hw2-Q1

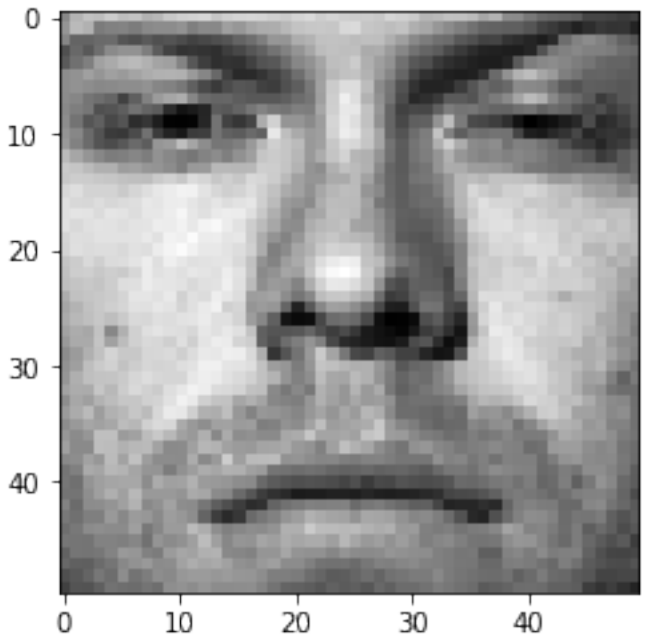
October 10, 2019

[12]:
```
import numpy as np
from scipy import misc
from matplotlib import pylab as plt
import matplotlib.cm as cm
import imageio
%matplotlib inline
```

[13]:
```
#(b)
#loading data from the training data set
#https://stackoverflow.com/questions/15345790/
 ↪scipy-misc-module-has-no-attribute-imread
train_labels, train_data = [], []
for line in open('./faces/train.txt'):
    im = imageio.imread(line.strip().split()[0])
    train_data.append(im.reshape(2500,))
    train_labels.append(line.strip().split()[1])
train_data, train_labels = np.array(train_data, dtype=float), np.
 ↪array(train_labels, dtype=int)

print(train_data.shape, train_labels.shape)
plt.imshow(train_data[10, :].reshape(50,50), cmap = cm.Greys_r)
plt.show()
print(train_data)
```

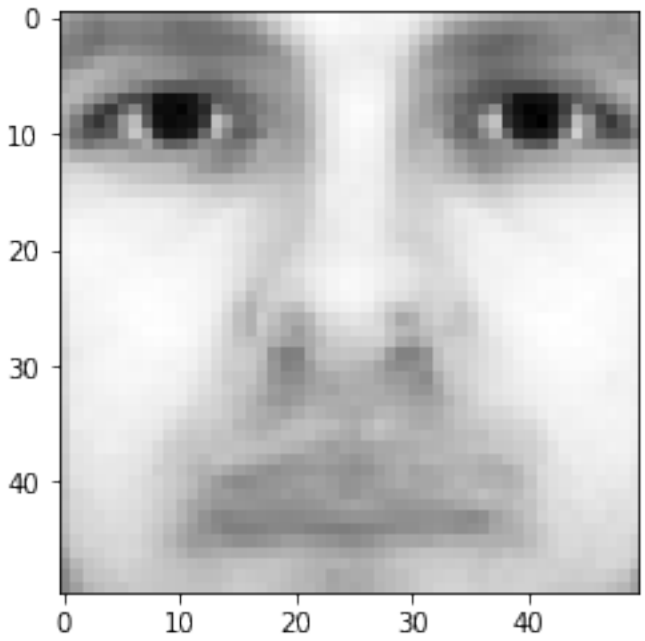
```
(540, 2500) (540,)
```




```
[[  5.   7.   7. …  13.  20.  31.]
 [ 65.  74.  74. … 111. 106.  96.]
 [101. 116. 130. …  61.  52.  41.]
 …
 [107. 115. 108. …  26.  23.  24.]
 [255. 255. 255. …  22.  22.  22.]
 [174. 178. 202. …  28.  26.  28.]]
```

[14]:
```
# (c)
#Average Face
#Compute the average face from the whole training set
#by summing up every row in X then dividing by the number of faces
average_face = np.sum(train_data, axis = 0) /train_labels.shape[0]
print(average_face)
#Display the average face as a grayscale image.
plt.imshow(average_face.reshape(50,50), cmap = cm.Greys_r)
plt.show()
```

```
[59.25185185 56.10185185 52.42222222 … 67.22222222 64.61851852
 59.27592593]
```

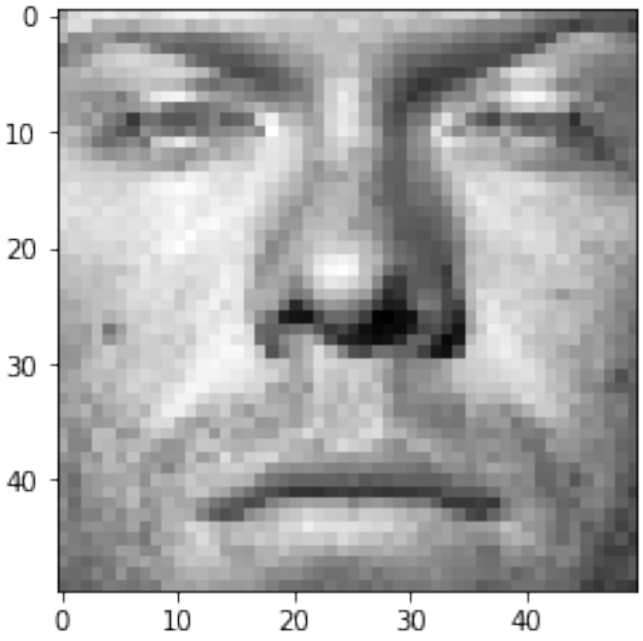


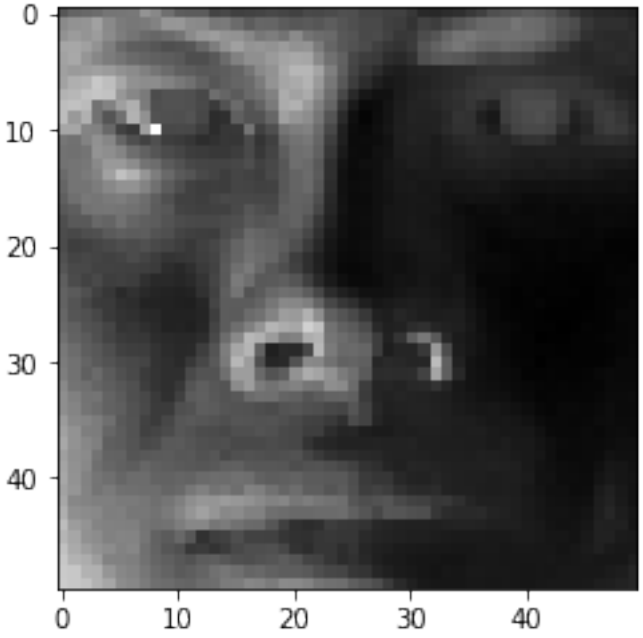
[15]:
```
#(d)
#Mean Subtraction.
#Subtract average face μ from every row in X.
sub_avg_face = train_data - average_face

#Pick a face image after mean subtraction from the new X and display that image␣
 ↪in grayscale.
plt.imshow(sub_avg_face[10, :].reshape(50,50), cmap = cm.Greys_r)
plt.show()

#Do the same thing for the test set Xtest using the pre-computed average face μ␣
 ↪in (c).
#loading data from the testing data set
test_labels, test_data = [], []
for line in open('./faces/test.txt'):
    im = imageio.imread(line.strip().split()[0])
    test_data.append(im.reshape(2500,))
    test_labels.append(line.strip().split()[1])
test_data, test_labels = np.array(test_data, dtype=float), np.
 ↪array(test_labels, dtype=int)

#Subtract average face μ from every row in Xtest.
sub_avg_face_test = test_data - average_face
plt.imshow(sub_avg_face_test[10, :].reshape(50,50), cmap = cm.Greys_r)
plt.show()
```

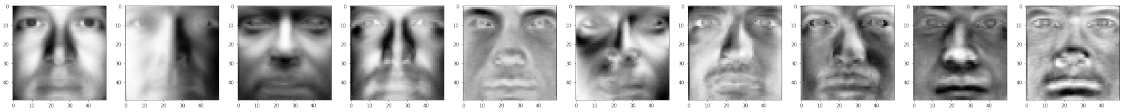




[17]:
```
#(e)
#Eigenface.
#Perform Singular Value Decomposition (SVD) on training set X (X = UΣVT) to get␣
 ↪matrix VT
```

```
u, s, vt = np.linalg.svd(sub_avg_face)
s = np.diag(s)
#create 10 subplots and set appropriate size
fig, ax = plt.subplots(nrows=1, ncols=10)
fig.set_size_inches(40,40)

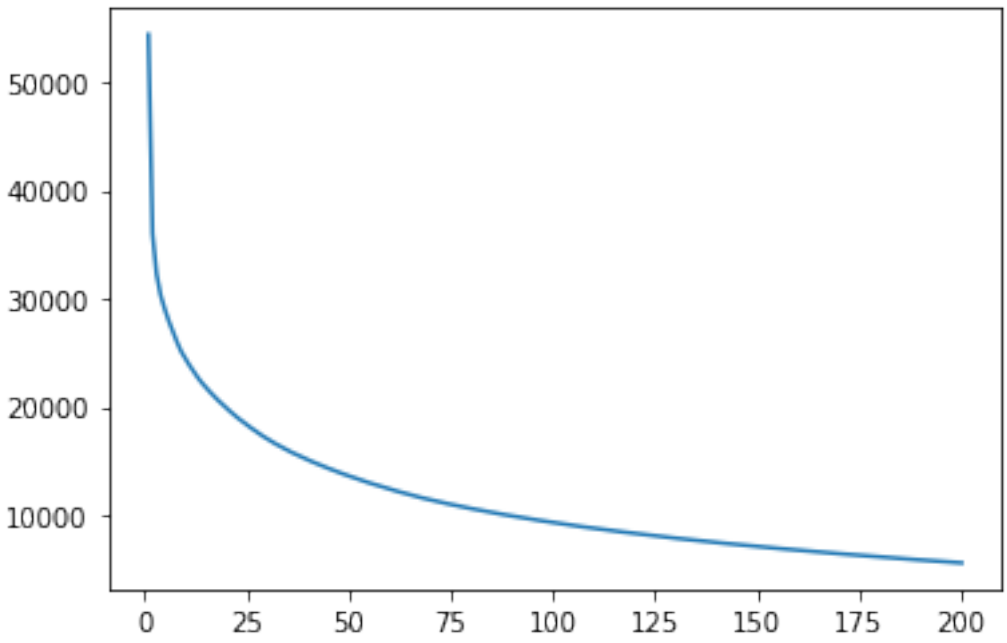
#We refer to vi,the i-th row of V T, as i-th eigenface.
#Display the first 10 eigenfaces as 10 images in grayscale
for i in range(10):
    ax[i].imshow(vt[i, :].reshape(50,50), cmap = cm.Greys_r)
plt.show()
```



[7]:
```
#(f)
#Low-rank Approximation.
#we can approximate X by X^r = U[:,: r ] Σ[: r,: r ] VT[: r,:].
#The matrix X^r is called rank-r approximation of X.

err = []
for r in range(1,201):
    temp = u[:,:r].dot(s[:r,:r])
    Xr = temp.dot(vt[:r,:])
    err_fnorm = np.linalg.norm(sub_avg_face - Xr, ord='fro')
    err.append(err_fnorm)
#Plot the rank-r approximation error ||X-X^r||F as a function of r when r = 1,␣
 ↪2,..., 200.
plt.plot(range(1,201),err)
```

[7]: [<matplotlib.lines.Line2D at 0x111425e10>]



[8]:
```
#(g)
#Eigenface Feature.
#Write a function to generate r-dimensional feature matrix F and Ftest for␣
 ↪training images X and test images Xtest, respectively
#(to get F, multiply X to the transpose of first r rows of VT
#F should have same number of rows as X and r columns

def train_featurematrix_generator(r):
#multiply X to the transpose of first r rows of VT
    F = np.dot(sub_avg_face, vt[:r,:].T)
    return F

def test_featurematrix_generator(r):
#multiply X to the transpose of first r rows of VT
    Ftest = np.dot(sub_avg_face_test, vt[:r,:].T)
    return Ftest

F = train_featurematrix_generator(10)
Ftest = test_featurematrix_generator(10)
print(F.shape)
print(Ftest.shape)
```

```
(540, 10)
(100, 10)
```

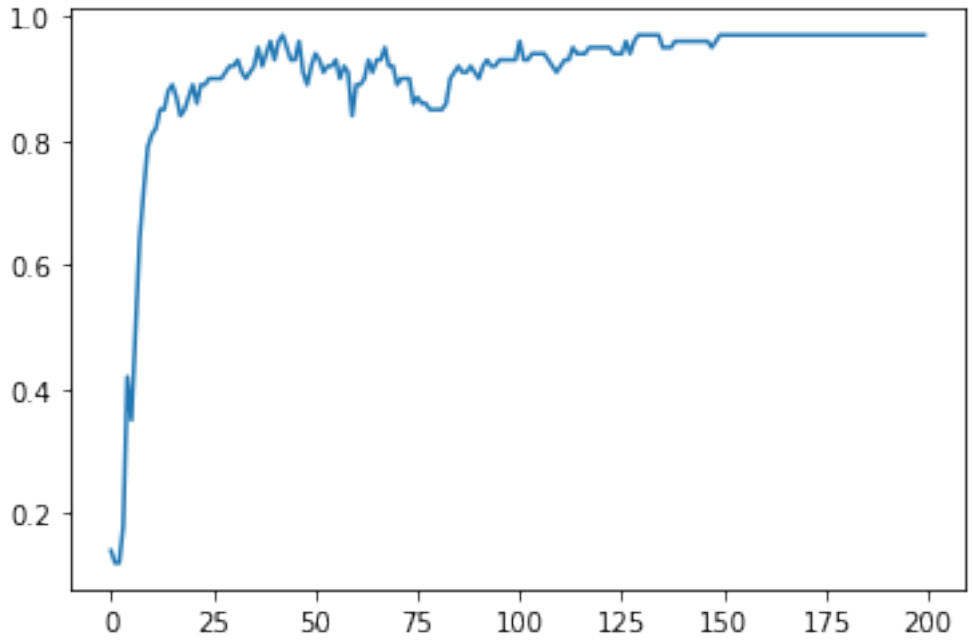
[9]:
```
from sklearn.linear_model import LogisticRegression
```

[10]:
```
# import warnings filter
import warnings
# ignore all future warnings
warnings.simplefilter('ignore')
```

[11]:
```
#(h)
#Face Recognition.
#Extract training and test features for r = 10.
#Train a Logistic Regression model using F and test on Ftest.
#Report the classification accuracy on the test set.
#Plot the classification accuracy on the test set as a function of r when r =␣
 ↪1, 2,..., 200.
accuracy = []
logreg = LogisticRegression(multi_class='ovr')

for r in range(1, 201):
    F = train_featurematrix_generator(r)
    Ftest = test_featurematrix_generator(r)
    model = logreg.fit(F, train_labels)
    pred = model.predict(Ftest)
    score = model.score(Ftest, test_labels)
    accuracy.append(score)

plt.plot(accuracy)
plt.show()
```



[13]:
```
F = train_featurematrix_generator(10)
Ftest = test_featurematrix_generator(10)
model = LogisticRegression().fit(F, train_labels)
pred = model.predict(Ftest)
score = model.score(Ftest, test_labels)
print(score)
```

```
0.79
```

[ ]:
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```