Face Recognition

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Introduction

This is the first part of Homework 2. SVD is used to do the dimension reduction. Logistic regression is used to classify the faces.

Implementation

Read Data

Read data from the downloaded files and store them into numpy arrays.

```
# Part a and Part b Read Data
train_labels, train_data = [], []
for line in open('./faces/train.txt'):
    im = misc.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[11, :].reshape(50,50), cmap = cm.Greys_r)
plt.show()

test_labels, test_data = [], []
for line in open('./faces/test.txt'):
    im = misc.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)
```

Calculate the Mean

Calculate the mean vector of all the training data.

```
# Part c Calculate Mean
mu = np.sum(train_data,axis=0)
mu /= train_data.shape[0]
print mu
plt.imshow(mu.reshape(50,50),cmap = cm.Greys_r)
plt.show()
```

Show the mean picture of train data. 

Subtract Mean Vector

Subtract the mean vector from all the train data vectors and test data vectors.

```
# Part d Subtract Mean
for i in range(train_data.shape[0]):
    train_data[i] = train_data[i] - mu
plt.imshow(train_data[10, :].reshape(50,50), cmap = cm.Greys_r)
for i in range(test_data.shape[0]):
    test_data[i] = test_data[i] - mu
plt.imshow(test_data[10, :].reshape(50,50), cmap = cm.Greys_r)
```

SVD

Implement SVD on the train data matrix and extract the 10 eigenvectors corresponding to 10 biggest eigenvalues.

```
# Part e SVD
U, s, V = np.linalg.svd(train_data, full_matrices=False)
for i in range(10):
    plt.imshow(V[i].reshape(50,50), cmap = cm.Greys_r)
    plt.show()
    plt.imsave(str(i)+".png",V[i].reshape(50,50), cmap = cm.Greys_r)
```

And show these eigenvectors in picture.

1. 
2. 
3. 
4. 
5. 
6. 

7. 
8. 
9. 

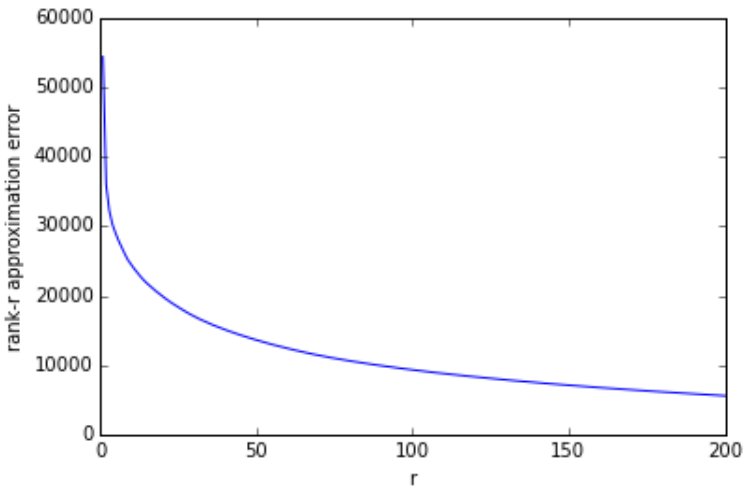
Rank-r Approximation

For r between 1 and 200, calculate the rank-r approximation error.

```
# Part f rank-r approximation error
y_axis = []
x_axis = range(1,201)
for r in x_axis:
    sigma = np.zeros((r,r))
    for i in range(r):
        sigma[i][i] = s[i]
    U_r = U[:,:r]
    V_r = V[:r,:]
    X_r = np.mat(U_r) * np.mat(sigma) * np.mat(V_r)
    sub = train_data-X_r
    y_axis.append(np.linalg.norm(sub))

plt.plot(x_axis,y_axis)
plt.xlabel("r")
plt.ylabel("rank-r approximation error ")
#plt.savefig('rank-r_approximation_error.png')
plt.show()
```

Plot the histogram of rank-r approximation error and r.



Eigenface Feature

Reduce the Feature dimension by reconstruct the train and test data with first r eigenvectors.

```
# Part g Eigenface feature
def eigenface(r):
    V_r = np.transpose(V[:r,:])
    F = np.mat(train_data) * np.mat(V_r)
    F_test = np.mat(test_data) * np.mat(V_r)
    return F,F_test
```

Face Recognition

Implement logistic regression classification on the r-eigenvector based reconstructed data.

```
# Part h
F,F_test = eigenface(10)
logistic = linear_model.LogisticRegression()
logistic.fit(F,train_labels)
score = logistic.score(F_test,test_labels)
print score
# The accuracy with r = 10 is 0.79
y_axis = []
for r in x_axis:
    F,F_test = eigenface(r)
    logistic = linear_model.LogisticRegression()
    logistic.fit(F,train_labels)
    score = logistic.score(F_test,test_labels)
    y_axis.append(score)

plt.plot(x_axis,y_axis)
plt.xlabel("r")
plt.ylabel("classification accuracy")
#plt.savefig('classification_accuracy.png')
plt.show()
```

Plot the histogram of classification accuracy and r.