

```
In [2]: import numpy as np
import pandas as pd

import matplotlib.image as mpimg
import matplotlib.pyplot as plt

from sklearn.metrics import accuracy_score
from sklearn.cross_validation import train_test_split
from sklearn.cross_validation import cross_val_score
from sklearn import metrics
```

```
/Users/thp/anaconda3/lib/python3.6/site-packages/sklearn/cross_validation.py:41: DeprecationWarning: This module was deprecated in version 0.18 in favor of the model_selection module into which all the refactored classes and functions are moved. Also note that the interface of the new CV iterators are different from that of this module. This module will be removed in 0.20.
```

```
"This module will be removed in 0.20.", DeprecationWarning)
```

```
In [3]: %matplotlib inline
```

#A Read image and plot

```
In [4]: i=0
```

```
In [5]: a = mpimg.imread('/Users/thp/Documents/CSULA/5661 Data Science/hw3/HW3/Face/'+str(i)+'.jpg')
```

```
In [6]: a
```

```
Out[6]: array([[186, 183, 179, ..., 25, 63, 71],
               [183, 183, 181, ..., 31, 34, 68],
               [179, 184, 185, ..., 48, 9, 59],
               ...,
               [ 32, 27, 23, ..., 3, 3, 4],
               [ 26, 28, 24, ..., 5, 2, 4],
               [ 18, 29, 33, ..., 9, 3, 5]], dtype=uint8)
```

```
In [8]: a.size
```

```
Out[8]: 4096
```

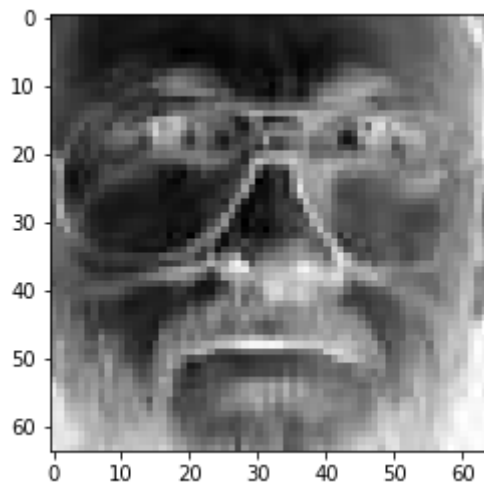
```
In [12]: label.head()
```

```
Out[12]:
```

	Label
0	13
1	30
2	34
3	19
4	24

```
In [13]: #ploting the image  
plt.imshow(a, cmap=plt.cm.gray_r, interpolation='nearest')
```

```
Out[13]: <matplotlib.image.AxesImage at 0x1a172d77f0>
```



#B build feature matrix

```
In [14]: a[0]
```

```
Out[14]: array([186, 183, 179, 190, 212, 219, 221, 232, 230, 231, 233, 234, 233,  
                230, 228, 226, 230, 229, 230, 231, 233, 233, 232, 231, 227, 229,  
                227, 224, 224, 229, 232, 230, 228, 227, 221, 215, 217, 222, 221,  
                214, 212, 206, 198, 192, 189, 185, 179, 174, 173, 169, 165, 165,  
                165, 161, 152, 144, 135, 117, 100, 102,  56,  25,  63,  71], dtype=  
uint8)
```

```
In [16]: a[0].size
```

```
Out[16]: 64
```

```
In [17]: col = np.append(a[0],a[1])
```

In [18]: col

```
Out[18]: array([186, 183, 179, 190, 212, 219, 221, 232, 230, 231, 233, 234, 233,
                230, 228, 226, 230, 229, 230, 231, 233, 233, 232, 231, 227, 229,
                227, 224, 224, 229, 232, 230, 228, 227, 221, 215, 217, 222, 221,
                214, 212, 206, 198, 192, 189, 185, 179, 174, 173, 169, 165, 165,
                165, 161, 152, 144, 135, 117, 100, 102,  56,  25,  63,  71, 183,
                183, 181, 193, 214, 221, 222, 233, 235, 234, 233, 232, 230, 228,
                226, 225, 229, 231, 234, 237, 238, 235, 230, 227, 229, 230, 228,
                223, 223, 227, 229, 228, 225, 227, 225, 219, 217, 220, 219, 215,
                211, 208, 204, 201, 198, 191, 181, 173, 170, 166, 162, 163, 165,
                163, 157, 150, 134, 127, 104,  99,  77,  31,  34,  68], dtype=ui
nt8)
```

In [19]: col.size

Out[19]: 128

```
In [22]: #create one vector for one image
for x in range (2,64):
    col = np.append(col,a[x])
```

In [23]: col.size

Out[23]: 4096

```
In [28]: #creating a dataframe for the images
images = pd.DataFrame(data=col, columns=['0'])
```

In [34]: images.size

Out[34]: 4096

```
In [35]: #use a loop to include all images as different columns into above dataframe

for i in range(1,400):
    b = mpimg.imread('/Users/thp/Documents/CSULA/5661 Data Science/hw3/HW3/Face/'+str(i)+'.jpg')
    col = np.append(b[0],b[1])
    for x in range (2,64):
        col = np.append(col,b[x])
    images[str(i)]=col

images.head()
```

Out[35]:

	0	1	2	3	4	5	6	7	8	9	...	390	391	392	393	394	395	396	397
0	186	204	86	61	99	44	120	111	158	26	...	22	106	53	33	69	19	109	16
1	183	198	79	90	134	58	168	126	162	46	...	25	120	77	39	58	13	145	17
2	179	194	82	98	165	92	184	161	168	69	...	16	135	106	54	47	7	182	19
3	190	195	95	119	183	98	185	200	174	84	...	33	147	132	99	75	7	196	20
4	212	198	100	144	201	176	184	220	180	96	...	59	160	151	155	142	14	195	21

5 rows × 400 columns

```
In [38]: #make the feature matrix coordinate with the dimensions of the label
feature = images.T

feature.head()
```

Out[38]:

	0	1	2	3	4	5	6	7	8	9	...	4086	4087	4088	4089	4090	4091
0	186	183	179	190	212	219	221	232	230	231	...	56	45	47	18	0	8
1	204	198	194	195	198	195	190	186	190	193	...	19	0	29	52	90	146
2	86	79	82	95	100	102	121	146	169	179	...	160	167	179	169	192	188
3	61	90	98	119	144	156	174	177	183	195	...	119	244	246	168	126	187
4	99	134	165	183	201	210	215	224	232	236	...	83	90	94	90	70	41

5 rows × 4096 columns

#C Normalize feature matrix

```
In [87]: from sklearn import preprocessing
```

```
In [88]: feature_scaled = preprocessing.scale(df)
```

```
In [90]: feature_scaled
```

```
Out[90]: array([[ 1.37649641,  1.11885303,  0.79610373, ..., -1.17094622,
                 -1.24726506, -1.21711982],
                [ 1.68113398,  1.3654141 ,  1.03570156, ...,  0.68710075,
                 1.48558299,  1.58234648],
                [-0.31593455, -0.59063704, -0.75329558, ...,  1.84210291,
                 1.84204144,  1.13304942],
                ...,
                [ 0.98723729,  1.02022861,  1.01972837, ..., -0.58507555,
                 -0.48342554, -0.38764832],
                [ 0.68259971,  0.52710647,  0.34885444, ...,  0.88797069,
                 0.63687242,  0.71831368],
                [-0.231313 , -0.67282406, -1.0088666 , ..., -0.06616154,
                 -0.55132239, -0.50861291]])
```

#D split the into train and test data set

```
In [53]: label = pd.read_csv('/Users/thp/Documents/CSULA/5661 Data Science/hw3/HW
3/Face/label.csv')
```

```
In [55]: label.head()
```

```
Out[55]:
```

	Label
0	13
1	30
2	34
3	19
4	24

```
In [57]: label.size
```

```
Out[57]: 400
```

```
In [91]: #splitting data accroding to the assignment
X_train, X_test, y_train, y_test = train_test_split(feature_scaled, label,
1, test_size=0.25, random_state=5)
```

#E use PCA to do dimentionality reduction

```
In [59]: from sklearn.decomposition import PCA
```

```
In [60]: k=50
```

```
In [92]: my_pca = PCA(n_components = k)
X_train_new = my_pca.fit_transform(X_train)
X_test_new = my_pca.transform(X_test)
```

```
In [126]: X_train_new.shape
```

```
Out[126]: (300, 50)
```

```
In [127]: X_test_new.shape
```

```
Out[127]: (100, 50)
```

```
In [168]: y_new = pd.concat([y_train,y_test])
```

```
In [169]: y_new.shape
```

```
Out[169]: (400, 1)
```

#F Use non-linear SVM classifier

```
In [75]: from sklearn.svm import SVC
```

```
In [96]: my_SVM = SVC(C=1,kernel='rbf',gamma=0.0005,random_state=1)
```

```
In [103]: my_SVM.fit (X_train_new, y_train)
```

```
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d array was expected. Please change the shape of y to (n_samples, ), fo
r example using ravel().
  y = column_or_1d(y, warn=True)
```

```
Out[103]: SVC(C=1, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.0005, kernel='rbf',
  max_iter=-1, probability=False, random_state=1, shrinking=True,
  tol=0.001, verbose=False)
```

```
In [98]: y_predict = my_SVM.predict (X_test_new)
```

```
In [113]: #check accuracy
```

```
score_SVM= accuracy_score(y_test, y_predict)
print(score_SVM)
```

```
0.91
```

```
In [125]: #Confusion Matrix

cm_SVM = metrics.confusion_matrix(y_test, y_predict)
print("Confusion matrix:")
print(cm_SVM)

Confusion matrix:
[[3 0 0 ..., 0 0 0]
 [0 3 0 ..., 0 0 0]
 [0 0 1 ..., 0 0 0]
 ...,
 [0 0 0 ..., 0 0 0]
 [0 0 0 ..., 0 4 0]
 [0 0 0 ..., 0 0 1]]
```

#Grid Search for best C

```
In [129]: #merging X dataset
X_1 = pd.DataFrame(X_train_new)
X_1.head()
```

Out[129]:

	0	1	2	3	4	5	6	
0	-47.809943	-6.740401	-7.059032	-13.358404	3.596551	5.422508	2.024244	-3.1
1	-23.305562	-8.885534	-8.401887	6.476879	-16.263499	7.027839	13.273875	-7.2
2	26.314219	4.819515	6.812379	-5.477064	-0.820429	18.277638	-14.548281	15.2
3	8.266427	4.638028	3.078472	25.603084	1.841109	-14.817230	6.585413	-14.
4	-45.410689	-7.332661	-17.590844	-0.655902	0.724138	-9.391717	-4.122996	-15.

5 rows × 50 columns

```
In [130]: X_2 = pd.DataFrame(X_test_new)
X_2.head()
```

Out[130]:

	0	1	2	3	4	5	6	
0	4.223422	-59.430047	3.250010	10.228930	-4.364699	-2.121271	6.548920	-5.2
1	51.078981	-30.859767	-4.917374	-21.213531	15.904366	-11.228930	9.522003	-1.3
2	-46.294452	-23.566680	-1.339628	-0.625463	13.818934	-17.979491	-2.888877	4.90
3	-31.162143	-17.600575	-11.222512	5.842147	-15.126561	-0.229525	2.785043	2.30
4	-2.094782	20.679116	-13.582743	-25.525720	-6.117823	-3.478038	-9.557178	4.74

5 rows × 50 columns

```
In [172]: X_new = pd.concat([X_1,X_2])
```

```
In [145]: X_new_df = pd.concat(X_new)
X_new_df.shape
```

```
Out[145]: (400, 50)
```

```
In [ ]: #Grid Search
```

```
In [146]: from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import cross_val_score
```

```
In [160]: param_grid = {
    'kernel':('linear','rbf'),
    'C':[0.1, 1, 10, 100, 1e3, 5e3, 1e4, 5e4, 1e5]
}
```

```
In [161]: grid = GridSearchCV(my_SVM, param_grid,cv=10,scoring ='accuracy')
```



```
In [170]: grid.fit(X_new_df, y_new)
```

```

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```

```
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```

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```

```
Out[170]: GridSearchCV(cv=10, error_score='raise',
                      estimator=SVC(C=1, cache_size=200, class_weight=None, coef0=0.0,
                      decision_function_shape='ovr', degree=3, gamma=0.0005, kernel='rbf',
                      max_iter=-1, probability=False, random_state=1, shrinking=True,
                      tol=0.001, verbose=False),
                      fit_params=None, iid=True, n_jobs=1,
                      param_grid={'kernel': ('linear', 'rbf'), 'C': [0.1, 1, 10, 100,
                      1000.0, 5000.0, 10000.0, 50000.0, 100000.0]},
                      pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
                      scoring='accuracy', verbose=0)
```

```
In [171]: print(grid.best_score_)
          print(grid.best_params_)
```

```
0.9775
{'C': 0.1, 'kernel': 'linear'}
```