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ECE 1395
Homework 5

1b.

```
Sigma: 0.01, Accuracy: 0.68
Sigma: 0.07, Accuracy: 0.92
Sigma: 0.15, Accuracy: 0.92
Sigma: 1.5, Accuracy: 0.76
Sigma: 3.0, Accuracy: 0.76
Sigma: 4.5, Accuracy: 0.76
```

When sigma is too low, the model assigns more drop-off to farther away samples, and the prediction comes closer to a 1-NN model, which is overfit. When sigma is too high, it assigns less drop-off, so the model becomes underfit.
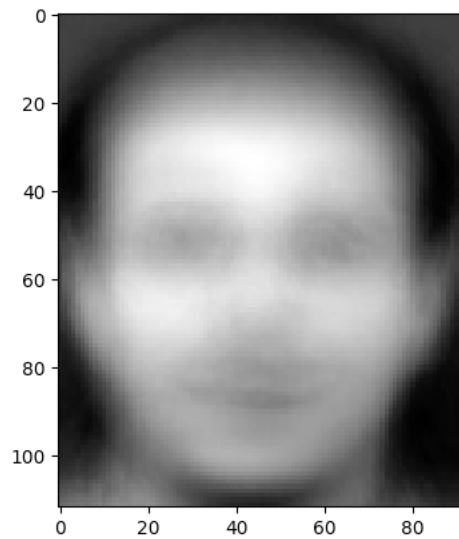
2.0

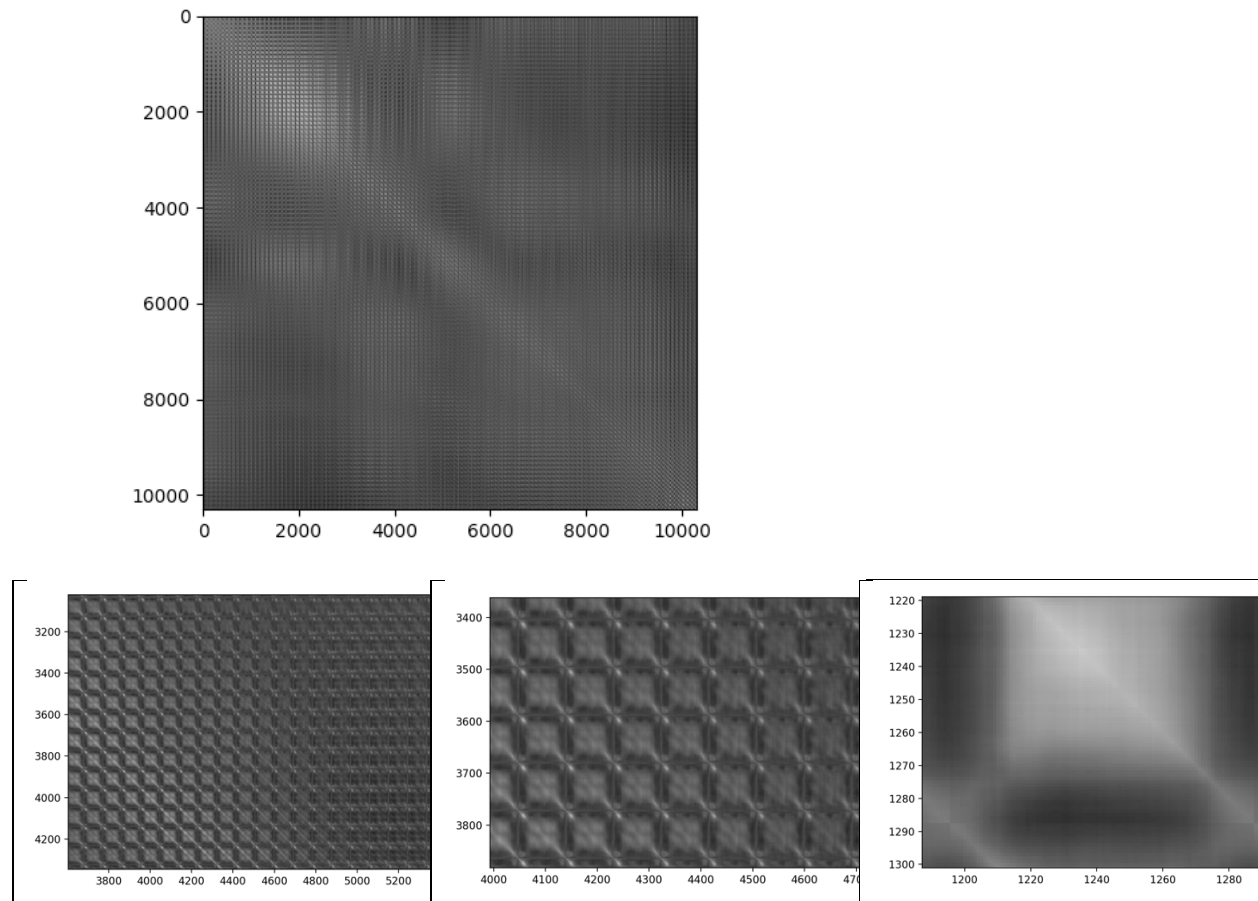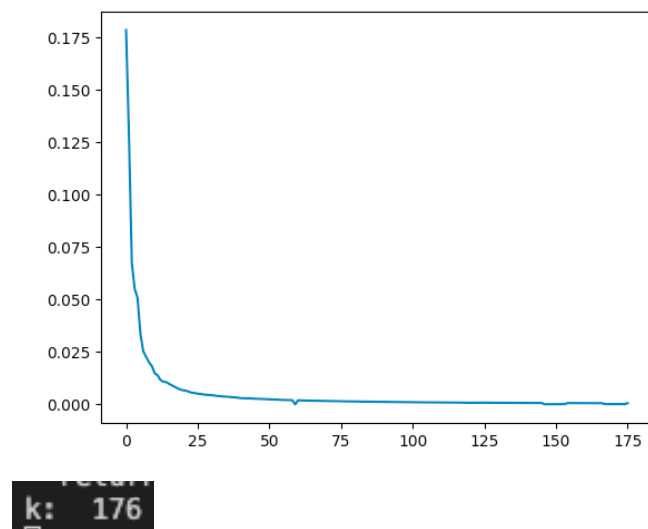s39-4.pgm   s32-8.pgm   s40-6.pgm

2.1a
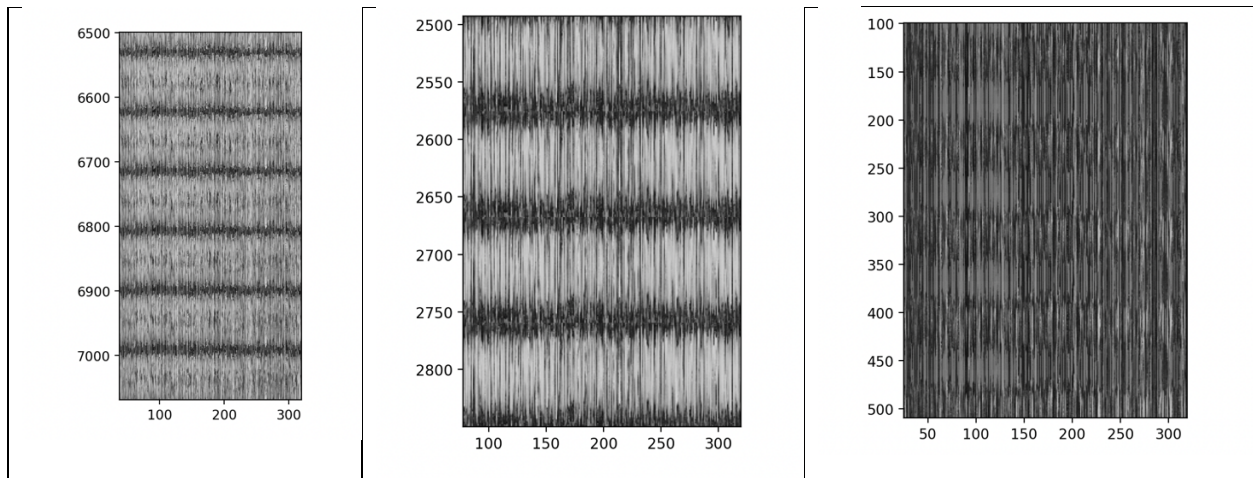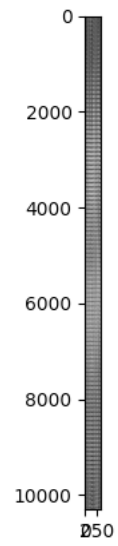
2.1b

The figure clearly resembles a face. It is blurry due to the pictures being taken of various facial poses, but key facial features are visible.
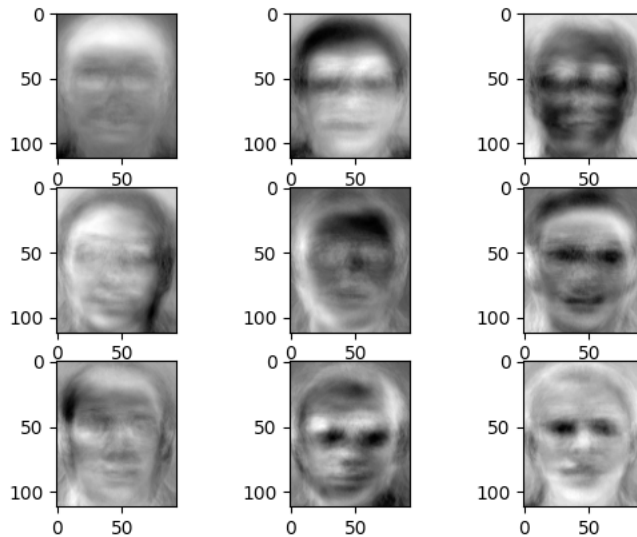
2.1c

2.1d

k: 176

2.1e

k: 176
U Dim: (10304, 176)

The eigenfaces are clearly distinct from the original images and retain much less detail. However, they clearly maintain essential facial features, such as eyes, nose, mouth, and facial shape.

2.2b

U Dim: (10304, 176)
W_training Dim: (320, 176)
W_testing Dim: (80, 176)
k: 1, Accuracy: 0.95

2.3a

k: 1, Accuracy: 0.95
k: 3, Accuracy: 0.9
k: 4, Accuracy: 0.9125
k: 7, Accuracy: 0.825
k: 9, Accuracy: 0.7625
k: 11, Accuracy: 0.7125

The accuracy of KNN steadily decreases as k increases, with k=1 having the highest accuracy.

2.3b
Training Time

	One-vs-One	One-vs-All
Linear	0.019240856170654297	0.01748514175415039
Polynomial	0.019793272018432617	0.019698143005371094
RBF	0.02229619026184082	0.022463083267211914

Testing Time

	One-vs-One	One-vs-All
Linear	0.002153158187866211	0.0020782947540283203
Polynomial	0.002110004425048828	0.002087831497192383
RBF	0.003975868225097656	0.004006147384643555

Testing Accuracy

	One-vs-One	One-vs-All
Linear	0.95	0.95
Polynomial	0.8125	0.8125
RBF	0.95	0.95

3.

Features that would be useful for planning the locations of electric chargers include:
- Population density in given areas
- Density of existing electric car ownership
- Number of highways in terms of length per square mile
- Average income per capita
- Historic data regarding public opinion of electric vehicles in given areas
- Level of infrastructure of power grids