Notebook

December 16, 2024

1 Import libraries

```
import os
import sys
import cv2
import math
import json
import joblib
import nbformat
import numpy as np
import pandas as pd
import seaborn as sns
from tqdm import tqdm
from sklearn.svm import SVC
from datetime import datetime
import matplotlib.pyplot as plt
from nbconvert.exporters import PDFExporter
from skimage.feature import hog as skimage_hog
from sklearn.preprocessing import LabelEncoder
from IPython.display import display, Javascript
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import classification_report, confusion_matrix
from scipy.spatial.distance import cityblock, cosine, sqeuclidean, euclidean
```

2 Load data

```
project_dir = os.getcwd()
project_dir = os.path.dirname(project_dir)
```

```
width = 64
height = 64
```

```
data_dir = project_dir + "\\data"

train_path = os.path.join(data_dir, "train")
```

```
test_path = os.path.join(data_dir, "test")

train_images = []
test_images = []

train_labels = []
test_labels = []

for path in (train_path, test_path):
    if (path.split('\\')[-1] == "train"):
        for dir in os.listdir(path):
            label_path = os.path.join(path, dir)
            label = dir.split('\\')[-1]
            for image in os.listdir(label_path):
                # print(image)
                image_path = os.path.join(label_path, image)
                image = cv2.imread(image_path)
                image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
                image = cv2.resize(image, (width, height))
                train_images.append(image)
                train_labels.append(label)
    else:
        for dir in os.listdir(path):
            label_path = os.path.join(path, dir)
            label = dir.split('\\')[-1]
            for image in os.listdir(label_path):
                image_path = os.path.join(label_path, image)
                image = cv2.imread(image_path)
                image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
                image = cv2.resize(image, (width, height))
                test_images.append(image)
                test_labels.append(label)
```

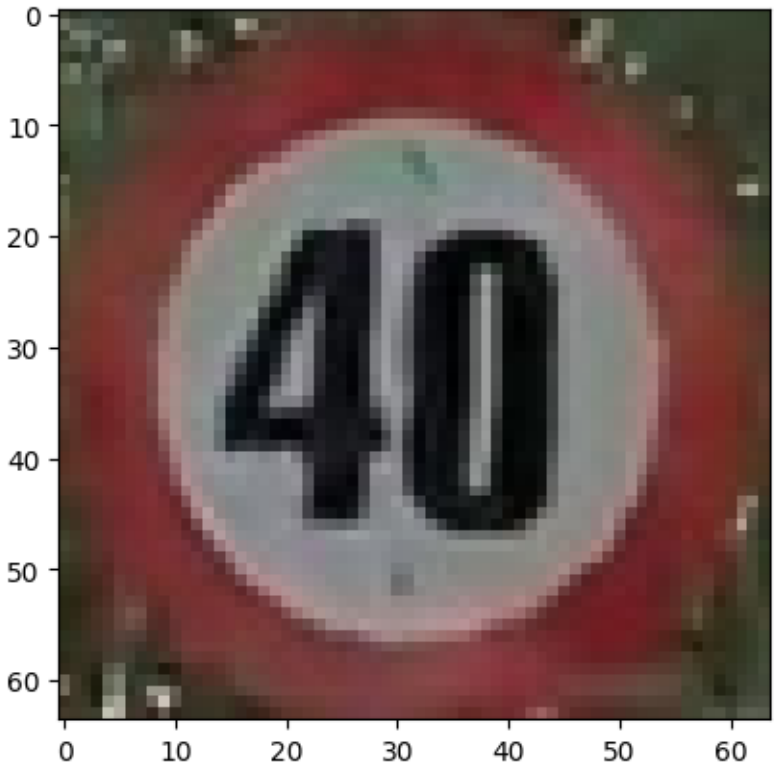
```
label_encoder = LabelEncoder()
train_labels_encoded = label_encoder.fit_transform(train_labels)
test_labels_encoded = label_encoder.transform(test_labels)
```

```
joblib.dump(train_images, project_dir + '\\joblib\\train_images.joblib')
joblib.dump(test_images, project_dir + '\\joblib\\test_images.joblib')
joblib.dump(train_labels_encoded, project_dir + '\\joblib\\train_labels_encoded.
 ↪joblib')
joblib.dump(test_labels_encoded, project_dir + '\\joblib\\test_labels_encoded.
 ↪joblib')
joblib.dump(label_encoder, project_dir + '\\joblib\\label_encoder.joblib')
```

```
['e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\joblib\\label_encoder.joblib']
```

```
plt.imshow(test_images[0])
```

```
<matplotlib.image.AxesImage at 0x2596b90db70>
```




```
plt.imshow(train_images[1])
```

```
<matplotlib.image.AxesImage at 0x2596b9e9900>
```

3 Extract features

```
# def blur_image(image):
#     blurred_image = cv2.medianBlur(image, 5)
#     return blurred_image
```

```
# plt.imshow(blur_image(test_images[0]))
```

```
# plt.imshow(blur_image(train_images[1]))
```

```
def blur_image(image):
    blurred_image = cv2.GaussianBlur(image, (5,5), 0)
    return blurred_image
```

```
# plt.imshow(blur_image(train_images[0]))
```

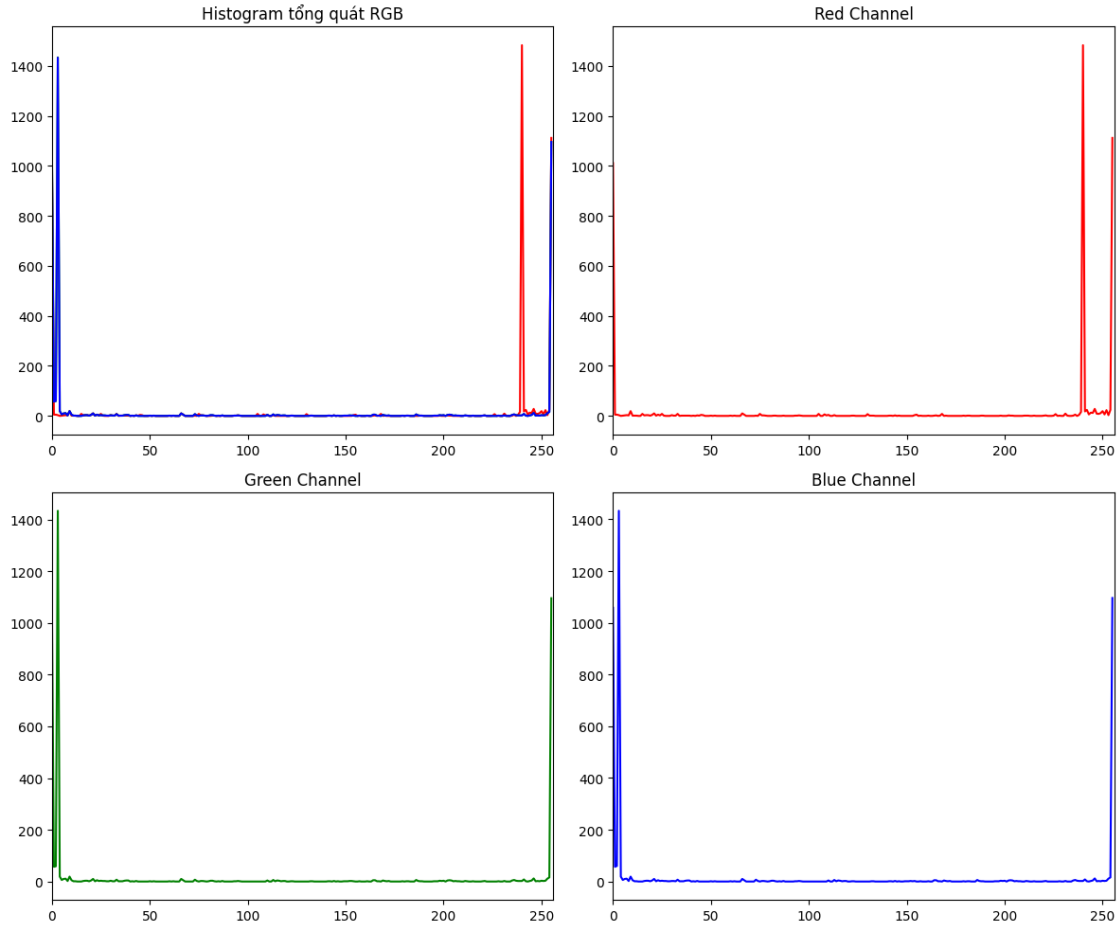
```
# plt.imshow(blur_image1(test_images[0]))
```

```
# plt.imshow(blur_image1(train_images[1]))
```

```python
def color_histogram(image):
    # image = cv2.cvtColor(image, cv2.COLOR_RGB2LUV)
    row, column, channel = image.shape[:3]
    size = row * column
    feature = []
    for k in range(channel):
        histogram = np.squeeze(cv2.calcHist([image], [k], None, [32], [0, 256]))
        histogram = histogram / size
        feature.extend(histogram)
    return feature
```

```python
def plot_color_histogram(image):
    fig, axs = plt.subplots(2, 2, figsize=(12, 10))

    color = ("r", "g", "b")
    for k, clr in enumerate(color):
        histogram = np.squeeze(cv2.calcHist([image], [k], None, [256], [0,␣
 ↪256]))
        axs[0, 0].plot(histogram, color=clr)
        axs[0, 0].set_xlim(0, 256)
    axs[0, 0].set_title('Histogram tổng quát RGB')

    titles = ['Red Channel', 'Green Channel', 'Blue Channel']
    positions = [(0, 1), (1, 0), (1, 1)]

    for idx, (clr, title, pos) in enumerate(zip(color, titles, positions)):
        histogram = np.squeeze(cv2.calcHist([image], [idx], None, [256], [0,␣
 ↪256]))
        axs[pos].plot(histogram, color=clr)
        axs[pos].set_xlim(0, 256)
        axs[pos].set_title(title)

    plt.tight_layout()
    plt.show()
```

```python
plot_color_histogram(train_images[0])
```




```
def hog(image):
    # image = cv2.cvtColor(image, cv2.COLOR_RGB2LUV)
    hog_features = skimage_hog(image, orientations=9, pixels_per_cell=(8, 8),␣
 ↪cells_per_block=(2, 2), visualize=False, block_norm='L2-Hys',␣
 ↪transform_sqrt=True, channel_axis=2)
    return hog_features
```

```
# def hog1(image):
#     # image = cv2.cvtColor(image, cv2.COLOR_RGB2LUV)
#     hog_features, image = skimage_hog(image, orientations=9,␣
 ↪pixels_per_cell=(16, 16), cells_per_block=(2, 2), visualize=True,␣
 ↪block_norm='L2-Hys', transform_sqrt=True, channel_axis=2)
#     return hog_features, image
```

```
# temp_image = train_images[12]
# temp_image = cv2.resize(temp_image, (512,512))
```

```
# plt.imshow(temp_image, cmap=plt.cm.gray)
```

```
# _, image1 = hog1(blur_image(temp_image))
# plt.imshow(image1, cmap=plt.cm.gray)
```

```
# _, image2 = hog1(blur_image1(train_images[1]))
# plt.imshow(image2, cmap=plt.cm.gray)
```

```
def extract_features(images):
    blurred_images = [blur_image(image) for image in tqdm(images, desc="Blur␣
 ↪Images")]
    color_features = [color_histogram(image) for image in tqdm(blurred_images,␣
 ↪desc="Extracting Color Features")]
    hog_features = [hog(image) for image in tqdm(blurred_images,␣
 ↪desc="Extracting HOG Features")]
    combined_features = [np.concatenate((color_feature, hog_feature))
                         for color_feature, hog_feature in␣
 ↪tqdm(zip(color_features, hog_features), desc="Combining Features")]

    return combined_features
```

```
train_features = extract_features(train_images)
joblib.dump(train_features, project_dir + '\\joblib\\train_features.joblib')
```

```
Blur Images: 100%|      | 1415/1415 [00:00<00:00, 52281.47it/s]
Extracting Color Features: 100%|      | 1415/1415 [00:00<00:00,
31829.05it/s]
Extracting HOG Features: 100%|      | 1415/1415 [00:02<00:00, 655.21it/s]
Combining Features: 1415it [00:00, 76325.78it/s]

['e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\joblib\\train_features.joblib']
```

```
test_features = extract_features(test_images)
joblib.dump(test_features, project_dir + '\\joblib\\test_features.joblib')
```

```
Blur Images: 100%|      | 150/150 [00:00<00:00, 59617.70it/s]
Extracting Color Features: 100%|      | 150/150 [00:00<00:00, 33337.52it/s]
Extracting HOG Features: 100%|      | 150/150 [00:00<00:00, 643.06it/s]
Combining Features: 150it [00:00, 74684.90it/s]

['e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\joblib\\test_features.joblib']
```

4 Distance metrics KNN

```
def chi_square_distance(x, y):
    return cv2.compareHist(np.array(x, dtype=np.float32), np.array(y, dtype=np.
 ↪float32), cv2.HISTCMP_CHISQR)

def bhattacharyya_distance(x, y):
    return cv2.compareHist(np.array(x, dtype=np.float32), np.array(y, dtype=np.
 ↪float32), cv2.HISTCMP_BHATTACHARYYA)

def intersection_distance(x, y):
    return 1 - cv2.compareHist(np.array(x, dtype=np.float32), np.array(y,␣
 ↪dtype=np.float32), cv2.HISTCMP_INTERSECT)
```

5 Load Best Model

```
knn_model = joblib.load(project_dir + '\\joblib\\best_knn_model.joblib')
# svm_model = joblib.load(project_dir + '\\joblib\\best_svm_model.joblib')

y_pred_knn = knn_model.predict(test_features)
# y_pred_svm = svm_model.predict(test_features)
```

```
print("Tham số của KNN Model:")
print(knn_model.get_params())

# print("\nTham số của SVM Model:")
# print(svm_model.get_params())
```

```
Tham số của KNN Model:
{'algorithm': 'auto', 'leaf_size': 30, 'metric': <function cityblock at
0x00000259681D5630>, 'metric_params': None, 'n_jobs': None, 'n_neighbors': 4,
'p': 2, 'weights': 'distance'}
```

6 Gridsearch KNN

```
knn_model = KNeighborsClassifier()
knn_model.fit(train_features, train_labels_encoded)
y_pred_knn = knn_model.predict(test_features)
```

```
# param_grid = {
#     'n_neighbors': [3, 4, 5, 6, 7, 10],
#     'weights': ['uniform', 'distance'],
#     'metric': [
#         cityblock,
#         euclidean,
#         cosine,
```

```
#         sqeuclidean,
#         chi_square_distance,
#         bhattacharyya_distance,
#         intersection_distance
#     ]
# }

# knn_model = KNeighborsClassifier()
# grid_search_knn = GridSearchCV(
#     knn_model,
#     param_grid,
#     cv=3,
#     scoring='f1_macro',
#     verbose=3
# )

# grid_search_knn.fit(train_features, train_labels_encoded)
```

```
# best_knn = grid_search_knn.best_estimator_
# print(f"Best Params: {grid_search_knn.best_params_}")

# print(f"Thuật toán sử dụng: {best_knn.algorithm}")

# y_pred_knn = best_knn.predict(test_features)

# joblib.dump(best_knn, project_dir + '\\joblib\\best_knn_model.joblib')
```

7 Gridsearch SVM

```
# svm_model = SVC()
# svm_model.fit(train_features, train_labels_encoded)
# y_pred_svm = svm_model.predict(test_features)
```

```
param_grid = {
    'C': [0.05, 0.001 , 0.1],
    'kernel': ['rbf', 'linear', 'poly', 'sigmoid'],
    'gamma': ['scale', 'auto', 0.1, 1, 1.1, 1.2],
    'degree': [4, 5, 6],
}

svm_model = SVC()

grid_search_svm = GridSearchCV(
    estimator=svm_model,
    param_grid=param_grid,
    cv=3,
```

```
    scoring='f1_macro',
    verbose=3,
)

grid_search_svm.fit(train_features, train_labels_encoded)
```

```
Fitting 3 folds for each of 216 candidates, totalling 648 fits
[CV 1/3] END C=0.05, degree=4, gamma=scale, kernel=rbf;, score=0.438 total time=
0.8s
[CV 2/3] END C=0.05, degree=4, gamma=scale, kernel=rbf;, score=0.464 total time=
0.8s
[CV 3/3] END C=0.05, degree=4, gamma=scale, kernel=rbf;, score=0.407 total time=
0.7s
[CV 1/3] END C=0.05, degree=4, gamma=scale, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=4, gamma=scale, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.05, degree=4, gamma=scale, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=4, gamma=scale, kernel=poly;, score=0.762 total
time=   0.4s
[CV 2/3] END C=0.05, degree=4, gamma=scale, kernel=poly;, score=0.743 total
time=   0.3s
[CV 3/3] END C=0.05, degree=4, gamma=scale, kernel=poly;, score=0.698 total
time=   0.3s
[CV 1/3] END C=0.05, degree=4, gamma=scale, kernel=sigmoid;, score=0.436 total
time=   0.4s
[CV 2/3] END C=0.05, degree=4, gamma=scale, kernel=sigmoid;, score=0.465 total
time=   0.6s
[CV 3/3] END C=0.05, degree=4, gamma=scale, kernel=sigmoid;, score=0.426 total
time=   0.8s
[CV 1/3] END C=0.05, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
1.0s
[CV 2/3] END C=0.05, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.9s
[CV 3/3] END C=0.05, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
1.1s
[CV 1/3] END C=0.05, degree=4, gamma=auto, kernel=linear;, score=0.870 total
time=   0.4s
[CV 2/3] END C=0.05, degree=4, gamma=auto, kernel=linear;, score=0.833 total
time=   0.3s
[CV 3/3] END C=0.05, degree=4, gamma=auto, kernel=linear;, score=0.798 total
time=   0.2s
[CV 1/3] END C=0.05, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
```

```
0.7s
[CV 1/3] END C=0.05, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.7s
[CV 2/3] END C=0.05, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.7s
[CV 3/3] END C=0.05, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.6s
[CV 1/3] END C=0.05, degree=4, gamma=0.1, kernel=rbf;, score=0.181 total time=
0.8s
[CV 2/3] END C=0.05, degree=4, gamma=0.1, kernel=rbf;, score=0.109 total time=
0.9s
[CV 3/3] END C=0.05, degree=4, gamma=0.1, kernel=rbf;, score=0.183 total time=
1.0s
[CV 1/3] END C=0.05, degree=4, gamma=0.1, kernel=linear;, score=0.870 total
time=   0.3s
[CV 2/3] END C=0.05, degree=4, gamma=0.1, kernel=linear;, score=0.833 total
time=   0.4s
[CV 3/3] END C=0.05, degree=4, gamma=0.1, kernel=linear;, score=0.798 total
time=   0.3s
[CV 1/3] END C=0.05, degree=4, gamma=0.1, kernel=poly;, score=0.906 total time=
0.5s
[CV 2/3] END C=0.05, degree=4, gamma=0.1, kernel=poly;, score=0.870 total time=
0.4s
[CV 3/3] END C=0.05, degree=4, gamma=0.1, kernel=poly;, score=0.850 total time=
0.5s
[CV 1/3] END C=0.05, degree=4, gamma=0.1, kernel=sigmoid;, score=0.291 total
time=   0.7s
[CV 2/3] END C=0.05, degree=4, gamma=0.1, kernel=sigmoid;, score=0.282 total
time=   0.7s
[CV 3/3] END C=0.05, degree=4, gamma=0.1, kernel=sigmoid;, score=0.229 total
time=   0.7s
[CV 1/3] END C=0.05, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
1.0s
[CV 2/3] END C=0.05, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.9s
[CV 3/3] END C=0.05, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.8s
[CV 1/3] END C=0.05, degree=4, gamma=1, kernel=linear;, score=0.870 total time=
0.2s
[CV 2/3] END C=0.05, degree=4, gamma=1, kernel=linear;, score=0.833 total time=
0.2s
[CV 3/3] END C=0.05, degree=4, gamma=1, kernel=linear;, score=0.798 total time=
0.2s
[CV 1/3] END C=0.05, degree=4, gamma=1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.05, degree=4, gamma=1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.05, degree=4, gamma=1, kernel=poly;, score=0.850 total time=
```

```
0.3s
[CV 1/3] END C=0.05, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.05, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.05, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.05, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.8s
[CV 1/3] END C=0.05, degree=4, gamma=1.1, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=4, gamma=1.1, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.05, degree=4, gamma=1.1, kernel=linear;, score=0.798 total
time=   0.2s
[CV 1/3] END C=0.05, degree=4, gamma=1.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.05, degree=4, gamma=1.1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.05, degree=4, gamma=1.1, kernel=poly;, score=0.850 total time=
0.3s
[CV 1/3] END C=0.05, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.05, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.05, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.05, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.8s
[CV 2/3] END C=0.05, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.05, degree=4, gamma=1.2, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=4, gamma=1.2, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.05, degree=4, gamma=1.2, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=4, gamma=1.2, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.05, degree=4, gamma=1.2, kernel=poly;, score=0.870 total time=
0.4s
[CV 3/3] END C=0.05, degree=4, gamma=1.2, kernel=poly;, score=0.850 total time=
```

```
0.3s
[CV 1/3] END C=0.05, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.05, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.05, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.05, degree=5, gamma=scale, kernel=rbf;, score=0.438 total time=
0.7s
[CV 2/3] END C=0.05, degree=5, gamma=scale, kernel=rbf;, score=0.464 total time=
0.7s
[CV 3/3] END C=0.05, degree=5, gamma=scale, kernel=rbf;, score=0.407 total time=
0.6s
[CV 1/3] END C=0.05, degree=5, gamma=scale, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=5, gamma=scale, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.05, degree=5, gamma=scale, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=5, gamma=scale, kernel=poly;, score=0.811 total
time=   0.3s
[CV 2/3] END C=0.05, degree=5, gamma=scale, kernel=poly;, score=0.800 total
time=   0.4s
[CV 3/3] END C=0.05, degree=5, gamma=scale, kernel=poly;, score=0.745 total
time=   0.4s
[CV 1/3] END C=0.05, degree=5, gamma=scale, kernel=sigmoid;, score=0.436 total
time=   0.4s
[CV 2/3] END C=0.05, degree=5, gamma=scale, kernel=sigmoid;, score=0.465 total
time=   0.4s
[CV 3/3] END C=0.05, degree=5, gamma=scale, kernel=sigmoid;, score=0.426 total
time=   0.4s
[CV 1/3] END C=0.05, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.8s
[CV 3/3] END C=0.05, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.8s
[CV 1/3] END C=0.05, degree=5, gamma=auto, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=5, gamma=auto, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.05, degree=5, gamma=auto, kernel=linear;, score=0.798 total
time=   0.2s
[CV 1/3] END C=0.05, degree=5, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.05, degree=5, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.05, degree=5, gamma=auto, kernel=poly;, score=0.076 total time=
```

```
0.5s
[CV 1/3] END C=0.05, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.05, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.05, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.05, degree=5, gamma=0.1, kernel=rbf;, score=0.181 total time=
0.7s
[CV 2/3] END C=0.05, degree=5, gamma=0.1, kernel=rbf;, score=0.109 total time=
0.8s
[CV 3/3] END C=0.05, degree=5, gamma=0.1, kernel=rbf;, score=0.183 total time=
0.7s
[CV 1/3] END C=0.05, degree=5, gamma=0.1, kernel=linear;, score=0.870 total
time=   0.1s
[CV 2/3] END C=0.05, degree=5, gamma=0.1, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.05, degree=5, gamma=0.1, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=5, gamma=0.1, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.05, degree=5, gamma=0.1, kernel=poly;, score=0.875 total time=
0.4s
[CV 3/3] END C=0.05, degree=5, gamma=0.1, kernel=poly;, score=0.834 total time=
0.4s
[CV 1/3] END C=0.05, degree=5, gamma=0.1, kernel=sigmoid;, score=0.291 total
time=   0.5s
[CV 2/3] END C=0.05, degree=5, gamma=0.1, kernel=sigmoid;, score=0.282 total
time=   0.5s
[CV 3/3] END C=0.05, degree=5, gamma=0.1, kernel=sigmoid;, score=0.229 total
time=   0.5s
[CV 1/3] END C=0.05, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.05, degree=5, gamma=1, kernel=linear;, score=0.870 total time=
0.2s
[CV 2/3] END C=0.05, degree=5, gamma=1, kernel=linear;, score=0.833 total time=
0.2s
[CV 3/3] END C=0.05, degree=5, gamma=1, kernel=linear;, score=0.798 total time=
0.2s
[CV 1/3] END C=0.05, degree=5, gamma=1, kernel=poly;, score=0.894 total time=
0.4s
[CV 2/3] END C=0.05, degree=5, gamma=1, kernel=poly;, score=0.875 total time=
0.4s
[CV 3/3] END C=0.05, degree=5, gamma=1, kernel=poly;, score=0.834 total time=
```

```
0.4s
[CV 1/3] END C=0.05, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.05, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.05, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.05, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.05, degree=5, gamma=1.1, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=5, gamma=1.1, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.05, degree=5, gamma=1.1, kernel=linear;, score=0.798 total
time=   0.2s
[CV 1/3] END C=0.05, degree=5, gamma=1.1, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.05, degree=5, gamma=1.1, kernel=poly;, score=0.875 total time=
0.3s
[CV 3/3] END C=0.05, degree=5, gamma=1.1, kernel=poly;, score=0.834 total time=
0.3s
[CV 1/3] END C=0.05, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.05, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.05, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.05, degree=5, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=5, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=5, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.05, degree=5, gamma=1.2, kernel=linear;, score=0.870 total
time=   0.1s
[CV 2/3] END C=0.05, degree=5, gamma=1.2, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.05, degree=5, gamma=1.2, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=5, gamma=1.2, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.05, degree=5, gamma=1.2, kernel=poly;, score=0.875 total time=
0.4s
[CV 3/3] END C=0.05, degree=5, gamma=1.2, kernel=poly;, score=0.834 total time=
```

```
0.4s
[CV 1/3] END C=0.05, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.05, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.05, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.05, degree=6, gamma=scale, kernel=rbf;, score=0.438 total time=
0.6s
[CV 2/3] END C=0.05, degree=6, gamma=scale, kernel=rbf;, score=0.464 total time=
0.6s
[CV 3/3] END C=0.05, degree=6, gamma=scale, kernel=rbf;, score=0.407 total time=
0.6s
[CV 1/3] END C=0.05, degree=6, gamma=scale, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=6, gamma=scale, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.05, degree=6, gamma=scale, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=6, gamma=scale, kernel=poly;, score=0.847 total
time=   0.4s
[CV 2/3] END C=0.05, degree=6, gamma=scale, kernel=poly;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.05, degree=6, gamma=scale, kernel=poly;, score=0.771 total
time=   0.4s
[CV 1/3] END C=0.05, degree=6, gamma=scale, kernel=sigmoid;, score=0.436 total
time=   0.4s
[CV 2/3] END C=0.05, degree=6, gamma=scale, kernel=sigmoid;, score=0.465 total
time=   0.4s
[CV 3/3] END C=0.05, degree=6, gamma=scale, kernel=sigmoid;, score=0.426 total
time=   0.4s
[CV 1/3] END C=0.05, degree=6, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=6, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=6, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.05, degree=6, gamma=auto, kernel=linear;, score=0.870 total
time=   0.2s
[CV 2/3] END C=0.05, degree=6, gamma=auto, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.05, degree=6, gamma=auto, kernel=linear;, score=0.798 total
time=   0.2s
[CV 1/3] END C=0.05, degree=6, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.05, degree=6, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.05, degree=6, gamma=auto, kernel=poly;, score=0.076 total time=
```

```
0.4s
[CV 1/3] END C=0.05, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.05, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.05, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.05, degree=6, gamma=0.1, kernel=rbf;, score=0.181 total time=
0.7s
[CV 2/3] END C=0.05, degree=6, gamma=0.1, kernel=rbf;, score=0.109 total time=
0.7s
[CV 3/3] END C=0.05, degree=6, gamma=0.1, kernel=rbf;, score=0.183 total time=
0.7s
[CV 1/3] END C=0.05, degree=6, gamma=0.1, kernel=linear;, score=0.870 total
time=   0.1s
[CV 2/3] END C=0.05, degree=6, gamma=0.1, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.05, degree=6, gamma=0.1, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=6, gamma=0.1, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.05, degree=6, gamma=0.1, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.05, degree=6, gamma=0.1, kernel=poly;, score=0.829 total time=
0.4s
[CV 1/3] END C=0.05, degree=6, gamma=0.1, kernel=sigmoid;, score=0.291 total
time=   0.5s
[CV 2/3] END C=0.05, degree=6, gamma=0.1, kernel=sigmoid;, score=0.282 total
time=   0.5s
[CV 3/3] END C=0.05, degree=6, gamma=0.1, kernel=sigmoid;, score=0.229 total
time=   0.5s
[CV 1/3] END C=0.05, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.05, degree=6, gamma=1, kernel=linear;, score=0.870 total time=
0.1s
[CV 2/3] END C=0.05, degree=6, gamma=1, kernel=linear;, score=0.833 total time=
0.2s
[CV 3/3] END C=0.05, degree=6, gamma=1, kernel=linear;, score=0.798 total time=
0.1s
[CV 1/3] END C=0.05, degree=6, gamma=1, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.05, degree=6, gamma=1, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.05, degree=6, gamma=1, kernel=poly;, score=0.829 total time=
```

```
0.5s
[CV 1/3] END C=0.05, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.05, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.05, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.05, degree=6, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.8s
[CV 2/3] END C=0.05, degree=6, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=6, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.05, degree=6, gamma=1.1, kernel=linear;, score=0.870 total
time=   0.1s
[CV 2/3] END C=0.05, degree=6, gamma=1.1, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.05, degree=6, gamma=1.1, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=6, gamma=1.1, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.05, degree=6, gamma=1.1, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.05, degree=6, gamma=1.1, kernel=poly;, score=0.829 total time=
0.4s
[CV 1/3] END C=0.05, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.05, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.05, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.05, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.05, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.05, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.8s
[CV 1/3] END C=0.05, degree=6, gamma=1.2, kernel=linear;, score=0.870 total
time=   0.1s
[CV 2/3] END C=0.05, degree=6, gamma=1.2, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.05, degree=6, gamma=1.2, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.05, degree=6, gamma=1.2, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.05, degree=6, gamma=1.2, kernel=poly;, score=0.863 total time=
0.3s
[CV 3/3] END C=0.05, degree=6, gamma=1.2, kernel=poly;, score=0.829 total time=
```

```
0.4s
[CV 1/3] END C=0.05, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.05, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.05, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=4, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.7s
[CV 2/3] END C=0.001, degree=4, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.8s
[CV 3/3] END C=0.001, degree=4, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.7s
[CV 1/3] END C=0.001, degree=4, gamma=scale, kernel=linear;, score=0.447 total
time=   0.4s
[CV 2/3] END C=0.001, degree=4, gamma=scale, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=scale, kernel=linear;, score=0.427 total
time=   0.4s
[CV 1/3] END C=0.001, degree=4, gamma=scale, kernel=poly;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=4, gamma=scale, kernel=poly;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=scale, kernel=poly;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=4, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=4, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=4, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=4, gamma=auto, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=4, gamma=auto, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=auto, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=4, gamma=auto, kernel=poly;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=4, gamma=auto, kernel=poly;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=auto, kernel=poly;, score=0.076 total
```

```
time=   0.5s
[CV 1/3] END C=0.001, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=4, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=4, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=4, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=4, gamma=0.1, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=4, gamma=0.1, kernel=linear;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.001, degree=4, gamma=0.1, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=4, gamma=0.1, kernel=poly;, score=0.860 total time=
0.2s
[CV 2/3] END C=0.001, degree=4, gamma=0.1, kernel=poly;, score=0.834 total time=
0.2s
[CV 3/3] END C=0.001, degree=4, gamma=0.1, kernel=poly;, score=0.778 total time=
0.2s
[CV 1/3] END C=0.001, degree=4, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
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time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=4, gamma=1, kernel=linear;, score=0.447 total time=
0.3s
[CV 2/3] END C=0.001, degree=4, gamma=1, kernel=linear;, score=0.486 total time=
0.3s
[CV 3/3] END C=0.001, degree=4, gamma=1, kernel=linear;, score=0.427 total time=
0.3s
[CV 1/3] END C=0.001, degree=4, gamma=1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.001, degree=4, gamma=1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.001, degree=4, gamma=1, kernel=poly;, score=0.850 total time=
```

```
0.3s
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time=   0.5s
[CV 2/3] END C=0.001, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=4, gamma=1.1, kernel=linear;, score=0.447 total
time=   0.4s
[CV 2/3] END C=0.001, degree=4, gamma=1.1, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=1.1, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=4, gamma=1.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.001, degree=4, gamma=1.1, kernel=poly;, score=0.870 total time=
0.3s
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0.3s
[CV 1/3] END C=0.001, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.001, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=4, gamma=1.2, kernel=linear;, score=0.447 total
time=   0.4s
[CV 2/3] END C=0.001, degree=4, gamma=1.2, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=4, gamma=1.2, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=4, gamma=1.2, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.001, degree=4, gamma=1.2, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.001, degree=4, gamma=1.2, kernel=poly;, score=0.850 total time=
```

```
0.3s
[CV 1/3] END C=0.001, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=5, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.8s
[CV 2/3] END C=0.001, degree=5, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.7s
[CV 3/3] END C=0.001, degree=5, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.7s
[CV 1/3] END C=0.001, degree=5, gamma=scale, kernel=linear;, score=0.447 total
time=   0.4s
[CV 2/3] END C=0.001, degree=5, gamma=scale, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=5, gamma=scale, kernel=linear;, score=0.427 total
time=   0.4s
[CV 1/3] END C=0.001, degree=5, gamma=scale, kernel=poly;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=5, gamma=scale, kernel=poly;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=5, gamma=scale, kernel=poly;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=5, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=5, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=5, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.001, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=5, gamma=auto, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=5, gamma=auto, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=5, gamma=auto, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=5, gamma=auto, kernel=poly;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=5, gamma=auto, kernel=poly;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=5, gamma=auto, kernel=poly;, score=0.076 total
```

```
time=   0.4s
[CV 1/3] END C=0.001, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=5, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=5, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=5, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=5, gamma=0.1, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=5, gamma=0.1, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=5, gamma=0.1, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=5, gamma=0.1, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.001, degree=5, gamma=0.1, kernel=poly;, score=0.875 total time=
0.3s
[CV 3/3] END C=0.001, degree=5, gamma=0.1, kernel=poly;, score=0.834 total time=
0.3s
[CV 1/3] END C=0.001, degree=5, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=5, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=5, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=5, gamma=1, kernel=linear;, score=0.447 total time=
0.4s
[CV 2/3] END C=0.001, degree=5, gamma=1, kernel=linear;, score=0.486 total time=
0.4s
[CV 3/3] END C=0.001, degree=5, gamma=1, kernel=linear;, score=0.427 total time=
0.3s
[CV 1/3] END C=0.001, degree=5, gamma=1, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.001, degree=5, gamma=1, kernel=poly;, score=0.875 total time=
0.4s
[CV 3/3] END C=0.001, degree=5, gamma=1, kernel=poly;, score=0.834 total time=
```

```
0.3s
[CV 1/3] END C=0.001, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.8s
[CV 2/3] END C=0.001, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=5, gamma=1.1, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=5, gamma=1.1, kernel=linear;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.001, degree=5, gamma=1.1, kernel=linear;, score=0.427 total
time=   0.4s
[CV 1/3] END C=0.001, degree=5, gamma=1.1, kernel=poly;, score=0.894 total time=
0.4s
[CV 2/3] END C=0.001, degree=5, gamma=1.1, kernel=poly;, score=0.875 total time=
0.4s
[CV 3/3] END C=0.001, degree=5, gamma=1.1, kernel=poly;, score=0.834 total time=
0.5s
[CV 1/3] END C=0.001, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.7s
[CV 2/3] END C=0.001, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.6s
[CV 3/3] END C=0.001, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
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0.7s
[CV 2/3] END C=0.001, degree=5, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=5, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=5, gamma=1.2, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=5, gamma=1.2, kernel=linear;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.001, degree=5, gamma=1.2, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=5, gamma=1.2, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.001, degree=5, gamma=1.2, kernel=poly;, score=0.875 total time=
0.3s
[CV 3/3] END C=0.001, degree=5, gamma=1.2, kernel=poly;, score=0.834 total time=
```

```
0.3s
[CV 1/3] END C=0.001, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.001, degree=6, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.7s
[CV 2/3] END C=0.001, degree=6, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.7s
[CV 3/3] END C=0.001, degree=6, gamma=scale, kernel=rbf;, score=0.076 total
time=   0.7s
[CV 1/3] END C=0.001, degree=6, gamma=scale, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=6, gamma=scale, kernel=linear;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.001, degree=6, gamma=scale, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=6, gamma=scale, kernel=poly;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=6, gamma=scale, kernel=poly;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=6, gamma=scale, kernel=poly;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.001, degree=6, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=6, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=6, gamma=scale, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=6, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=6, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=6, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=6, gamma=auto, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=6, gamma=auto, kernel=linear;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.001, degree=6, gamma=auto, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=6, gamma=auto, kernel=poly;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=6, gamma=auto, kernel=poly;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=6, gamma=auto, kernel=poly;, score=0.076 total
```

```
time=   0.4s
[CV 1/3] END C=0.001, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=6, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=6, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=6, gamma=0.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=6, gamma=0.1, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=6, gamma=0.1, kernel=linear;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.001, degree=6, gamma=0.1, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=6, gamma=0.1, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.001, degree=6, gamma=0.1, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.001, degree=6, gamma=0.1, kernel=poly;, score=0.829 total time=
0.4s
[CV 1/3] END C=0.001, degree=6, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=6, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=6, gamma=0.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=6, gamma=1, kernel=linear;, score=0.447 total time=
0.3s
[CV 2/3] END C=0.001, degree=6, gamma=1, kernel=linear;, score=0.486 total time=
0.3s
[CV 3/3] END C=0.001, degree=6, gamma=1, kernel=linear;, score=0.427 total time=
0.3s
[CV 1/3] END C=0.001, degree=6, gamma=1, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.001, degree=6, gamma=1, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.001, degree=6, gamma=1, kernel=poly;, score=0.829 total time=
```

```
0.3s
[CV 1/3] END C=0.001, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.001, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.001, degree=6, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.6s
[CV 2/3] END C=0.001, degree=6, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=6, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=6, gamma=1.1, kernel=linear;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.001, degree=6, gamma=1.1, kernel=linear;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.001, degree=6, gamma=1.1, kernel=linear;, score=0.427 total
time=   0.3s
[CV 1/3] END C=0.001, degree=6, gamma=1.1, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.001, degree=6, gamma=1.1, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.001, degree=6, gamma=1.1, kernel=poly;, score=0.829 total time=
0.4s
[CV 1/3] END C=0.001, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.001, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.001, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.001, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.001, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.001, degree=6, gamma=1.2, kernel=linear;, score=0.447 total
time=   0.4s
[CV 2/3] END C=0.001, degree=6, gamma=1.2, kernel=linear;, score=0.486 total
time=   0.4s
[CV 3/3] END C=0.001, degree=6, gamma=1.2, kernel=linear;, score=0.427 total
time=   0.4s
[CV 1/3] END C=0.001, degree=6, gamma=1.2, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.001, degree=6, gamma=1.2, kernel=poly;, score=0.863 total time=
0.5s
[CV 3/3] END C=0.001, degree=6, gamma=1.2, kernel=poly;, score=0.829 total time=
```

```
0.4s
[CV 1/3] END C=0.001, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.001, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.001, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.542 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.551 total time=
0.6s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.513 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.835 total
time=   0.2s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.862 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.834 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.766 total time=
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.491 total
time=   0.3s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.3s
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0.7s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
```

```
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.427 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.373 total time=
0.7s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.872 total time=
0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.850 total time=
0.3s
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time=   0.5s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.395 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.385 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=4, gamma=1, kernel=linear;, score=0.872 total time=
0.1s
[CV 2/3] END C=0.1, degree=4, gamma=1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=4, gamma=1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=4, gamma=1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=1, kernel=poly;, score=0.850 total time=
```

```
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.8s
[CV 1/3] END C=0.1, degree=4, gamma=1.1, kernel=linear;, score=0.872 total time=
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[CV 2/3] END C=0.1, degree=4, gamma=1.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=4, gamma=1.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=4, gamma=1.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=1.1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=1.1, kernel=poly;, score=0.850 total time=
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[CV 1/3] END C=0.1, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
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[CV 2/3] END C=0.1, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
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[CV 2/3] END C=0.1, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=4, gamma=1.2, kernel=linear;, score=0.872 total time=
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[CV 2/3] END C=0.1, degree=4, gamma=1.2, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=4, gamma=1.2, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=4, gamma=1.2, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=1.2, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=1.2, kernel=poly;, score=0.850 total time=
```

```
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.1, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.1, degree=5, gamma=scale, kernel=rbf;, score=0.542 total time=
0.6s
[CV 2/3] END C=0.1, degree=5, gamma=scale, kernel=rbf;, score=0.551 total time=
0.6s
[CV 3/3] END C=0.1, degree=5, gamma=scale, kernel=rbf;, score=0.513 total time=
0.6s
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time=   0.2s
[CV 2/3] END C=0.1, degree=5, gamma=scale, kernel=linear;, score=0.835 total
time=   0.2s
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time=   0.1s
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[CV 3/3] END C=0.1, degree=5, gamma=scale, kernel=poly;, score=0.802 total time=
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time=   0.4s
[CV 2/3] END C=0.1, degree=5, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   0.3s
[CV 3/3] END C=0.1, degree=5, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.3s
[CV 1/3] END C=0.1, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.1, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=5, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=5, gamma=auto, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=5, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=5, gamma=auto, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=5, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=5, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.1, degree=5, gamma=auto, kernel=poly;, score=0.076 total time=
```

```
0.4s
[CV 1/3] END C=0.1, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=5, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.1, degree=5, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.7s
[CV 2/3] END C=0.1, degree=5, gamma=0.1, kernel=rbf;, score=0.427 total time=
0.7s
[CV 3/3] END C=0.1, degree=5, gamma=0.1, kernel=rbf;, score=0.373 total time=
0.7s
[CV 1/3] END C=0.1, degree=5, gamma=0.1, kernel=linear;, score=0.872 total time=
0.1s
[CV 2/3] END C=0.1, degree=5, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=5, gamma=0.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=5, gamma=0.1, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.1, degree=5, gamma=0.1, kernel=poly;, score=0.875 total time=
0.4s
[CV 3/3] END C=0.1, degree=5, gamma=0.1, kernel=poly;, score=0.834 total time=
0.3s
[CV 1/3] END C=0.1, degree=5, gamma=0.1, kernel=sigmoid;, score=0.393 total
time=   0.4s
[CV 2/3] END C=0.1, degree=5, gamma=0.1, kernel=sigmoid;, score=0.395 total
time=   0.4s
[CV 3/3] END C=0.1, degree=5, gamma=0.1, kernel=sigmoid;, score=0.385 total
time=   0.4s
[CV 1/3] END C=0.1, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.1, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=5, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=5, gamma=1, kernel=linear;, score=0.872 total time=
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[CV 2/3] END C=0.1, degree=5, gamma=1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=5, gamma=1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=5, gamma=1, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.1, degree=5, gamma=1, kernel=poly;, score=0.875 total time=
0.3s
[CV 3/3] END C=0.1, degree=5, gamma=1, kernel=poly;, score=0.834 total time=
```

```
0.3s
[CV 1/3] END C=0.1, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total time=
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[CV 2/3] END C=0.1, degree=5, gamma=1, kernel=sigmoid;, score=0.076 total time=
0.4s
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[CV 1/3] END C=0.1, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
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[CV 2/3] END C=0.1, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=5, gamma=1.1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=5, gamma=1.1, kernel=linear;, score=0.872 total time=
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[CV 2/3] END C=0.1, degree=5, gamma=1.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=5, gamma=1.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=5, gamma=1.1, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.1, degree=5, gamma=1.1, kernel=poly;, score=0.875 total time=
0.3s
[CV 3/3] END C=0.1, degree=5, gamma=1.1, kernel=poly;, score=0.834 total time=
0.3s
[CV 1/3] END C=0.1, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=5, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
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[CV 2/3] END C=0.1, degree=5, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=5, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=5, gamma=1.2, kernel=linear;, score=0.872 total time=
0.1s
[CV 2/3] END C=0.1, degree=5, gamma=1.2, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=5, gamma=1.2, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=5, gamma=1.2, kernel=poly;, score=0.894 total time=
0.3s
[CV 2/3] END C=0.1, degree=5, gamma=1.2, kernel=poly;, score=0.875 total time=
0.3s
[CV 3/3] END C=0.1, degree=5, gamma=1.2, kernel=poly;, score=0.834 total time=
```

```
0.3s
[CV 1/3] END C=0.1, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=5, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.1, degree=6, gamma=scale, kernel=rbf;, score=0.542 total time=
0.5s
[CV 2/3] END C=0.1, degree=6, gamma=scale, kernel=rbf;, score=0.551 total time=
0.5s
[CV 3/3] END C=0.1, degree=6, gamma=scale, kernel=rbf;, score=0.513 total time=
0.5s
[CV 1/3] END C=0.1, degree=6, gamma=scale, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=6, gamma=scale, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=6, gamma=scale, kernel=linear;, score=0.793 total
time=   0.1s
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time=   0.3s
[CV 3/3] END C=0.1, degree=6, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.3s
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0.7s
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time=   0.1s
[CV 2/3] END C=0.1, degree=6, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=6, gamma=auto, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=6, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=6, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.1, degree=6, gamma=auto, kernel=poly;, score=0.076 total time=
```

```
0.4s
[CV 1/3] END C=0.1, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=6, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.1, degree=6, gamma=0.1, kernel=rbf;, score=0.390 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=0.1, kernel=rbf;, score=0.427 total time=
0.7s
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[CV 1/3] END C=0.1, degree=6, gamma=0.1, kernel=linear;, score=0.872 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=6, gamma=0.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=6, gamma=0.1, kernel=poly;, score=0.886 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=0.1, kernel=poly;, score=0.863 total time=
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[CV 3/3] END C=0.1, degree=6, gamma=0.1, kernel=poly;, score=0.829 total time=
0.4s
[CV 1/3] END C=0.1, degree=6, gamma=0.1, kernel=sigmoid;, score=0.393 total
time=   0.4s
[CV 2/3] END C=0.1, degree=6, gamma=0.1, kernel=sigmoid;, score=0.395 total
time=   0.4s
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time=   0.4s
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[CV 2/3] END C=0.1, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=6, gamma=1, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=6, gamma=1, kernel=linear;, score=0.872 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=1, kernel=linear;, score=0.835 total time=
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[CV 3/3] END C=0.1, degree=6, gamma=1, kernel=linear;, score=0.793 total time=
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[CV 1/3] END C=0.1, degree=6, gamma=1, kernel=poly;, score=0.886 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=1, kernel=poly;, score=0.863 total time=
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[CV 3/3] END C=0.1, degree=6, gamma=1, kernel=poly;, score=0.829 total time=
```

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0.3s
[CV 1/3] END C=0.1, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=1, kernel=sigmoid;, score=0.076 total time=
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[CV 3/3] END C=0.1, degree=6, gamma=1.1, kernel=rbf;, score=0.076 total time=
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[CV 1/3] END C=0.1, degree=6, gamma=1.1, kernel=poly;, score=0.886 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=1.1, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.1, degree=6, gamma=1.1, kernel=poly;, score=0.829 total time=
0.4s
[CV 1/3] END C=0.1, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.1, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=6, gamma=1.1, kernel=sigmoid;, score=0.076 total
time=   0.4s
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0.7s
[CV 2/3] END C=0.1, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.1, degree=6, gamma=1.2, kernel=rbf;, score=0.076 total time=
0.7s
[CV 1/3] END C=0.1, degree=6, gamma=1.2, kernel=linear;, score=0.872 total time=
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[CV 2/3] END C=0.1, degree=6, gamma=1.2, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=6, gamma=1.2, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=6, gamma=1.2, kernel=poly;, score=0.886 total time=
0.4s
[CV 2/3] END C=0.1, degree=6, gamma=1.2, kernel=poly;, score=0.863 total time=
0.4s
[CV 3/3] END C=0.1, degree=6, gamma=1.2, kernel=poly;, score=0.829 total time=
```

```
0.3s
[CV 1/3] END C=0.1, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=6, gamma=1.2, kernel=sigmoid;, score=0.076 total
time=   0.4s

GridSearchCV(cv=3, estimator=SVC(),
             param_grid={'C': [0.05, 0.001, 0.1], 'degree': [4, 5, 6],
                         'gamma': ['scale', 'auto', 0.1, 1, 1.1, 1.2],
                         'kernel': ['rbf', 'linear', 'poly', 'sigmoid']},
             scoring='f1_macro', verbose=3)
```

```
best_svm = grid_search_svm.best_estimator_
print("Best parameters:", grid_search_svm.best_params_)

y_pred_svm = best_svm.predict(test_features)

joblib.dump(best_svm, project_dir + '\\joblib\\best_svm_model.joblib')
```

```
Best parameters: {'C': 0.05, 'degree': 4, 'gamma': 0.1, 'kernel': 'poly'}

['e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\joblib\\best_svm_model.joblib']
```

8 Predict on test images for KNN

```
report_knn = classification_report(test_labels_encoded, y_pred_knn,␣
  ↪target_names=label_encoder.classes_)
print(report_knn)
```

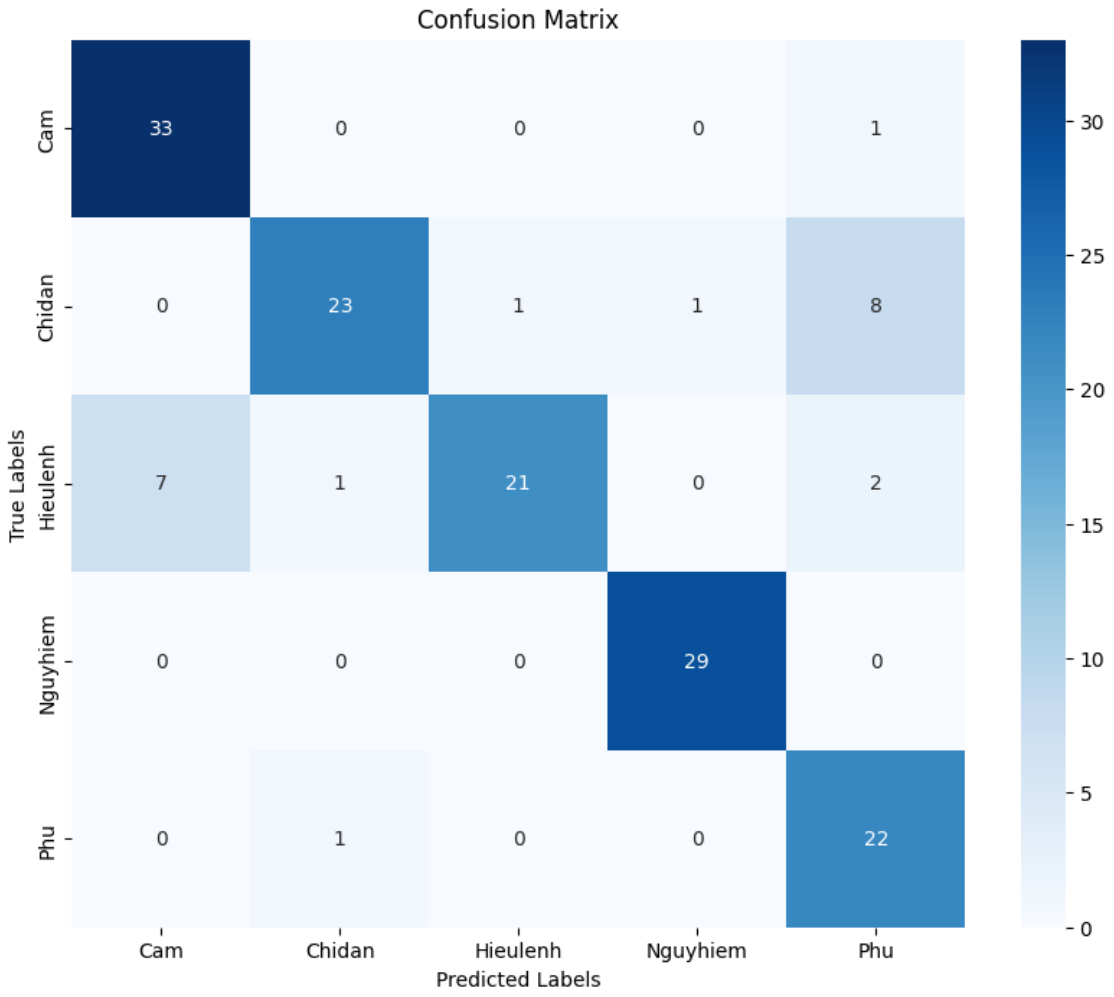
```
              precision    recall  f1-score   support

         Cam       0.82      0.97      0.89        34
      Chidan       0.92      0.70      0.79        33
    Hieulenh       0.95      0.68      0.79        31
    Nguyhiem       0.97      1.00      0.98        29
         Phu       0.67      0.96      0.79        23

    accuracy                           0.85       150
   macro avg       0.87      0.86      0.85       150
weighted avg       0.88      0.85      0.85       150
```

```
heatmap_label_knn = confusion_matrix(test_labels_encoded, y_pred_knn)
```

```
plt.figure(figsize=(10, 8))
sns.heatmap(heatmap_label_knn, annot=True, fmt='d', cmap='Blues',␣
 ↪xticklabels=label_encoder.classes_, yticklabels=label_encoder.classes_)
plt.title('Confusion Matrix')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()
```




```
n_columns = 10
n_rows = math.ceil(len(test_images) / n_columns)

fig, axes = plt.subplots(n_rows, n_columns, figsize=(30, n_rows * 3))

for idx, (image, true_label, pred_label) in enumerate(zip(test_images,␣
 ↪test_labels_encoded, y_pred_knn)):
```

```
    row = idx // n_columns
    col = idx % n_columns

    axes[row, col].imshow(image)
    axes[row, col].set_title(f'True: {label_encoder.classes_[true_label]}\nPred:
 ↪ {label_encoder.classes_[pred_label]}')
    axes[row, col].axis('off')

for ax in axes.flat:
    if not ax.has_data():
        ax.axis('off')

plt.tight_layout()
plt.show()
```


True: Cam Pred: Cam
True: Chidan Pred: Phu
True: Chidan Pred: Chidan
True: Chidan Pred: Nguyhiem
True: Hieulenh Pred: Cam
True: Hieulenh Pred: Hieulenh
True: Hieulenh Pred: Phu
True: Nguyhiem Pred: Nguyhiem
True: Phu Pred: Phu

9 Predict on test images for SVM

```
report_svm = classification_report(test_labels_encoded, y_pred_svm,␣
  ↪target_names=label_encoder.classes_)
print(report_svm)
```

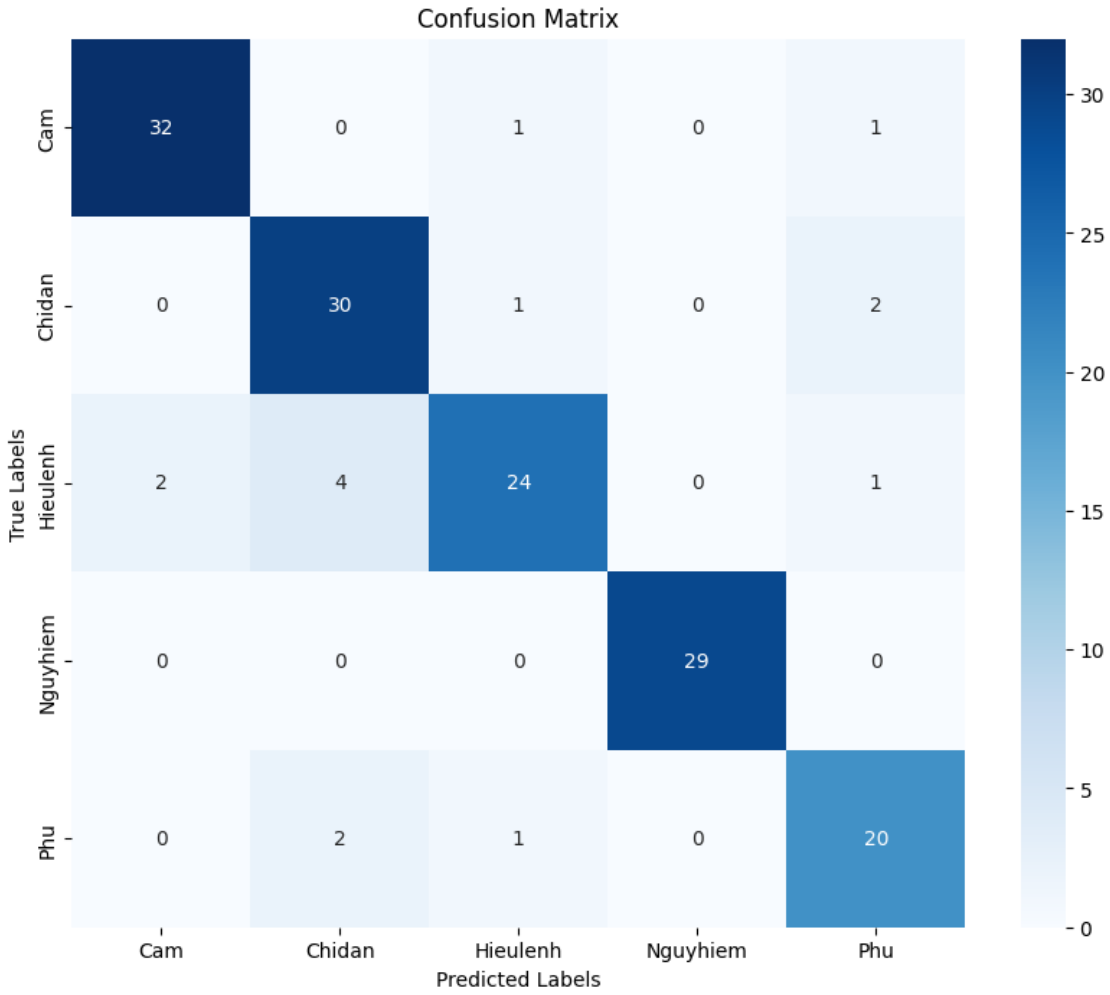
```
              precision    recall  f1-score   support

         Cam       0.94      0.94      0.94        34
      Chidan       0.83      0.91      0.87        33
    Hieulenh       0.89      0.77      0.83        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.83      0.87      0.85        23

    accuracy                           0.90       150
   macro avg       0.90      0.90      0.90       150
weighted avg       0.90      0.90      0.90       150
```

```
heatmap_label_svm = confusion_matrix(test_labels_encoded, y_pred_svm)

plt.figure(figsize=(10, 8))
sns.heatmap(heatmap_label_svm, annot=True, fmt='d', cmap='Blues',␣
  ↪xticklabels=label_encoder.classes_, yticklabels=label_encoder.classes_)
plt.title('Confusion Matrix')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()
```




```
n_columns = 10
n_rows = math.ceil(len(test_images) / n_columns)

fig, axes = plt.subplots(n_rows, n_columns, figsize=(30, n_rows * 3))

for idx, (image, true_label, pred_label) in enumerate(zip(test_images,␣
 ↪test_labels_encoded, y_pred_svm)):
    row = idx // n_columns
    col = idx % n_columns

    axes[row, col].imshow(image)
    axes[row, col].set_title(f'True: {label_encoder.classes_[true_label]}\nPred:
 ↪ {label_encoder.classes_[pred_label]}')
    axes[row, col].axis('off')
```

```
for ax in axes.flat:
    if not ax.has_data():
        ax.axis('off')

plt.tight_layout()
plt.show()
```

10 Save grid search results

```
def export_notebook_to_pdf(notebook_path, project_dir):
    results_dir = os.path.join(project_dir)
    os.makedirs(results_dir, exist_ok=True)

    # Đọc notebook
    with open(notebook_path, 'r', encoding='utf-8') as f:
        nb = nbformat.read(f, as_version=4)

    # Cấu hình PDF exporter
    pdf_exporter = PDFExporter()
    pdf_exporter.exclude_input_prompt = True
    pdf_exporter.exclude_output_prompt = True

    # Thêm template và style cơ bản
    pdf_exporter.template_name = 'classic'

    # Chuyển đổi sang PDF
    pdf_data, resources = pdf_exporter.from_notebook_node(nb)

    # Tạo tên file với timestamp
    current_time = datetime.now().strftime('%Y-%m-%d_%H_%M_%S')
    pdf_file = os.path.join(results_dir, f"notebook_export_{current_time}.pdf")

    # Lưu file PDF
    with open(pdf_file, 'wb') as f:
        f.write(pdf_data)

    print(f"Đã xuất file PDF thành công: {pdf_file}")
    return pdf_file
```

```
# project_dir = os.path.dirname(project_dir)
notebook_path = project_dir + "\\model\\main.ipynb"
proj_dir = project_dir + "\\grid_search_results"

export_notebook_to_pdf(notebook_path, proj_dir)
```

```
Đã xuất file PDF thành công: e:\Documents\CS231\project\Traffic-Sign-
Classification-through-
```

```
Images\grid_search_results\notebook_export_2024-12-16_21_33_57.pdf
```

```
'e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\grid_search_results\\notebook_export_2024-12-16_21_33_57.pdf'
```

param_grid_KNN = { ‘n_neighbors’: [3, 4, 5, 6, 7, 10], ‘weights’: [‘uniform’, ‘distance’], ‘metric’: [cityblock, cosine, sqeuclidean, chi_square_distance, bhattacharyya_distance, intersection_distance] }

Best Params: {‘metric’: , ‘n_neighbors’: 4, ‘weights’: ‘distance’}

param_grid_SVC = { ‘C’: [0.1, 0.2, 0.3, 0.4],
‘kernel’: [‘rbf’, ‘linear’, ‘poly’, ‘sigmoid’], ‘gamma’: [‘scale’, ‘auto’, 0.1, 0.01, 0.001],
‘degree’: [2, 3, 4],
}

Best parameters: {‘C’: 0.1, ‘degree’: 4, ‘gamma’: 0.1, ‘kernel’: ‘poly’}