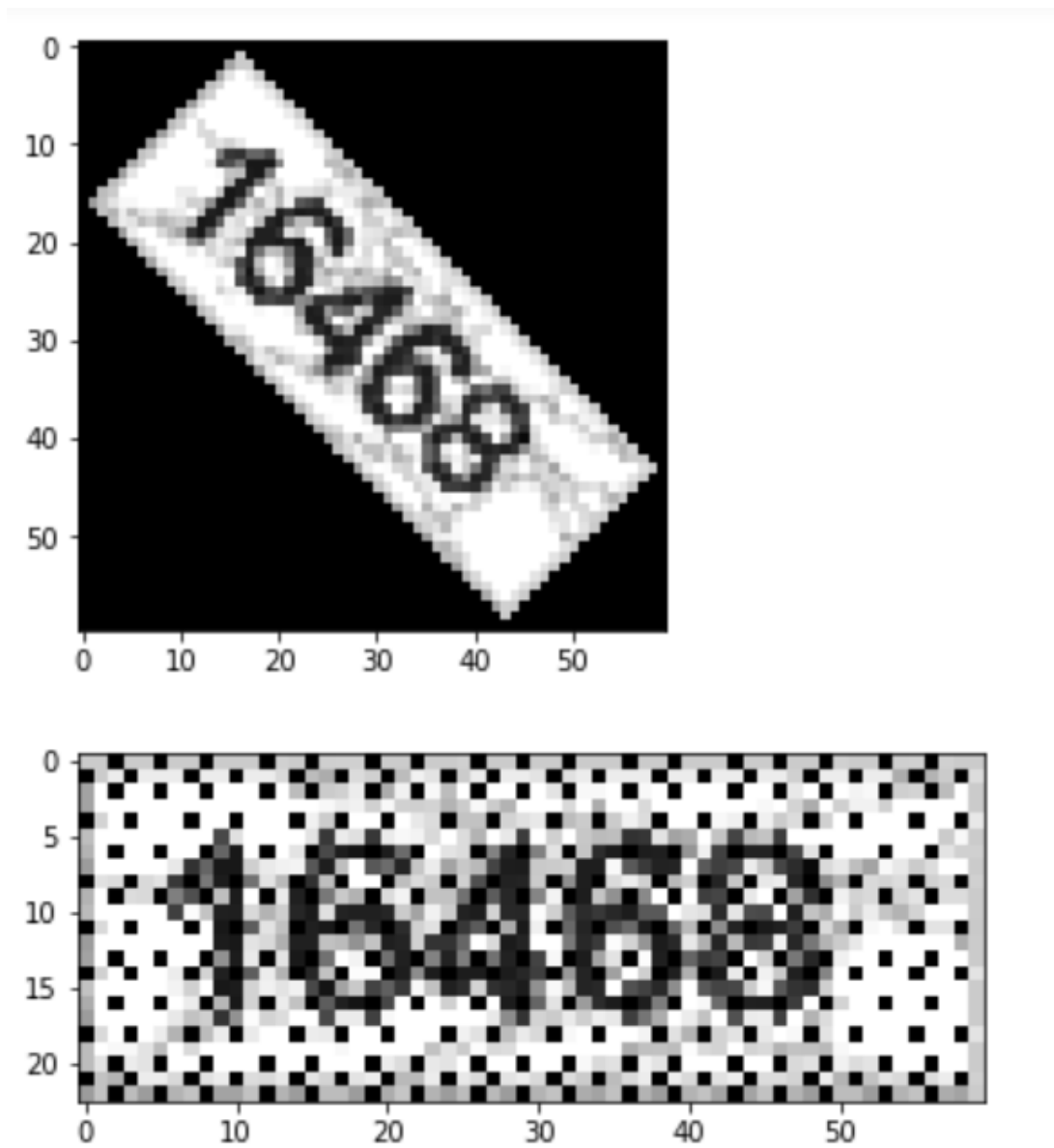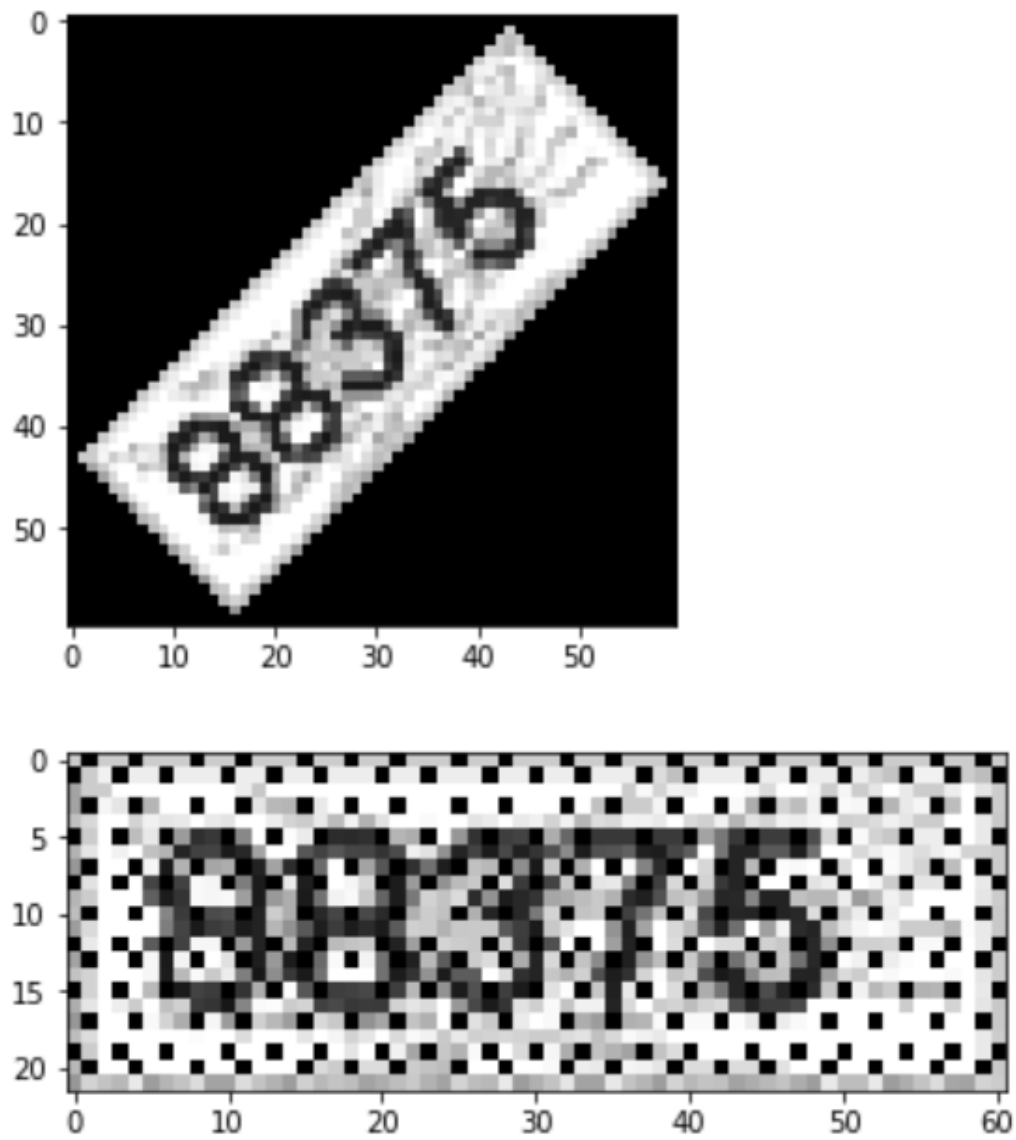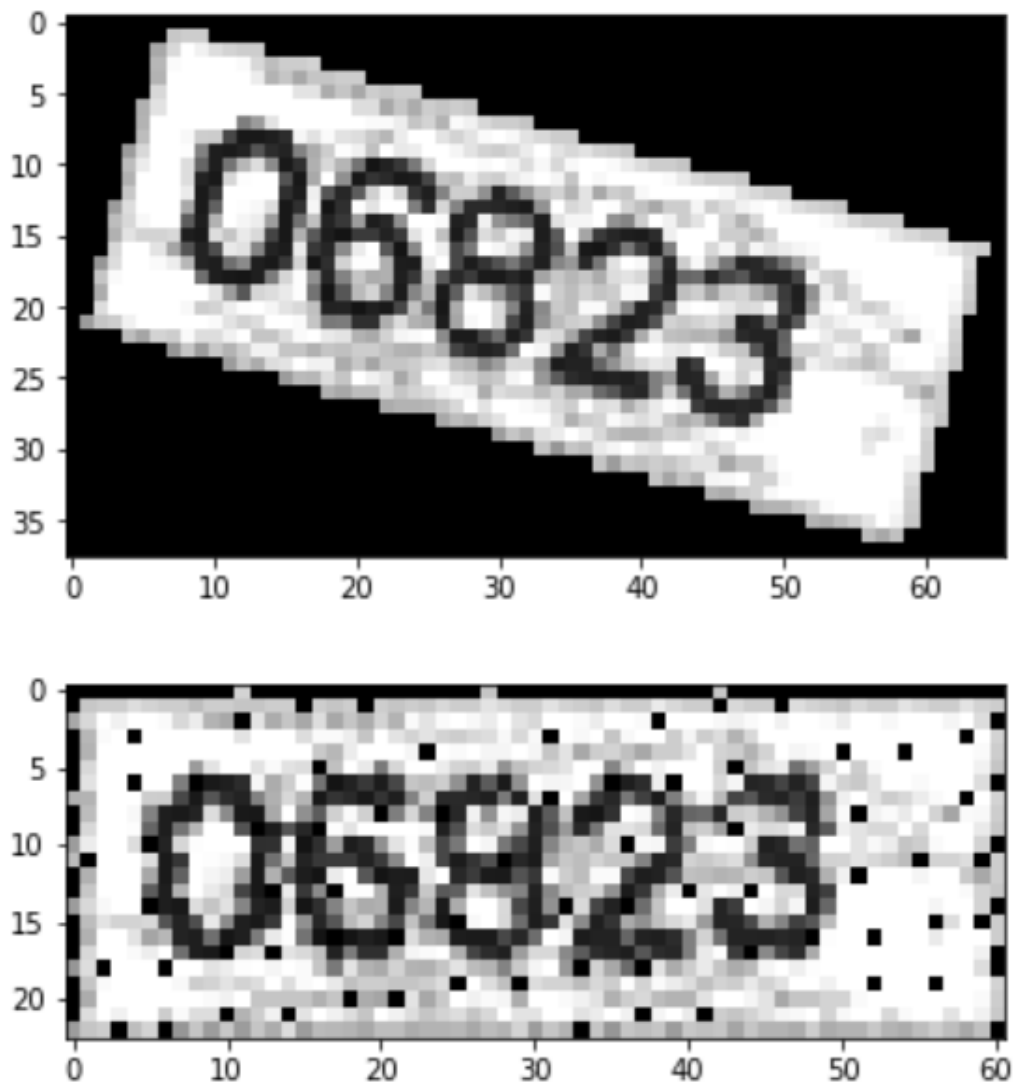
Answer:

Figure 3: result

Figure 4: result

Figure 5: result

Figure 6: result

Figure 7: result

(b) Now let us apply PCA to a face image dataset.

Answer:

Figure 8: result

Figure 9: result

d = 8, test error = 0.245

d = 16, test error = 0.19999999999999996

Figure 10: result

d = 32, test error = 0.18000000000000005

d = 64, test error = 0.15000000000000002

Figure 11: result

d = 128, test error = 0.15000000000000002

Figure 12: result

Using PCA,
dim = 8, error rate = 24.5%
dim = 16, error rate = 20%
dim = 32, error rate = 18%
dim = 64, error rate = 15%
dim = 128, error rate = 15%
Using LDA,
dim = 8, error rate = 13%
dim = 16, error rate = 4.5%
dim = 32, error rate = 4.5%
dim = 39, error rate = 4.0%