

Notebook

December 23, 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):
                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')

```

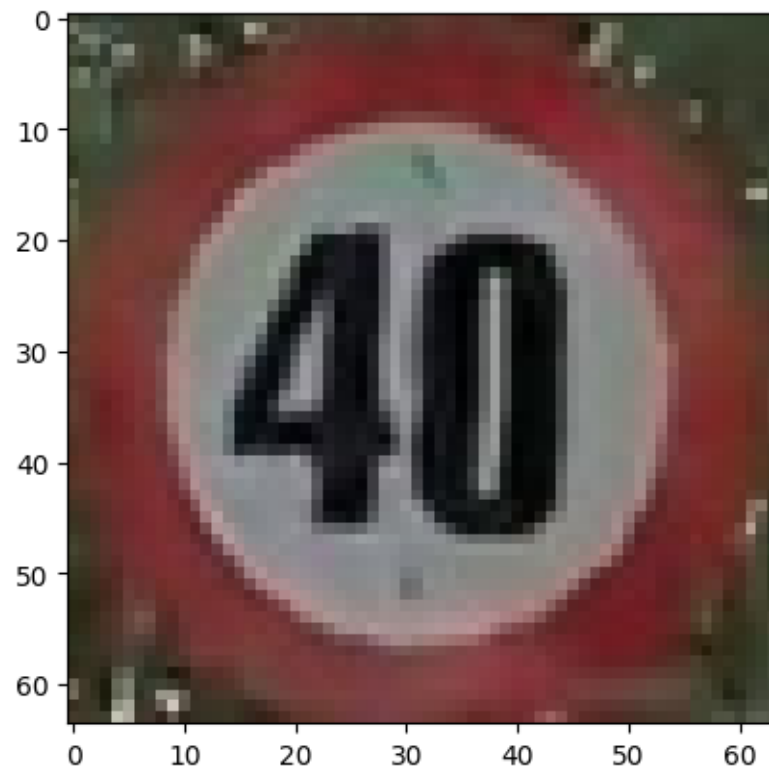
```

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

```

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

<matplotlib.image.AxesImage at 0x12a3469ae30>



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

<matplotlib.image.AxesImage at 0x12a34744160>



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, (3,3), 0)  
    return blurred_image
```

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

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

```
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

```

```

# def plot_color_histogram(image):

#     fig, axs = plt.subplots(2, 2, figsize=(12, 10))

#     num_pixels = image.shape[0] * image.shape[1]

#     color = ("r", "g", "b")
#     for k, clr in enumerate(color):
#         histogram = np.squeeze(cv2.calcHist([image], [k], None, [256], [0,
↪256]))
#         histogram = histogram / num_pixels
#         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]))
#         histogram = histogram / num_pixels
#         axs[pos].plot(histogram, color=clr)
#         axs[pos].set_xlim(0, 256)
#         axs[pos].set_title(f"{title}")

#     plt.tight_layout()
#     plt.show()

```

```

# 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

```

```
# _, image1 = hog(blur_image(train_images[1]))
# plt.imshow(image1, cmap=plt.cm.gray)
```

```
# _, image2 = hog(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%|      | 1416/1416 [00:00<00:00, 52435.74it/s]
Extracting Color Features: 100%|      | 1416/1416 [00:00<00:00,
31714.46it/s]
Extracting HOG Features: 100%|      | 1416/1416 [00:02<00:00, 613.91it/s]
Combining Features: 1416it [00:00, 70804.29it/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%|      | 149/149 [00:00<00:00, 49686.06it/s]
Extracting Color Features: 100%|      | 149/149 [00:00<00:00, 37263.81it/s]
Extracting HOG Features: 100%|      | 149/149 [00:00<00:00, 595.07it/s]
Combining Features: 149it [00:00, 33337.85it/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())
```

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)

```

```

Fitting 3 folds for each of 84 candidates, totalling 252 fits
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;; score=0.891 total time= 2.7s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;; score=0.842 total time= 2.6s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;; score=0.836 total time= 2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;; score=0.894 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;; score=0.857 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;; score=0.845 total time= 2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=uniform;; score=0.867 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=uniform;; score=0.841 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=uniform;; score=0.790 total time= 2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;; score=0.905 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;; score=0.863 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;; score=0.847 total time= 2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;; score=0.862 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;; score=0.825 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;; score=0.821 total time= 2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=distance;; score=0.883 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,

```



```

weights=distance;; score=0.844 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=distance;; score=0.833 total time= 2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;; score=0.856 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;; score=0.825 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;; score=0.794 total time= 2.6s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;; score=0.883 total time= 2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;; score=0.834 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;; score=0.837 total time= 2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=uniform;; score=0.846 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=uniform;; score=0.822 total time= 2.7s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=uniform;; score=0.790 total time= 2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=distance;; score=0.874 total time= 2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=distance;; score=0.833 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=distance;; score=0.819 total time= 2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=uniform;; score=0.825 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=uniform;; score=0.796 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=uniform;; score=0.766 total time= 2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;; score=0.857 total time= 2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;; score=0.822 total time= 2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;; score=0.784 total time= 2.5s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;; score=0.873 total time= 3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;; score=0.803 total time= 3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;; score=0.793 total time= 3.3s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=distance;; score=0.881 total time= 3.6s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,

```

```

weights=distance;; score=0.805 total time= 3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=distance;; score=0.798 total time= 3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=uniform;; score=0.837 total time= 3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=uniform;; score=0.792 total time= 3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=uniform;; score=0.769 total time= 3.5s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;; score=0.877 total time= 3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;; score=0.822 total time= 3.3s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;; score=0.795 total time= 3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=uniform;; score=0.850 total time= 3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=uniform;; score=0.783 total time= 3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=uniform;; score=0.753 total time= 3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=distance;; score=0.868 total time= 3.3s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=distance;; score=0.791 total time= 3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=distance;; score=0.764 total time= 3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=6,
weights=uniform;; score=0.822 total time= 3.3s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=6,
weights=uniform;; score=0.771 total time= 3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=6,
weights=uniform;; score=0.725 total time= 3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=6,
weights=distance;; score=0.870 total time= 3.3s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=6,
weights=distance;; score=0.794 total time= 3.7s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=6,
weights=distance;; score=0.768 total time= 3.8s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=uniform;; score=0.830 total time= 3.8s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=uniform;; score=0.763 total time= 3.5s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=uniform;; score=0.730 total time= 3.5s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=distance;; score=0.838 total time= 3.3s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,

```

```

weights=distance;; score=0.773 total time= 3.3s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=distance;; score=0.747 total time= 3.3s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=uniform;; score=0.810 total time= 3.3s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=uniform;; score=0.735 total time= 3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=uniform;; score=0.717 total time= 3.3s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=distance;; score=0.826 total time= 3.3s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=distance;; score=0.756 total time= 3.3s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=distance;; score=0.737 total time= 3.3s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;; score=0.877 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;; score=0.803 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;; score=0.793 total time= 6.6s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=distance;; score=0.888 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=distance;; score=0.808 total time= 6.5s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=distance;; score=0.801 total time= 6.5s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;; score=0.836 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;; score=0.792 total time= 6.5s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;; score=0.767 total time= 6.6s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;; score=0.881 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;; score=0.822 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;; score=0.790 total time= 6.5s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=uniform;; score=0.854 total time= 6.5s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=uniform;; score=0.783 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=uniform;; score=0.749 total time= 6.7s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=distance;; score=0.872 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,

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weights=distance;; score=0.793 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=distance;; score=0.765 total time= 6.7s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
weights=uniform;; score=0.822 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
weights=uniform;; score=0.769 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
weights=uniform;; score=0.725 total time= 6.7s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
weights=distance;; score=0.876 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
weights=distance;; score=0.800 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
weights=distance;; score=0.776 total time= 6.6s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=uniform;; score=0.828 total time= 6.5s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=uniform;; score=0.765 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=uniform;; score=0.730 total time= 6.6s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=distance;; score=0.850 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=distance;; score=0.782 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=distance;; score=0.763 total time= 6.6s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=uniform;; score=0.808 total time= 6.5s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=uniform;; score=0.735 total time= 6.5s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=uniform;; score=0.724 total time= 6.6s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=distance;; score=0.837 total time= 6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=distance;; score=0.767 total time= 6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=distance;; score=0.759 total time= 6.6s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
weights=uniform;; score=0.873 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
weights=uniform;; score=0.803 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
weights=uniform;; score=0.793 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
weights=distance;; score=0.883 total time= 2.5s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,

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weights=distance;; score=0.805 total time= 2.5s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
weights=distance;; score=0.801 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
weights=uniform;; score=0.837 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
weights=uniform;; score=0.792 total time= 2.5s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
weights=uniform;; score=0.769 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
weights=distance;; score=0.881 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
weights=distance;; score=0.822 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
weights=distance;; score=0.795 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
weights=uniform;; score=0.850 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
weights=uniform;; score=0.783 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
weights=uniform;; score=0.753 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
weights=distance;; score=0.872 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
weights=distance;; score=0.793 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
weights=distance;; score=0.767 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=uniform;; score=0.822 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=uniform;; score=0.771 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=uniform;; score=0.725 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;; score=0.874 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;; score=0.797 total time= 2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;; score=0.774 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=uniform;; score=0.830 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=uniform;; score=0.763 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=uniform;; score=0.730 total time= 2.5s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=distance;; score=0.852 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,

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weights=distance;; score=0.782 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=distance;; score=0.761 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=uniform;; score=0.810 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=uniform;; score=0.735 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=uniform;; score=0.717 total time= 2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=distance;; score=0.833 total time= 2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=distance;; score=0.765 total time= 2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=distance;; score=0.755 total time= 2.7s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=3, weights=uniform;; score=0.740 total time= 3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=3, weights=uniform;; score=0.754 total time= 3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=3, weights=uniform;; score=0.751 total time= 3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=3, weights=distance;; score=0.773 total time= 3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=3, weights=distance;; score=0.768 total time= 3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=3, weights=distance;; score=0.761 total time= 3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=4, weights=uniform;; score=0.745 total time= 3.2s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=4, weights=uniform;; score=0.734 total time= 3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=4, weights=uniform;; score=0.733 total time= 3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=4, weights=distance;; score=0.769 total time= 3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=4, weights=distance;; score=0.776 total time= 3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=4, weights=distance;; score=0.772 total time= 3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=5, weights=uniform;; score=0.756 total time= 3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=5, weights=uniform;; score=0.740 total time= 3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=5, weights=uniform;; score=0.729 total time= 3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
n_neighbors=5, weights=distance;; score=0.763 total time= 3.2s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,

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n_neighbors=5, weights=distance;; score=0.776 total time= 3.1s
 [CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=5, weights=distance;; score=0.763 total time= 3.2s
 [CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=6, weights=uniform;; score=0.715 total time= 3.2s
 [CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=6, weights=uniform;; score=0.728 total time= 3.2s
 [CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=6, weights=uniform;; score=0.701 total time= 3.2s
 [CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=6, weights=distance;; score=0.777 total time= 3.3s
 [CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=6, weights=distance;; score=0.767 total time= 3.4s
 [CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=6, weights=distance;; score=0.767 total time= 3.2s
 [CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=7, weights=uniform;; score=0.735 total time= 3.1s
 [CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=7, weights=uniform;; score=0.722 total time= 3.2s
 [CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=7, weights=uniform;; score=0.711 total time= 3.1s
 [CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=7, weights=distance;; score=0.760 total time= 3.2s
 [CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=7, weights=distance;; score=0.745 total time= 3.2s
 [CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=7, weights=distance;; score=0.752 total time= 3.1s
 [CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=10, weights=uniform;; score=0.702 total time= 3.3s
 [CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=10, weights=uniform;; score=0.703 total time= 3.2s
 [CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=10, weights=uniform;; score=0.695 total time= 3.2s
 [CV 1/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=10, weights=distance;; score=0.756 total time= 3.1s
 [CV 2/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=10, weights=distance;; score=0.741 total time= 3.2s
 [CV 3/3] END metric=<function chi_square_distance at 0x0000012A37F336D0>,
 n_neighbors=10, weights=distance;; score=0.734 total time= 3.3s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=3, weights=uniform;; score=0.854 total time= 3.2s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=3, weights=uniform;; score=0.783 total time= 3.5s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=3, weights=uniform;; score=0.735 total time= 3.2s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=3, weights=distance;; score=0.863 total time= 3.2s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,

n_neighbors=3, weights=distance;; score=0.798 total time= 3.2s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=3, weights=distance;; score=0.734 total time= 3.3s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=4, weights=uniform;; score=0.830 total time= 3.9s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=4, weights=uniform;; score=0.780 total time= 5.0s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=4, weights=uniform;; score=0.729 total time= 4.1s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=4, weights=distance;; score=0.875 total time= 4.0s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=4, weights=distance;; score=0.798 total time= 4.5s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=4, weights=distance;; score=0.749 total time= 4.1s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=5, weights=uniform;; score=0.846 total time= 4.4s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=5, weights=uniform;; score=0.771 total time= 4.0s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=5, weights=uniform;; score=0.717 total time= 4.2s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=5, weights=distance;; score=0.855 total time= 5.0s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=5, weights=distance;; score=0.777 total time= 4.7s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=5, weights=distance;; score=0.725 total time= 4.1s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=6, weights=uniform;; score=0.817 total time= 3.9s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=6, weights=uniform;; score=0.741 total time= 3.8s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=6, weights=uniform;; score=0.699 total time= 3.6s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=6, weights=distance;; score=0.852 total time= 3.8s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=6, weights=distance;; score=0.775 total time= 3.5s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=6, weights=distance;; score=0.708 total time= 3.3s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=7, weights=uniform;; score=0.802 total time= 3.4s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=7, weights=uniform;; score=0.741 total time= 3.3s
 [CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=7, weights=uniform;; score=0.688 total time= 3.6s
 [CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
 n_neighbors=7, weights=distance;; score=0.819 total time= 3.5s
 [CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,

n_neighbors=7, weights=distance;; score=0.743 total time= 3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
n_neighbors=7, weights=distance;; score=0.700 total time= 3.4s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
n_neighbors=10, weights=uniform;; score=0.772 total time= 3.6s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
n_neighbors=10, weights=uniform;; score=0.717 total time= 3.4s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
n_neighbors=10, weights=uniform;; score=0.667 total time= 3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
n_neighbors=10, weights=distance;; score=0.811 total time= 3.4s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
n_neighbors=10, weights=distance;; score=0.738 total time= 3.2s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A37F33B50>,
n_neighbors=10, weights=distance;; score=0.663 total time= 3.3s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=3, weights=uniform;; score=0.756 total time= 2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=3, weights=uniform;; score=0.706 total time= 2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=3, weights=uniform;; score=0.648 total time= 2.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=3, weights=distance;; score=0.075 total time= 2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=3, weights=distance;; score=0.075 total time= 2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=3, weights=distance;; score=0.075 total time= 2.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=4, weights=uniform;; score=0.750 total time= 2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=4, weights=uniform;; score=0.719 total time= 2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=4, weights=uniform;; score=0.642 total time= 2.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=4, weights=distance;; score=0.075 total time= 2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=4, weights=distance;; score=0.075 total time= 2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=4, weights=distance;; score=0.075 total time= 2.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=5, weights=uniform;; score=0.728 total time= 2.9s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=5, weights=uniform;; score=0.681 total time= 2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=5, weights=uniform;; score=0.628 total time= 2.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=5, weights=distance;; score=0.075 total time= 2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,

```

n_neighbors=5, weights=distance;; score=0.075 total time= 2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=5, weights=distance;; score=0.075 total time= 2.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=6, weights=uniform;; score=0.719 total time= 2.7s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=6, weights=uniform;; score=0.652 total time= 2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=6, weights=uniform;; score=0.615 total time= 2.8s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=6, weights=distance;; score=0.075 total time= 2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=6, weights=distance;; score=0.075 total time= 2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=6, weights=distance;; score=0.075 total time= 2.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=7, weights=uniform;; score=0.705 total time= 2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=7, weights=uniform;; score=0.660 total time= 2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=7, weights=uniform;; score=0.609 total time= 2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=7, weights=distance;; score=0.075 total time= 2.7s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=7, weights=distance;; score=0.075 total time= 2.8s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=7, weights=distance;; score=0.075 total time= 2.8s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=10, weights=uniform;; score=0.690 total time= 2.7s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=10, weights=uniform;; score=0.621 total time= 2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=10, weights=uniform;; score=0.569 total time= 2.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=10, weights=distance;; score=0.075 total time= 2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=10, weights=distance;; score=0.075 total time= 2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A37F339A0>,
n_neighbors=10, weights=distance;; score=0.075 total time= 2.7s

GridSearchCV(cv=3, estimator=KNeighborsClassifier(),
             param_grid={'metric': [<function cityblock at 0x0000012A22EB4EE0>,
                                     <function euclidean at 0x0000012A22EB4A60>,
                                     <function cosine at 0x0000012A22EB4C10>,
                                     <function sqeuclidean at
0x0000012A22EB4AF0>,
                                     <function chi_square_distance at

```

```

0x0000012A37F336D0>,
                                <function bhattacharyya_distance at
0x0000012A37F33B50>,
                                <function intersection_distance at
0x0000012A37F339A0>],
                                'n_neighbors': [3, 4, 5, 6, 7, 10],
                                'weights': ['uniform', 'distance']},
                                scoring='f1_macro', verbose=3)

```

```

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')

```

```

Best Params: {'metric': <function cityblock at 0x0000012A22EB4EE0>,
'n_neighbors': 4, 'weights': 'distance'}

```

Thuật toán sử dụng: auto

```

['e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\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': [0.1, 0.2, 0.3, 0.4],
    'kernel': ['rbf', 'linear', 'poly', 'sigmoid'],
    'gamma': ['scale', 'auto', 0.1, 0.01, 0.001],
    'degree': [2, 3, 4],
}

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 240 candidates, totalling 720 fits

[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;; score=0.559 total time=0.8s

[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;; score=0.564 total time=0.6s

[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;; score=0.544 total time=0.6s

[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=linear;; score=0.875 total time= 0.3s

[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=linear;; score=0.861 total time= 0.4s

[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=linear;; score=0.803 total time= 0.4s

[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=poly;; score=0.741 total time=0.3s

[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=poly;; score=0.745 total time=0.3s

[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=poly;; score=0.697 total time=0.3s

[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;; score=0.484 total time= 0.4s

[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;; score=0.496 total time= 0.4s

[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;; score=0.494 total time= 0.4s

[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;; score=0.075 total time=0.9s

[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;; score=0.075 total time=0.8s

[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;; score=0.075 total time=0.7s

[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=linear;; score=0.875 total time= 0.1s

[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=linear;; score=0.861 total time= 0.2s

[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=linear;; score=0.803 total time= 0.3s

[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=poly;; score=0.075 total time=0.5s

[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=poly;; score=0.075 total time=0.6s

[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=poly;; score=0.075 total time=0.5s

[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;; score=0.402 total time= 0.8s

[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;; score=0.441 total time= 0.8s

[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;; score=0.378 total time= 0.8s

[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;; score=0.875 total time= 0.1s

[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;; score=0.861 total time= 0.1s

[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;; score=0.803 total time= 0.1s

[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;; score=0.907 total time= 0.3s

[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;; score=0.872 total time= 0.3s

[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;; score=0.848 total time= 0.4s

[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;; score=0.384 total time= 0.7s

[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;; score=0.369 total time= 0.5s

[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;; score=0.400 total time= 0.5s

[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;; score=0.515 total time= 0.7s

[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;; score=0.513 total time= 0.6s

[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;; score=0.522 total time= 0.7s

[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;; score=0.875 total time= 0.2s

[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;; score=0.861 total time= 0.3s

[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;; score=0.803 total time= 0.2s

[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;; score=0.445 total time= 0.6s

[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;; score=0.463 total time= 0.6s

[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;; score=0.453 total time= 0.7s

[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;; score=0.451 total time= 0.7s

[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;; score=0.486 total time= 0.7s
 [CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;; score=0.460 total time= 0.5s
 [CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;; score=0.075 total time= 0.8s
 [CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;; score=0.075 total time= 0.8s
 [CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;; score=0.093 total time= 0.8s
 [CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;; score=0.875 total time= 0.1s
 [CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;; score=0.861 total time= 0.1s
 [CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;; score=0.803 total time= 0.1s
 [CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.7s
 [CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.7s
 [CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.7s
 [CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.6s
 [CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.6s
 [CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.6s
 [CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;; score=0.559 total time= 0.6s
 [CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;; score=0.564 total time= 0.5s
 [CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;; score=0.544 total time= 0.6s
 [CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=linear;; score=0.875 total time= 0.1s
 [CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=linear;; score=0.861 total time= 0.1s
 [CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=linear;; score=0.803 total time= 0.1s
 [CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=poly;; score=0.823 total time= 0.2s
 [CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=poly;; score=0.780 total time= 0.2s
 [CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=poly;; score=0.751 total time= 0.3s
 [CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;; score=0.484 total time= 0.5s

[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;; score=0.496 total time= 0.5s
 [CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;; score=0.494 total time= 0.4s
 [CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;; score=0.075 total time= 0.8s
 [CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;; score=0.075 total time= 0.8s
 [CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;; score=0.075 total time= 1.0s
 [CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=linear;; score=0.875 total time= 0.2s
 [CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=linear;; score=0.861 total time= 0.1s
 [CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=linear;; score=0.803 total time= 0.2s
 [CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.6s
 [CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.6s
 [CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.6s
 [CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.8s
 [CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.7s
 [CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.6s
 [CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;; score=0.402 total time= 0.9s
 [CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;; score=0.441 total time= 0.9s
 [CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;; score=0.378 total time= 0.8s
 [CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;; score=0.875 total time= 0.2s
 [CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;; score=0.861 total time= 0.2s
 [CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;; score=0.803 total time= 0.1s
 [CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;; score=0.915 total time= 0.3s
 [CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;; score=0.881 total time= 0.3s
 [CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;; score=0.857 total time= 0.3s
 [CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;; score=0.384 total time= 0.6s

[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;; score=0.369 total time= 0.6s

[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;; score=0.400 total time= 0.6s

[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;; score=0.515 total time= 0.6s

[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;; score=0.513 total time= 0.6s

[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;; score=0.522 total time= 0.6s

[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;; score=0.875 total time= 0.3s

[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;; score=0.861 total time= 0.2s

[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;; score=0.803 total time= 0.3s

[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;; score=0.299 total time= 0.5s

[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;; score=0.084 total time= 0.6s

[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;; score=0.186 total time= 0.6s

[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;; score=0.451 total time= 0.5s

[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;; score=0.486 total time= 0.6s

[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;; score=0.460 total time= 0.5s

[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;; score=0.075 total time= 0.8s

[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;; score=0.075 total time= 0.8s

[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;; score=0.093 total time= 0.8s

[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;; score=0.875 total time= 0.1s

[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;; score=0.861 total time= 0.2s

[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;; score=0.803 total time= 0.2s

[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.8s

[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;; score=0.559 total time= 0.8s

[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;; score=0.564 total time= 0.9s

[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;; score=0.544 total time= 0.8s

[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;; score=0.875 total time= 0.3s

[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;; score=0.861 total time= 0.4s

[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;; score=0.803 total time= 0.4s

[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;; score=0.872 total time= 0.5s

[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;; score=0.840 total time= 0.4s

[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;; score=0.805 total time= 0.5s

[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;; score=0.484 total time= 0.5s

[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;; score=0.496 total time= 0.6s

[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;; score=0.494 total time= 0.6s

[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;; score=0.075 total time= 1.0s

[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;; score=0.075 total time= 1.0s

[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;; score=0.075 total time= 0.9s

[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;; score=0.875 total time= 0.2s

[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;; score=0.861 total time= 0.1s

[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;; score=0.803 total time= 0.2s

[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;; score=0.402 total time= 0.8s

[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;; score=0.441 total time= 0.9s

[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;; score=0.378 total time= 1.1s

[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;; score=0.875 total time= 0.3s

[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;; score=0.861 total time= 0.1s

[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;; score=0.803 total time= 0.2s

[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;; score=0.908 total time= 0.4s

[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;; score=0.883 total time= 0.4s

[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;; score=0.854 total time= 0.5s

[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;; score=0.384 total time= 0.7s

[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;; score=0.369 total time= 0.6s

[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;; score=0.400 total time= 0.6s

[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;; score=0.515 total time= 0.6s

[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;; score=0.513 total time= 0.7s

[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;; score=0.522 total time= 0.6s

[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;; score=0.875 total time= 0.1s

[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;; score=0.861 total time= 0.2s

[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;; score=0.803 total time= 0.2s

[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;; score=0.075 total time= 0.6s

[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;; score=0.075 total time= 0.6s

[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;; score=0.451 total time= 0.4s

[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;; score=0.486 total time= 0.3s

[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;; score=0.460 total time= 0.3s

[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;; score=0.075 total time= 0.7s

[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;; score=0.075 total time= 0.7s

[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;; score=0.093 total time= 0.7s

[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;; score=0.875 total time= 0.1s

[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;; score=0.861 total time= 0.2s

[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;; score=0.803 total time= 0.1s

[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.6s

[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.6s

[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;; score=0.632 total time= 0.5s

[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;; score=0.643 total time= 0.5s

[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;; score=0.653 total time= 0.5s

[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=poly;; score=0.827 total time= 0.2s

[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=poly;; score=0.794 total time= 0.2s

[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=poly;; score=0.769 total time= 0.2s

[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;; score=0.511 total time= 0.3s

[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;; score=0.536 total time= 0.4s

[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;; score=0.538 total time= 0.4s

[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;; score=0.256 total time= 0.8s

[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;; score=0.134 total time= 0.8s

[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;; score=0.186 total time= 0.7s

[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;; score=0.444 total time= 0.7s

[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;; score=0.464 total time= 0.8s

[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;; score=0.413 total time= 0.7s

[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;; score=0.863 total time= 0.2s

[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;; score=0.902 total time= 0.3s

[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;; score=0.880 total time= 0.2s

[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;; score=0.840 total time= 0.2s

[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;; score=0.420 total time= 0.4s

[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;; score=0.451 total time= 0.5s

[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;; score=0.462 total time= 0.5s

[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;; score=0.564 total time= 0.6s

[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;; score=0.571 total time= 0.7s

[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;; score=0.551 total time= 0.5s

[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;; score=0.469 total time= 0.5s

[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;; score=0.509 total time= 0.5s

[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;; score=0.510 total time= 0.5s

[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;; score=0.506 total time= 0.4s

[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;; score=0.516 total time= 0.4s

[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;; score=0.528 total time= 0.3s

[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;; score=0.441 total time= 0.7s

[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;; score=0.455 total time= 0.8s

[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;; score=0.452 total time= 0.7s

[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;; score=0.157 total time= 0.6s

[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.5s
 [CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;; score=0.164 total time= 0.6s
 [CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;; score=0.632 total time= 0.5s
 [CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;; score=0.643 total time= 0.5s
 [CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;; score=0.653 total time= 0.6s
 [CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=linear;; score=0.863 total time= 0.1s
 [CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=linear;; score=0.853 total time= 0.2s
 [CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=linear;; score=0.825 total time= 0.1s
 [CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=poly;; score=0.875 total time= 0.3s
 [CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=poly;; score=0.864 total time= 0.3s
 [CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=poly;; score=0.818 total time= 0.2s
 [CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;; score=0.511 total time= 0.3s
 [CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;; score=0.536 total time= 0.3s
 [CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;; score=0.538 total time= 0.3s
 [CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;; score=0.256 total time= 0.7s
 [CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;; score=0.134 total time= 0.7s
 [CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;; score=0.186 total time= 0.7s
 [CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=linear;; score=0.863 total time= 0.2s
 [CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=linear;; score=0.853 total time= 0.1s
 [CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=linear;; score=0.825 total time= 0.1s
 [CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.6s

[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;; score=0.444 total time= 0.8s

[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;; score=0.464 total time= 0.7s

[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;; score=0.413 total time= 0.7s

[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;; score=0.863 total time= 0.2s

[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;; score=0.915 total time= 0.3s

[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;; score=0.881 total time= 0.3s

[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;; score=0.857 total time= 0.3s

[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;; score=0.420 total time= 0.5s

[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;; score=0.451 total time= 0.5s

[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;; score=0.462 total time= 0.5s

[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;; score=0.564 total time= 0.5s

[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;; score=0.571 total time= 0.5s

[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;; score=0.551 total time= 0.5s

[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;; score=0.438 total time= 0.4s

[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;; score=0.460 total time= 0.5s

[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;; score=0.439 total time= 0.5s

[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;; score=0.506 total time= 0.5s

[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;; score=0.516 total time= 0.4s
 [CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;; score=0.528 total time= 0.4s
 [CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;; score=0.441 total time= 0.7s
 [CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;; score=0.455 total time= 0.7s
 [CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;; score=0.452 total time= 0.7s
 [CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;; score=0.863 total time= 0.1s
 [CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;; score=0.853 total time= 0.1s
 [CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;; score=0.825 total time= 0.1s
 [CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s
 [CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s
 [CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.6s
 [CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;; score=0.157 total time= 0.6s
 [CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.6s
 [CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;; score=0.164 total time= 0.5s
 [CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;; score=0.632 total time= 0.5s
 [CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;; score=0.643 total time= 0.5s
 [CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;; score=0.653 total time= 0.5s
 [CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=linear;; score=0.863 total time= 0.1s
 [CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=linear;; score=0.853 total time= 0.1s
 [CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=linear;; score=0.825 total time= 0.1s
 [CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=poly;; score=0.908 total time= 0.3s
 [CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=poly;; score=0.881 total time= 0.2s
 [CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=poly;; score=0.841 total time= 0.3s
 [CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;; score=0.511 total time= 0.3s

[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;; score=0.536 total time= 0.5s

[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;; score=0.538 total time= 0.4s

[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;; score=0.256 total time= 0.7s

[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;; score=0.134 total time= 0.7s

[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;; score=0.186 total time= 0.8s

[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.6s

[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.6s

[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;; score=0.444 total time= 0.8s

[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;; score=0.464 total time= 0.7s

[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;; score=0.413 total time= 0.7s

[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;; score=0.825 total time= 0.1s

[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;; score=0.908 total time= 0.3s

[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;; score=0.883 total time= 0.3s

[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;; score=0.854 total time= 0.4s

[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;; score=0.420 total time= 0.6s

[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;; score=0.451 total time= 0.6s

[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;; score=0.462 total time= 0.5s

[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;; score=0.564 total time= 0.5s

[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;; score=0.571 total time= 0.5s

[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;; score=0.551 total time= 0.5s

[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;; score=0.863 total time= 0.2s

[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;; score=0.853 total time= 0.2s

[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;; score=0.825 total time= 0.2s

[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;; score=0.075 total time= 0.6s

[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;; score=0.506 total time= 0.3s

[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;; score=0.516 total time= 0.3s

[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;; score=0.528 total time= 0.4s

[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;; score=0.441 total time= 0.7s

[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;; score=0.455 total time= 0.8s

[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;; score=0.452 total time= 0.7s

[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;; score=0.863 total time= 0.1s

[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;; score=0.853 total time= 0.1s

[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;; score=0.825 total time= 0.2s

[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.6s

[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;; score=0.157 total time= 0.5s

[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;; score=0.075 total time= 0.5s
 [CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;; score=0.164 total time= 0.6s
 [CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;; score=0.753 total time= 0.5s
 [CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;; score=0.739 total time= 0.5s
 [CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;; score=0.700 total time= 0.9s
 [CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=linear;; score=0.867 total time= 0.2s
 [CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=linear;; score=0.851 total time= 0.3s
 [CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=poly;; score=0.854 total time= 0.3s
 [CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=poly;; score=0.834 total time= 0.3s
 [CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=poly;; score=0.789 total time= 0.3s
 [CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;; score=0.565 total time= 0.3s
 [CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;; score=0.604 total time= 0.3s
 [CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;; score=0.619 total time= 0.2s
 [CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;; score=0.413 total time= 0.7s
 [CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;; score=0.428 total time= 0.7s
 [CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;; score=0.404 total time= 0.8s
 [CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=linear;; score=0.867 total time= 0.2s
 [CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=linear;; score=0.851 total time= 0.2s
 [CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=linear;; score=0.829 total time= 0.2s
 [CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s
 [CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.4s

[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;; score=0.483 total time= 0.6s

[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;; score=0.527 total time= 0.7s

[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;; score=0.487 total time= 0.7s

[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;; score=0.867 total time= 0.2s

[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;; score=0.902 total time= 0.2s

[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;; score=0.880 total time= 0.2s

[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;; score=0.840 total time= 0.1s

[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;; score=0.424 total time= 0.4s

[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;; score=0.455 total time= 0.4s

[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;; score=0.469 total time= 0.4s

[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;; score=0.618 total time= 0.4s

[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;; score=0.629 total time= 0.5s

[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;; score=0.637 total time= 0.5s

[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;; score=0.867 total time= 0.2s

[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;; score=0.851 total time= 0.2s

[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;; score=0.551 total time= 0.3s

[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;; score=0.547 total time= 0.3s

[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;; score=0.536 total time= 0.4s

[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;; score=0.536 total time= 0.3s

[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;; score=0.545 total time= 0.4s

[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;; score=0.540 total time= 0.3s

[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;; score=0.445 total time= 0.6s

[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;; score=0.466 total time= 0.7s

[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;; score=0.456 total time= 0.7s

[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.6s

[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;; score=0.405 total time= 0.6s

[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;; score=0.422 total time= 0.5s

[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;; score=0.392 total time= 0.5s

[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;; score=0.753 total time= 0.5s

[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;; score=0.739 total time= 0.5s

[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;; score=0.700 total time= 0.5s

[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=poly;; score=0.899 total time= 0.3s

[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=poly;; score=0.883 total time= 0.3s

[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=poly;; score=0.841 total time= 0.3s

[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;; score=0.565 total time= 0.3s

[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;; score=0.604 total time= 0.3s
 [CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;; score=0.619 total time= 0.3s
 [CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;; score=0.413 total time= 0.7s
 [CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;; score=0.428 total time= 0.7s
 [CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;; score=0.404 total time= 0.9s
 [CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=linear;; score=0.867 total time= 0.2s
 [CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=linear;; score=0.851 total time= 0.1s
 [CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s
 [CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s
 [CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s
 [CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s
 [CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;; score=0.483 total time= 0.7s
 [CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;; score=0.527 total time= 0.7s
 [CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;; score=0.487 total time= 0.7s
 [CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;; score=0.867 total time= 0.2s
 [CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;; score=0.851 total time= 0.1s
 [CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;; score=0.915 total time= 0.3s
 [CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;; score=0.881 total time= 0.3s
 [CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;; score=0.857 total time= 0.3s
 [CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;; score=0.424 total time= 0.5s

[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;; score=0.455 total time= 0.5s

[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;; score=0.469 total time= 0.4s

[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;; score=0.618 total time= 0.5s

[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;; score=0.629 total time= 0.5s

[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;; score=0.637 total time= 0.5s

[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;; score=0.454 total time= 0.4s

[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;; score=0.469 total time= 0.4s

[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;; score=0.448 total time= 0.4s

[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;; score=0.536 total time= 0.3s

[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;; score=0.545 total time= 0.3s

[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;; score=0.540 total time= 0.4s

[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;; score=0.445 total time= 0.7s

[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;; score=0.466 total time= 0.7s

[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;; score=0.456 total time= 0.7s

[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;; score=0.867 total time= 0.2s

[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s

[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;; score=0.405 total time= 0.4s

[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;; score=0.422 total time= 0.4s

[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;; score=0.392 total time= 0.5s

[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;; score=0.753 total time= 0.5s

[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;; score=0.739 total time= 0.4s

[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;; score=0.700 total time= 0.4s

[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=poly;; score=0.911 total time= 0.3s

[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=poly;; score=0.883 total time= 0.3s

[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=poly;; score=0.856 total time= 0.3s

[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;; score=0.565 total time= 0.5s

[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;; score=0.604 total time= 0.2s

[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;; score=0.619 total time= 0.2s

[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;; score=0.413 total time= 0.9s

[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;; score=0.428 total time= 0.8s

[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;; score=0.404 total time= 0.8s

[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;; score=0.075 total time= 0.5s

[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;; score=0.483 total time= 0.6s

[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;; score=0.527 total time= 0.6s

[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;; score=0.487 total time= 0.6s

[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;; score=0.829 total time= 0.2s

[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;; score=0.908 total time= 0.4s

[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;; score=0.883 total time= 0.3s

[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;; score=0.854 total time= 0.4s

[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;; score=0.424 total time= 0.4s

[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;; score=0.455 total time= 0.4s

[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;; score=0.469 total time= 0.4s

[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;; score=0.618 total time= 0.4s

[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;; score=0.629 total time= 0.4s

[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;; score=0.637 total time= 0.4s

[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;; score=0.851 total time= 0.1s

[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;; score=0.365 total time= 0.5s

[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;; score=0.302 total time= 0.4s

[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;; score=0.307 total time= 0.4s

[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;; score=0.536 total time= 0.2s

[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;; score=0.545 total time= 0.2s
 [CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;; score=0.540 total time= 0.2s
 [CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;; score=0.445 total time= 0.6s
 [CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;; score=0.466 total time= 0.6s
 [CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;; score=0.456 total time= 0.6s
 [CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;; score=0.867 total time= 0.1s
 [CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;; score=0.851 total time= 0.1s
 [CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s
 [CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.3s
 [CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s
 [CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;; score=0.405 total time= 0.4s
 [CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;; score=0.422 total time= 0.4s
 [CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;; score=0.392 total time= 0.4s
 [CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;; score=0.801 total time= 0.5s
 [CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;; score=0.768 total time= 0.4s
 [CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;; score=0.726 total time= 0.4s
 [CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=linear;; score=0.867 total time= 0.1s
 [CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=linear;; score=0.849 total time= 0.1s
 [CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=poly;; score=0.875 total time= 0.2s
 [CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=poly;; score=0.848 total time= 0.2s
 [CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=poly;; score=0.808 total time= 0.1s
 [CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;; score=0.634 total time= 0.2s

[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;; score=0.682 total time= 0.2s

[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;; score=0.636 total time= 0.2s

[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;; score=0.442 total time= 0.6s

[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;; score=0.464 total time= 0.6s

[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;; score=0.454 total time= 0.6s

[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;; score=0.278 total time= 0.5s

[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;; score=0.178 total time= 0.4s

[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;; score=0.186 total time= 0.5s

[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;; score=0.611 total time= 0.6s

[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;; score=0.607 total time= 0.6s

[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;; score=0.616 total time= 0.6s

[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;; score=0.902 total time= 0.2s

[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;; score=0.880 total time= 0.1s

[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;; score=0.840 total time= 0.1s

[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;; score=0.422 total time= 0.3s

[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;; score=0.466 total time= 0.4s

[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;; score=0.467 total time= 0.3s

[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;; score=0.696 total time= 0.4s

[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;; score=0.716 total time= 0.4s

[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;; score=0.692 total time= 0.4s

[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;; score=0.564 total time= 0.2s

[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;; score=0.561 total time= 0.2s

[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;; score=0.551 total time= 0.2s

[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;; score=0.585 total time= 0.2s

[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;; score=0.583 total time= 0.2s

[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;; score=0.591 total time= 0.2s

[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;; score=0.451 total time= 0.6s

[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;; score=0.469 total time= 0.5s

[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;; score=0.461 total time= 0.5s

[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;; score=0.442 total time= 0.4s

[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;; score=0.460 total time= 0.4s

[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;; score=0.454 total time= 0.4s

[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;; score=0.801 total time= 0.4s

[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;; score=0.768 total time= 0.4s

[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;; score=0.726 total time= 0.4s

[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=poly;; score=0.913 total time= 0.2s

[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=poly;; score=0.880 total time= 0.2s

[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=poly;; score=0.847 total time= 0.2s

[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;; score=0.634 total time= 0.2s

[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;; score=0.682 total time= 0.2s

[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;; score=0.636 total time= 0.2s

[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;; score=0.442 total time= 0.7s

[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;; score=0.464 total time= 0.7s

[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;; score=0.454 total time= 0.6s

[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s

[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;; score=0.278 total time= 0.4s

[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;; score=0.178 total time= 0.4s

[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;; score=0.186 total time= 0.4s

[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;; score=0.611 total time= 0.6s

[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;; score=0.607 total time= 0.5s

[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;; score=0.616 total time= 0.6s

[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;; score=0.915 total time= 0.2s

[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;; score=0.881 total time= 0.2s

[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;; score=0.857 total time= 0.2s

[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;; score=0.422 total time= 0.4s

[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;; score=0.466 total time= 0.3s

[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;; score=0.467 total time= 0.3s

[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;; score=0.696 total time= 0.4s

[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;; score=0.716 total time= 0.4s

[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;; score=0.692 total time= 0.4s

[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;; score=0.456 total time= 0.3s

[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;; score=0.480 total time= 0.3s

[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;; score=0.468 total time= 0.4s

[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;; score=0.585 total time= 0.3s

[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;; score=0.583 total time= 0.3s
 [CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;; score=0.591 total time= 0.2s
 [CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;; score=0.451 total time= 0.6s
 [CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;; score=0.469 total time= 0.6s
 [CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;; score=0.461 total time= 0.6s
 [CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;; score=0.867 total time= 0.2s
 [CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;; score=0.849 total time= 0.1s
 [CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s
 [CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s
 [CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;; score=0.075 total time= 0.5s
 [CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;; score=0.442 total time= 0.4s
 [CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;; score=0.460 total time= 0.4s
 [CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;; score=0.454 total time= 0.4s
 [CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;; score=0.801 total time= 0.5s
 [CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;; score=0.768 total time= 0.5s
 [CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;; score=0.726 total time= 0.4s
 [CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=linear;; score=0.867 total time= 0.1s
 [CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=linear;; score=0.849 total time= 0.1s
 [CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=linear;; score=0.829 total time= 0.2s
 [CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=poly;; score=0.908 total time= 0.3s
 [CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=poly;; score=0.883 total time= 0.2s
 [CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=poly;; score=0.854 total time= 0.2s
 [CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;; score=0.634 total time= 0.2s

[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;; score=0.682 total time= 0.2s
 [CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;; score=0.636 total time= 0.2s
 [CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;; score=0.442 total time= 0.6s
 [CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;; score=0.464 total time= 0.7s
 [CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;; score=0.454 total time= 0.6s
 [CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=linear;; score=0.867 total time= 0.1s
 [CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=linear;; score=0.849 total time= 0.1s
 [CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s
 [CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s
 [CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=poly;; score=0.075 total time= 0.4s
 [CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;; score=0.278 total time= 0.5s
 [CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;; score=0.178 total time= 0.5s
 [CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;; score=0.186 total time= 0.5s
 [CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;; score=0.611 total time= 0.8s
 [CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;; score=0.607 total time= 0.6s
 [CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;; score=0.616 total time= 0.6s
 [CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;; score=0.867 total time= 0.1s
 [CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;; score=0.849 total time= 0.1s
 [CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;; score=0.829 total time= 0.1s
 [CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;; score=0.908 total time= 0.2s
 [CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;; score=0.883 total time= 0.2s
 [CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;; score=0.854 total time= 0.3s
 [CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;; score=0.422 total time= 0.5s

[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;; score=0.466 total time= 0.5s

[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;; score=0.467 total time= 0.3s

[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;; score=0.696 total time= 0.4s

[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;; score=0.716 total time= 0.4s

[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;; score=0.692 total time= 0.4s

[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;; score=0.424 total time= 0.4s

[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;; score=0.436 total time= 0.4s

[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;; score=0.408 total time= 0.4s

[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;; score=0.585 total time= 0.2s

[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;; score=0.583 total time= 0.2s

[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;; score=0.591 total time= 0.2s

[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;; score=0.451 total time= 0.6s

[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;; score=0.469 total time= 0.5s

[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;; score=0.461 total time= 0.5s

[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;; score=0.867 total time= 0.1s

[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;; score=0.849 total time= 0.1s

[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;; score=0.829 total time= 0.1s

[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;; score=0.075 total time= 0.4s

[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;; score=0.442 total time= 0.4s

```
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;; score=0.460 total
time= 0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;; score=0.454 total
time= 0.4s
```

```
GridSearchCV(cv=3, estimator=SVC(),
             param_grid={'C': [0.1, 0.2, 0.3, 0.4], 'degree': [2, 3, 4],
                          'gamma': ['scale', 'auto', 0.1, 0.01, 0.001],
                          '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': 0.1, 'degree': 3, '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

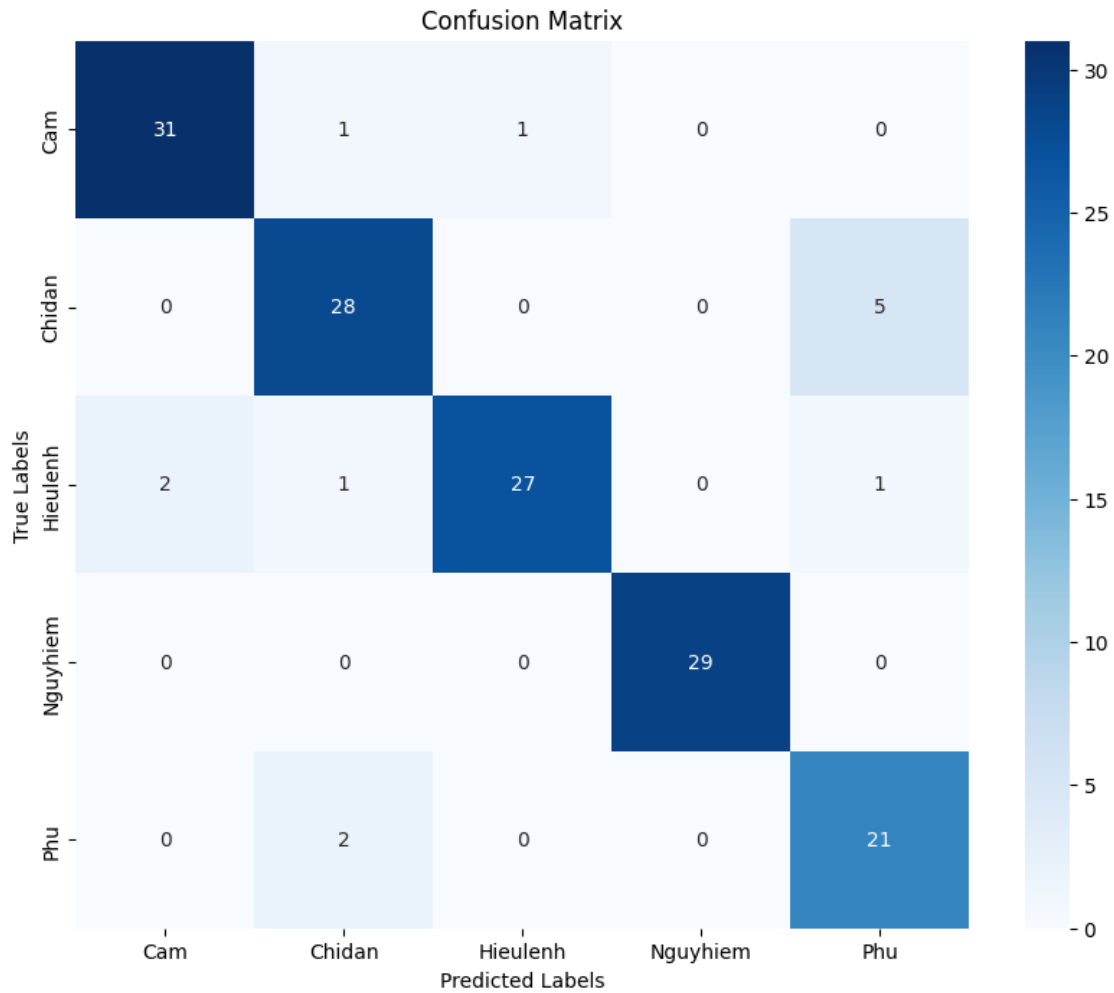
```
report_knn = classification_report(test_labels_encoded, y_pred_knn,
    ↪target_names=label_encoder.classes_)
print(report_knn)
```

	precision	recall	f1-score	support
Cam	0.94	0.94	0.94	33
Chidan	0.88	0.85	0.86	33
Hieulenh	0.96	0.87	0.92	31
Nguyhiem	1.00	1.00	1.00	29
Phu	0.78	0.91	0.84	23
accuracy			0.91	149
macro avg	0.91	0.91	0.91	149
weighted avg	0.92	0.91	0.91	149

```
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')

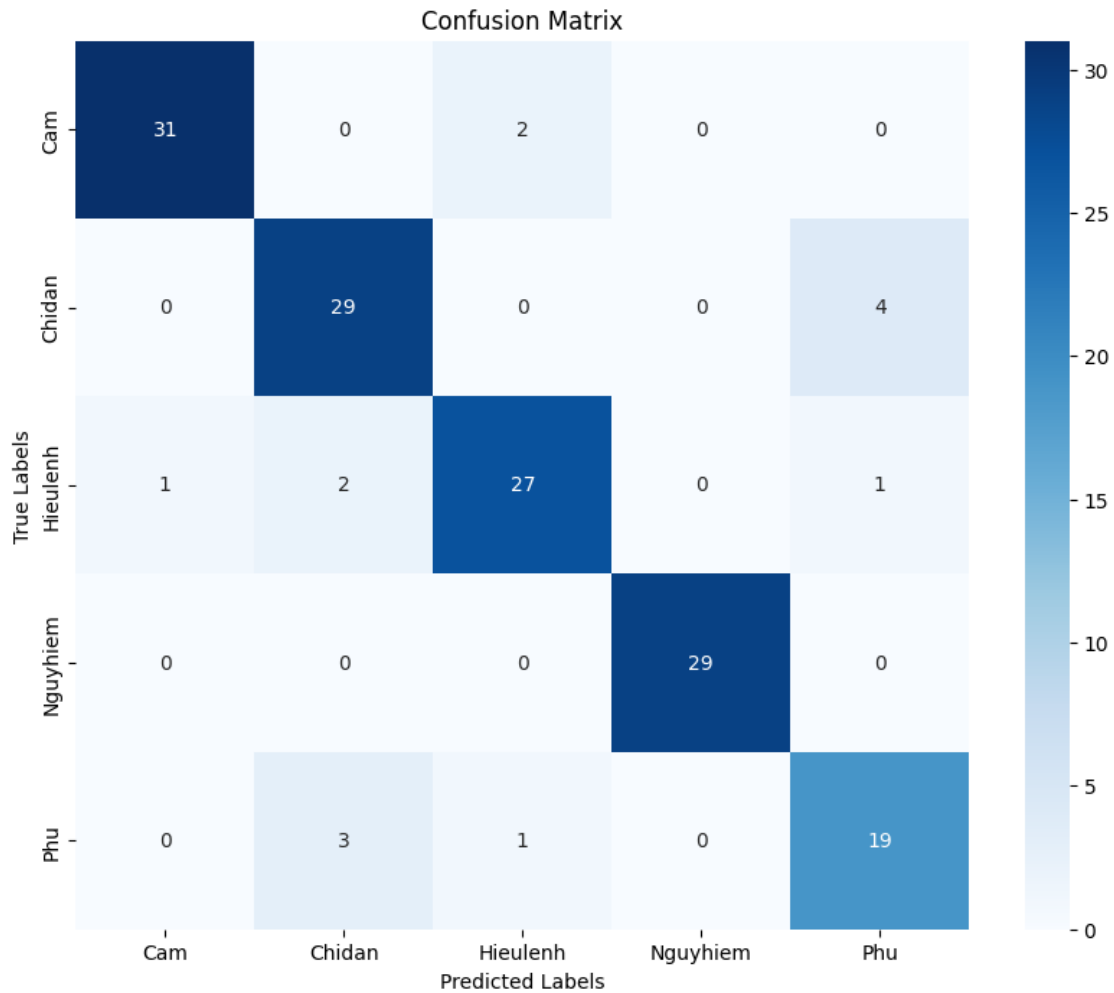
plt.tight_layout()
plt.show()
```


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	0.97	0.94	0.95	33
Chidan	0.85	0.88	0.87	33
Hieulenh	0.90	0.87	0.89	31
Nguyhiem	1.00	1.00	1.00	29
Phu	0.79	0.83	0.81	23
accuracy			0.91	149
macro avg	0.90	0.90	0.90	149
weighted avg	0.91	0.91	0.91	149

```
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_2024-12-23_20_23_33.pdf

```
'e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-  
Images\grid_search_results\notebook_export_2024-12-23_20_23_33.pdf'
```

```
param_grid_KNN = { 'n_neighbors': [3, 4, 5, 6, 7, 10], 'weights': ['uniform', 'distance'],  
'metric': [cityblock, cosine, sqeuclidean, chi_square_distance, bhattacharyya_distance, intersec-  
tion_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': 'scale', 'kernel': 'poly'}