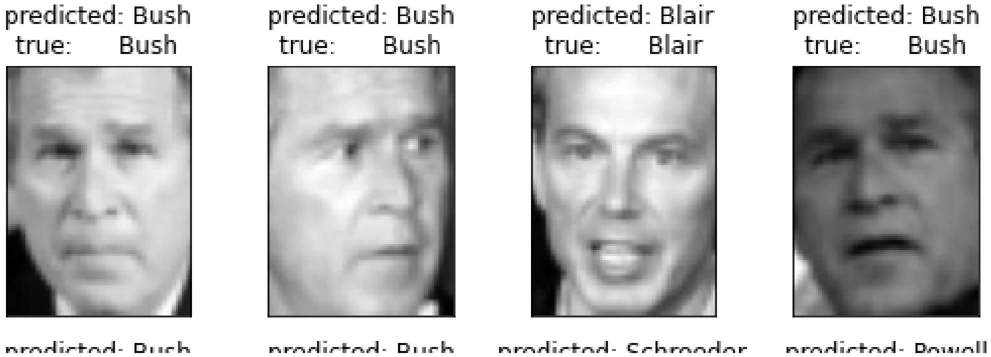
```python
from time import time
import logging
import matplotlib.pyplot as plt

from sklearn.model_selection import train_test_split
from sklearn.model_selection import GridSearchCV
from sklearn.datasets import fetch_lfw_people
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.decomposition import PCA
from sklearn.svm import SVC


print(__doc__)

# Display progress logs on stdout
logging.basicConfig(level=logging.INFO, format='%(asctime)s %(message)s')


# #############################################################################
# Download the data, if not already on disk and load it as numpy arrays

lfw_people = fetch_lfw_people(min_faces_per_person=70, resize=0.4)

# introspect the images arrays to find the shapes (for plotting)
n_samples, h, w = lfw_people.images.shape

# for machine learning we use the 2 data directly (as relative pixel
# positions info is ignored by this model)
X = lfw_people.data
n_features = X.shape[1]

# the label to predict is the id of the person
y = lfw_people.target
target_names = lfw_people.target_names
n_classes = target_names.shape[0]

print("Total dataset size:")
print("n_samples: %d" % n_samples)
print("n_features: %d" % n_features)
print("n_classes: %d" % n_classes)


# #############################################################################
# Split into a training set and a test set using a stratified k fold

# split into a training and testing set
X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.25, random_state=42)
```

```
# #############################################################################
# Compute a PCA (eigenfaces) on the face dataset (treated as unlabeled
# dataset): unsupervised feature extraction / dimensionality reduction
n_components = 150

print("Extracting the top %d eigenfaces from %d faces"
      % (n_components, X_train.shape[0]))
t0 = time()
pca = PCA(n_components=n_components, svd_solver='randomized',
          whiten=True).fit(X_train)
print("done in %0.3fs" % (time() - t0))

eigenfaces = pca.components_.reshape((n_components, h, w))

print("Projecting the input data on the eigenfaces orthonormal basis")
t0 = time()
X_train_pca = pca.transform(X_train)
X_test_pca = pca.transform(X_test)
print("done in %0.3fs" % (time() - t0))


# #############################################################################
# Train a SVM classification model

print("Fitting the classifier to the training set")
t0 = time()
param_grid = {'C': [1e3, 5e3, 1e4, 5e4, 1e5],
              'gamma': [0.0001, 0.0005, 0.001, 0.005, 0.01, 0.1], }
clf = GridSearchCV(
    SVC(kernel='rbf', class_weight='balanced'), param_grid
)
clf = clf.fit(X_train_pca, y_train)
print("done in %0.3fs" % (time() - t0))
print("Best estimator found by grid search:")
print(clf.best_estimator_)


# #############################################################################
# Quantitative evaluation of the model quality on the test set

print("Predicting people's names on the test set")
t0 = time()
y_pred = clf.predict(X_test_pca)
print("done in %0.3fs" % (time() - t0))

print(classification_report(y_test, y_pred, target_names=target_names))
print(confusion_matrix(y_test, y_pred, labels=range(n_classes)))


# #############################################################################
# Qualitative evaluation of the predictions using matplotlib
```

```
def plot_gallery(images, titles, h, w, n_row=3, n_col=4):
    """Helper function to plot a gallery of portraits"""
    plt.figure(figsize=(1.8 * n_col, 2.4 * n_row))
    plt.subplots_adjust(bottom=0, left=.01, right=.99, top=.90, hspace=.35)
    for i in range(n_row * n_col):
        plt.subplot(n_row, n_col, i + 1)
        plt.imshow(images[i].reshape((h, w)), cmap=plt.cm.gray)
        plt.title(titles[i], size=12)
        plt.xticks(())
        plt.yticks(())


# plot the result of the prediction on a portion of the test set

def title(y_pred, y_test, target_names, i):
    pred_name = target_names[y_pred[i]].rsplit(' ', 1)[-1]
    true_name = target_names[y_test[i]].rsplit(' ', 1)[-1]
    return 'predicted: %s\ntrue:      %s' % (pred_name, true_name)

prediction_titles = [title(y_pred, y_test, target_names, i)
                     for i in range(y_pred.shape[0])]

plot_gallery(X_test, prediction_titles, h, w)

# plot the gallery of the most significative eigenfaces

eigenface_titles = ["eigenface %d" % i for i in range(eigenfaces.shape[0])]
plot_gallery(eigenfaces, eigenface_titles, h, w)

plt.show()
```

```
Downloading LFW metadata: https://ndownloader.figshare.com/files/5976012
2021-03-01 00:22:36,925 Downloading LFW metadata: https://ndownloader.figshare.com/files/
Automatically created module for IPython interactive environment
Downloading LFW metadata: https://ndownloader.figshare.com/files/5976009
2021-03-01 00:22:37,203 Downloading LFW metadata: https://ndownloader.figshare.com/files/
Downloading LFW metadata: https://ndownloader.figshare.com/files/5976006
2021-03-01 00:22:37,427 Downloading LFW metadata: https://ndownloader.figshare.com/files/
Downloading LFW data (~200MB): https://ndownloader.figshare.com/files/5976015
2021-03-01 00:22:37,696 Downloading LFW data (~200MB): https://ndownloader.figshare.com/f
Total dataset size:
n_samples: 1288
n_features: 1850
n_classes: 7
Extracting the top 150 eigenfaces from 966 faces
done in 0.530s
Projecting the input data on the eigenfaces orthonormal basis
done in 0.035s
Fitting the classifier to the training set
done in 40.767s
Best estimator found by grid search:
SVC(C=1000.0, break_ties=False, cache_size=200, class_weight='balanced',
    coef0=0.0, decision_function_shape='ovr', degree=3, gamma=0.005,
    kernel='rbf', max_iter=-1, probability=False, random_state=None,
    shrinking=True, tol=0.001, verbose=False)
Predicting people's names on the test set
done in 0.070s
                   precision    recall  f1-score   support

     Ariel Sharon       0.75      0.46      0.57        13
     Colin Powell       0.80      0.87      0.83        60
  Donald Rumsfeld       0.86      0.70      0.78        27
    George W Bush       0.84      0.98      0.91       146
Gerhard Schroeder       0.95      0.80      0.87        25
      Hugo Chavez       1.00      0.53      0.70        15
       Tony Blair       0.96      0.75      0.84        36

         accuracy                           0.85       322
        macro avg       0.88      0.73      0.78       322
     weighted avg       0.86      0.85      0.85       322

[[  6   2   0   5   0   0   0]
 [  1  52   2   5   0   0   0]
 [  0   1  19   7   0   0   0]
 [  0   3   0 143   0   0   0]
 [  0   1   0   3  20   0   1]
 [  0   4   0   2   1   8   0]
 [  1   2   1   5   0   0  27]]
```



predicted: Bush
true: Bush

predicted: Bush
true: Bush

predicted: Blair
true: Blair

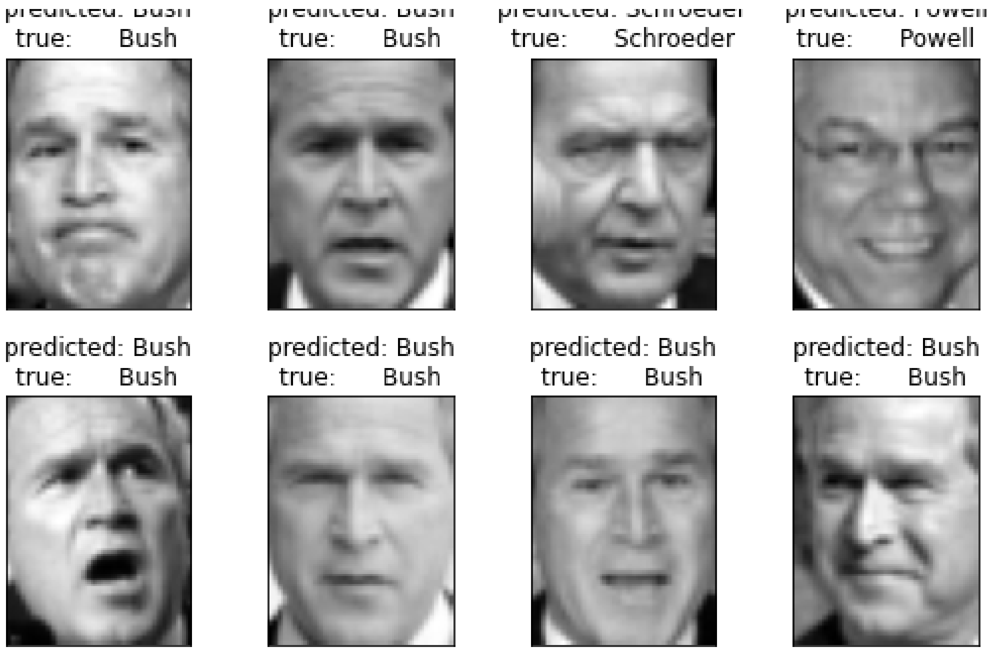
predicted: Bush
true: Bush

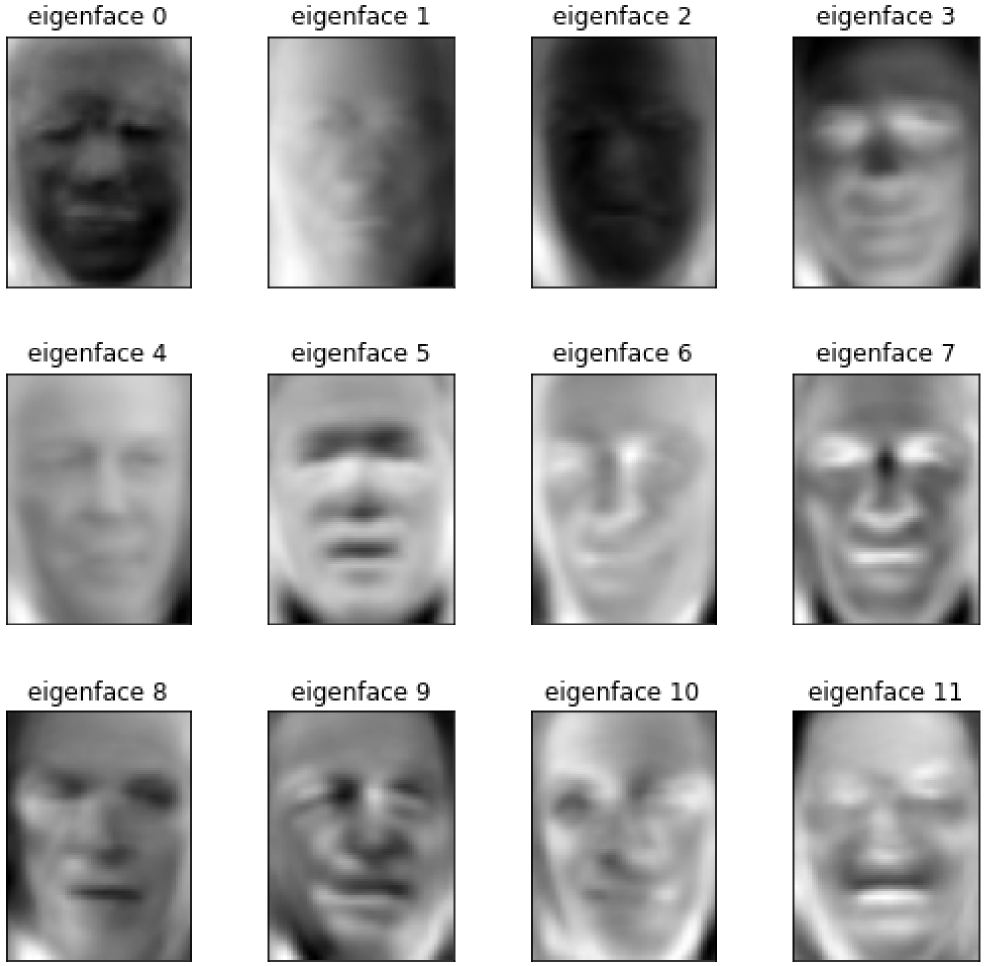
predicted: Bush

predicted: Bush

predicted: Schroeder

predicted: Powell


predicted: Bush
true: Bush
predicted: Bush
true: Bush
predicted: Schroeder
true: Schroeder
predicted: Powell
true: Powell
predicted: Bush
true: Bush
predicted: Bush
true: Bush
predicted: Bush
true: Bush
predicted: Bush
true: Bush


eigenface 0
eigenface 1
eigenface 2
eigenface 3
eigenface 4
eigenface 5
eigenface 6
eigenface 7
eigenface 8
eigenface 9
eigenface 10
eigenface 11