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)
```

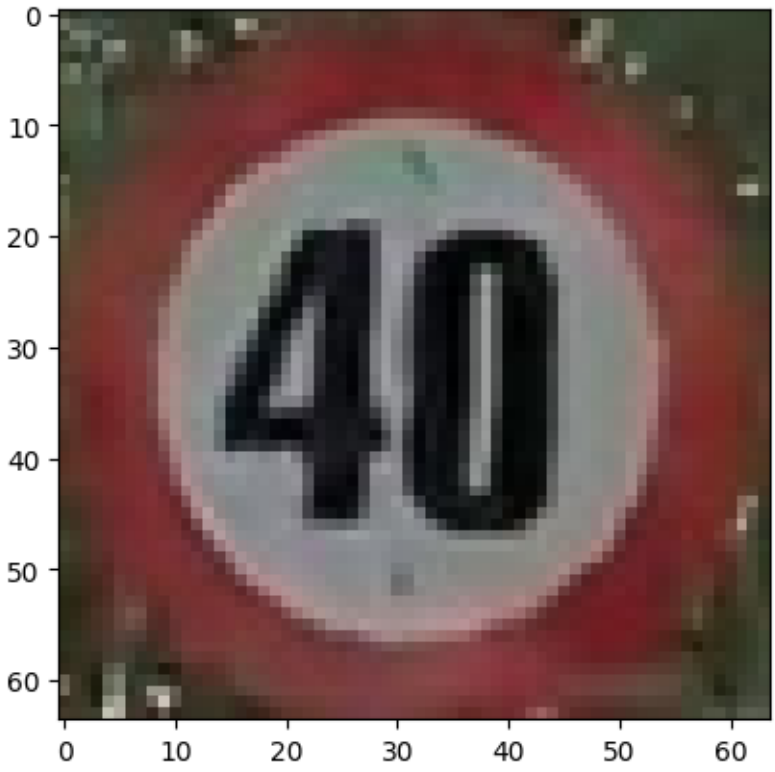
```
label_encoder = LabelEncoder()
train_labels_encoded = label_encoder.fit_transform(train_labels)
test_labels_encoded = label_encoder.transform(test_labels)
```

```
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\\New folder\\Traffic-Sign-Classification-
through-Images\\joblib\\label_encoder.joblib']
```

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

```
<matplotlib.image.AxesImage at 0x1e4308bf940>
```




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

```
<matplotlib.image.AxesImage at 0x1e43088e7d0>
```

3 Extract features

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

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

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

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

```
# plt.imshow(blur_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, 52444.08it/s]
Extracting Color Features: 100%|      | 1416/1416 [00:00<00:00,
27719.29it/s]
Extracting HOG Features: 100%|      | 1416/1416 [00:02<00:00, 701.05it/s]
Combining Features: 1416it [00:00, 78683.83it/s]

['e:\\Documents\\CS231\\project\\New folder\\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, 49690.01it/s]
Extracting Color Features: 100%|      | 149/149 [00:00<00:00, 37248.26it/s]
Extracting HOG Features: 100%|      | 149/149 [00:00<00:00, 721.19it/s]
Combining Features: 149it [00:00, 149617.26it/s]

['e:\\Documents\\CS231\\project\\New folder\\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 0x000001E423EB9750>, n_neighbors=3,
weights=uniform;, score=0.877 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=3,
weights=uniform;, score=0.856 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=3,
weights=uniform;, score=0.837 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=3,
weights=distance;, score=0.887 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=3,
weights=distance;, score=0.868 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=3,
weights=distance;, score=0.850 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=4,
weights=uniform;, score=0.867 total time=   2.5s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=4,
weights=uniform;, score=0.842 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=4,
weights=uniform;, score=0.833 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=4,
weights=distance;, score=0.899 total time=   2.2s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=4,
weights=distance;, score=0.875 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=4,
weights=distance;, score=0.851 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=5,
weights=uniform;, score=0.860 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=5,
weights=uniform;, score=0.846 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=5,
weights=uniform;, score=0.832 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=5,
weights=distance;, score=0.888 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=5,
```

```
weights=distance;, score=0.859 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=5,
weights=distance;, score=0.842 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=6,
weights=uniform;, score=0.850 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=6,
weights=uniform;, score=0.823 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=6,
weights=uniform;, score=0.807 total time=   2.2s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=6,
weights=distance;, score=0.881 total time=   2.2s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=6,
weights=distance;, score=0.854 total time=   2.3s
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weights=distance;, score=0.843 total time=   2.3s
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weights=uniform;, score=0.849 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=7,
weights=uniform;, score=0.824 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=7,
weights=uniform;, score=0.798 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=7,
weights=distance;, score=0.881 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=7,
weights=distance;, score=0.835 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=7,
weights=distance;, score=0.819 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=10,
weights=uniform;, score=0.813 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=10,
weights=uniform;, score=0.808 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=10,
weights=uniform;, score=0.757 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=10,
weights=distance;, score=0.856 total time=   2.3s
[CV 2/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=10,
weights=distance;, score=0.837 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x000001E423EB9750>, n_neighbors=10,
weights=distance;, score=0.808 total time=   2.3s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=3,
weights=uniform;, score=0.858 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=3,
weights=uniform;, score=0.827 total time=   3.3s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=3,
weights=uniform;, score=0.795 total time=   3.3s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=3,
weights=distance;, score=0.864 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=3,
```

```
weights=distance;, score=0.828 total time=   3.2s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=3,
weights=distance;, score=0.803 total time=   3.2s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=4,
weights=uniform;, score=0.842 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=4,
weights=uniform;, score=0.805 total time=   3.2s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=4,
weights=uniform;, score=0.765 total time=   3.2s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=4,
weights=distance;, score=0.878 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=4,
weights=distance;, score=0.832 total time=   3.2s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=4,
weights=distance;, score=0.789 total time=   3.2s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=5,
weights=uniform;, score=0.847 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=5,
weights=uniform;, score=0.797 total time=   3.3s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=5,
weights=uniform;, score=0.762 total time=   3.2s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=5,
weights=distance;, score=0.861 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=5,
weights=distance;, score=0.807 total time=   3.2s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=5,
weights=distance;, score=0.777 total time=   3.2s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=6,
weights=uniform;, score=0.825 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=6,
weights=uniform;, score=0.789 total time=   3.2s
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weights=uniform;, score=0.741 total time=   3.2s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=6,
weights=distance;, score=0.866 total time=   3.2s
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weights=distance;, score=0.817 total time=   3.2s
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weights=distance;, score=0.769 total time=   3.2s
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weights=uniform;, score=0.824 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=7,
weights=uniform;, score=0.788 total time=   3.2s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=7,
weights=uniform;, score=0.740 total time=   3.2s
[CV 1/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=7,
weights=distance;, score=0.846 total time=   3.5s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=7,
```

```
weights=distance;, score=0.796 total time=   3.6s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=7,
weights=distance;, score=0.754 total time=   3.2s
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weights=uniform;, score=0.789 total time=   3.2s
[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=10,
weights=uniform;, score=0.754 total time=   3.2s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=10,
weights=uniform;, score=0.740 total time=   3.3s
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[CV 2/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=10,
weights=distance;, score=0.775 total time=   3.2s
[CV 3/3] END metric=<function euclidean at 0x000001E423EB92D0>, n_neighbors=10,
weights=distance;, score=0.752 total time=   3.2s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=3,
weights=uniform;, score=0.862 total time=   6.4s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=3,
weights=uniform;, score=0.827 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=3,
weights=uniform;, score=0.797 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=3,
weights=distance;, score=0.873 total time=   6.3s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=3,
weights=distance;, score=0.831 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=3,
weights=distance;, score=0.812 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=4,
weights=uniform;, score=0.842 total time=   6.3s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=4,
weights=uniform;, score=0.803 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=4,
weights=uniform;, score=0.767 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=4,
weights=distance;, score=0.878 total time=   6.4s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=4,
weights=distance;, score=0.834 total time=   6.4s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=4,
weights=distance;, score=0.797 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=5,
weights=uniform;, score=0.852 total time=   6.3s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=5,
weights=uniform;, score=0.795 total time=   6.4s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=5,
weights=uniform;, score=0.760 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=5,
weights=distance;, score=0.872 total time=   6.4s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=5,
```

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weights=distance;, score=0.808 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=5,
weights=distance;, score=0.784 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=6,
weights=uniform;, score=0.825 total time=   6.4s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=6,
weights=uniform;, score=0.789 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=6,
weights=uniform;, score=0.739 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=6,
weights=distance;, score=0.868 total time=   6.3s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=6,
weights=distance;, score=0.818 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=6,
weights=distance;, score=0.773 total time=   6.3s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=7,
weights=uniform;, score=0.826 total time=   6.3s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=7,
weights=uniform;, score=0.784 total time=   6.4s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=7,
weights=uniform;, score=0.745 total time=   6.4s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=7,
weights=distance;, score=0.855 total time=   6.3s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=7,
weights=distance;, score=0.795 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=7,
weights=distance;, score=0.777 total time=   6.4s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=10,
weights=uniform;, score=0.793 total time=   6.3s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=10,
weights=uniform;, score=0.761 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=10,
weights=uniform;, score=0.739 total time=   6.2s
[CV 1/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=10,
weights=distance;, score=0.821 total time=   6.2s
[CV 2/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=10,
weights=distance;, score=0.791 total time=   6.3s
[CV 3/3] END metric=<function cosine at 0x000001E423EB9480>, n_neighbors=10,
weights=distance;, score=0.760 total time=   6.4s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=3,
weights=uniform;, score=0.858 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=3,
weights=uniform;, score=0.827 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=3,
weights=uniform;, score=0.795 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=3,
weights=distance;, score=0.868 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=3,
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weights=distance;, score=0.828 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=3,
weights=distance;, score=0.812 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=4,
weights=uniform;, score=0.842 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=4,
weights=uniform;, score=0.805 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=4,
weights=uniform;, score=0.765 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=4,
weights=distance;, score=0.880 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=4,
weights=distance;, score=0.834 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=4,
weights=distance;, score=0.794 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=5,
weights=uniform;, score=0.847 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=5,
weights=uniform;, score=0.797 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=5,
weights=uniform;, score=0.762 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=5,
weights=distance;, score=0.867 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=5,
weights=distance;, score=0.810 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=5,
weights=distance;, score=0.786 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=6,
weights=uniform;, score=0.825 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=6,
weights=uniform;, score=0.789 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=6,
weights=uniform;, score=0.741 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=6,
weights=distance;, score=0.870 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=6,
weights=distance;, score=0.820 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=6,
weights=distance;, score=0.773 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=7,
weights=uniform;, score=0.824 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=7,
weights=uniform;, score=0.788 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=7,
weights=uniform;, score=0.740 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=7,
weights=distance;, score=0.852 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=7,
```

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weights=distance;, score=0.801 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>, n_neighbors=7,
weights=distance;, score=0.772 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>,
n_neighbors=10, weights=uniform;, score=0.789 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>,
n_neighbors=10, weights=uniform;, score=0.754 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>,
n_neighbors=10, weights=uniform;, score=0.740 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000001E423EB9360>,
n_neighbors=10, weights=distance;, score=0.817 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000001E423EB9360>,
n_neighbors=10, weights=distance;, score=0.784 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000001E423EB9360>,
n_neighbors=10, weights=distance;, score=0.758 total time=   2.3s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=3, weights=uniform;, score=0.714 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=3, weights=uniform;, score=0.704 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=3, weights=uniform;, score=0.705 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=3, weights=distance;, score=0.742 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=3, weights=distance;, score=0.722 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=3, weights=distance;, score=0.730 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=4, weights=uniform;, score=0.696 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=4, weights=uniform;, score=0.700 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=4, weights=uniform;, score=0.711 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=4, weights=distance;, score=0.752 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=4, weights=distance;, score=0.733 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=4, weights=distance;, score=0.743 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=5, weights=uniform;, score=0.701 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=5, weights=uniform;, score=0.708 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=5, weights=uniform;, score=0.711 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=5, weights=distance;, score=0.726 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
```

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n_neighbors=5, weights=distance;, score=0.752 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=5, weights=distance;, score=0.739 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=6, weights=uniform;, score=0.701 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=6, weights=uniform;, score=0.707 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=6, weights=uniform;, score=0.712 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=6, weights=distance;, score=0.741 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=6, weights=distance;, score=0.754 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=6, weights=distance;, score=0.750 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=7, weights=uniform;, score=0.719 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=7, weights=uniform;, score=0.701 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=7, weights=uniform;, score=0.693 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=7, weights=distance;, score=0.730 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=7, weights=distance;, score=0.748 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=7, weights=distance;, score=0.750 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=10, weights=uniform;, score=0.690 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=10, weights=uniform;, score=0.678 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=10, weights=uniform;, score=0.674 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=10, weights=distance;, score=0.734 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=10, weights=distance;, score=0.729 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x000001E4298E7AC0>,
n_neighbors=10, weights=distance;, score=0.735 total time=   3.0s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=3, weights=uniform;, score=0.847 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=3, weights=uniform;, score=0.797 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=3, weights=uniform;, score=0.751 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=3, weights=distance;, score=0.866 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
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n_neighbors=3, weights=distance;, score=0.806 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=3, weights=distance;, score=0.753 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=4, weights=uniform;, score=0.823 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=4, weights=uniform;, score=0.785 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=4, weights=uniform;, score=0.737 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=4, weights=distance;, score=0.853 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=4, weights=distance;, score=0.809 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=4, weights=distance;, score=0.739 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=5, weights=uniform;, score=0.836 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=5, weights=uniform;, score=0.785 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=5, weights=uniform;, score=0.732 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=5, weights=distance;, score=0.844 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=5, weights=distance;, score=0.787 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=5, weights=distance;, score=0.740 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=6, weights=uniform;, score=0.806 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=6, weights=uniform;, score=0.761 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=6, weights=uniform;, score=0.715 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=6, weights=distance;, score=0.861 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=6, weights=distance;, score=0.797 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=6, weights=distance;, score=0.722 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=7, weights=uniform;, score=0.802 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=7, weights=uniform;, score=0.762 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=7, weights=uniform;, score=0.708 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=7, weights=distance;, score=0.820 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
```

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n_neighbors=7, weights=distance;, score=0.751 total time=   3.1s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=7, weights=distance;, score=0.718 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=10, weights=uniform;, score=0.767 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=10, weights=uniform;, score=0.738 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=10, weights=uniform;, score=0.687 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=10, weights=distance;, score=0.795 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=10, weights=distance;, score=0.739 total time=   3.2s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x000001E4298E7D90>,
n_neighbors=10, weights=distance;, score=0.692 total time=   3.2s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=3, weights=uniform;, score=0.765 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=3, weights=uniform;, score=0.737 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=3, weights=uniform;, score=0.662 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=3, weights=distance;, score=0.075 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=3, weights=distance;, score=0.075 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=3, weights=distance;, score=0.075 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=4, weights=uniform;, score=0.769 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=4, weights=uniform;, score=0.740 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=4, weights=uniform;, score=0.666 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=5, weights=uniform;, score=0.746 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=5, weights=uniform;, score=0.735 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=5, weights=uniform;, score=0.658 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=5, weights=distance;, score=0.075 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
```

```
n_neighbors=5, weights=distance;, score=0.075 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=5, weights=distance;, score=0.075 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=6, weights=uniform;, score=0.745 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=6, weights=uniform;, score=0.705 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=6, weights=uniform;, score=0.631 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=7, weights=uniform;, score=0.732 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=7, weights=uniform;, score=0.692 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=7, weights=uniform;, score=0.628 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.9s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=10, weights=uniform;, score=0.699 total time=   2.6s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=10, weights=uniform;, score=0.644 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=10, weights=uniform;, score=0.603 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x000001E4298E7B50>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.4s

GridSearchCV(cv=3, estimator=KNeighborsClassifier(),
             param_grid={'metric': [<function cityblock at 0x000001E423EB9750>,
                                    <function euclidean at 0x000001E423EB92D0>,
                                    <function cosine at 0x000001E423EB9480>,
                                    <function sqeuclidean at
0x000001E423EB9360>,
                                    <function chi_square_distance at
```

```
0x000001E4298E7AC0>,
                                    <function bhattacharyya_distance at
0x000001E4298E7D90>,
                                    <function intersection_distance at
0x000001E4298E7B50>],
                          'n_neighbors': [3, 4, 5, 6, 7, 10],
                          'weights': ['uniform', 'distance']},
             scoring='f1_macro', verbose=3)
```

```python
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 0x000001E423EB9750>,
'n_neighbors': 4, 'weights': 'distance'}
Thuật toán sử dụng: auto
```

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

7 Gridsearch SVM

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

```python
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=0.553 total time=
0.5s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.552 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.541 total time=
0.5s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.709 total time=
0.2s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.747 total time=
0.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.687 total time=
0.2s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.2s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.490 total
time=   0.2s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.439 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.377 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.863 total time=
0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.858 total time=
0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.906 total time=
0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.875 total time=
0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.844 total time=
0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.407 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.404 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.417 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.515 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.510 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.443 total time=
0.3s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.461 total time=
0.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.450 total time=
0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.2s
```

```
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.205 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.088 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.179 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.553 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.552 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.541 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.810 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.785 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.755 total time=
0.2s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.2s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.2s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.490 total
time=   0.2s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.6s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.6s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.439 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.377 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.863 total time=
0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.858 total time=
0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.887 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.859 total time=
0.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.407 total
time=   0.3s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.404 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.417 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.515 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.510 total time=
0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.309 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.084 total time=
0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.186 total time=
0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.205 total time=
0.6s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.088 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.179 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.553 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.552 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.541 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.860 total time=
0.2s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.842 total time=
0.2s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.796 total time=
0.2s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.2s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.490 total
time=   0.2s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.439 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.377 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.863 total time=
0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.858 total time=
0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.407 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.404 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.417 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.515 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.510 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.2s
```

```
[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=0.467 total
time=   0.2s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.205 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.088 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.179 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.863 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.619 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.622 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.644 total time=
0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.822 total time=
0.1s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.818 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.778 total time=
0.1s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.514 total
time=   0.2s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.532 total
time=   0.2s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.286 total time=
0.7s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.239 total time=
0.6s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.195 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[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=   0.3s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.434 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.395 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.847 total time=
0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.859 total time=
0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.816 total time=
0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.909 total time=
0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.882 total time=
0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.845 total time=
0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.419 total
time=   0.3s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.464 total
time=   0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.557 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.559 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.549 total time=
0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.469 total time=
0.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.503 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.510 total time=
0.2s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.516 total
time=   0.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.519 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.522 total
time=   0.2s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.443 total time=
0.6s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.453 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.252 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.198 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.3s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.619 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.622 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.644 total time=
0.4s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.874 total time=
0.1s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.870 total time=
0.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.826 total time=
0.1s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.514 total
time=   0.2s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.532 total
time=   0.2s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.286 total time=
0.6s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.239 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.195 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.434 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.395 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.847 total time=
0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.859 total time=
0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.816 total time=
0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.887 total time=
0.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.859 total time=
0.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.419 total
time=   0.3s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.464 total
time=   0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.557 total time=
0.3s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.559 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.549 total time=
0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.434 total time=
0.3s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.460 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.433 total time=
0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.516 total
time=   0.2s
```

```
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.519 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.522 total
time=   0.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.443 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.6s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.453 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.816 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=
0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.252 total
time=   0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.198 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.619 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.622 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.644 total time=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.903 total time=
0.2s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.886 total time=
0.2s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.849 total time=
0.2s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.514 total
time=   0.2s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.532 total
time=   0.2s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.286 total time=
0.6s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.239 total time=
0.6s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.195 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.434 total time=
0.6s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.395 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.847 total time=
0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.859 total time=
0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.816 total time=
0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.419 total
time=   0.3s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.464 total
time=   0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.557 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.559 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.549 total time=
0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.516 total
time=   0.2s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.519 total
time=   0.2s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.522 total
time=   0.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.443 total time=
0.6s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.453 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.847 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.859 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.252 total
time=   0.3s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.198 total
time=   0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.717 total time=
0.3s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.748 total time=
0.3s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.715 total time=
0.3s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.857 total time=
0.1s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.845 total time=
0.1s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.809 total time=
0.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.584 total
time=   0.2s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.609 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.612 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.429 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.442 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.437 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[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=   0.3s
```

```
[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=   0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.477 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.499 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.480 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.850 total time=
0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.816 total time=
0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.906 total time=
0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.880 total time=
0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.845 total time=
0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.413 total
time=   0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.454 total
time=   0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.472 total
time=   0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.622 total time=
0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.540 total time=
0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.542 total time=
0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.532 total time=
0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.543 total
time=   0.2s
```

```
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.460 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.420 total
time=   0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.434 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.409 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.717 total time=
0.3s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.748 total time=
0.3s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.715 total time=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.908 total time=
0.1s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.881 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.850 total time=
0.2s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.584 total
time=   0.2s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.609 total
time=   0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.612 total
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.429 total time=
0.5s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.442 total time=
0.5s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.437 total time=
0.5s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.477 total time=
0.5s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.499 total time=
0.5s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.480 total time=
0.5s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.850 total time=
0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.816 total time=
0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.887 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.859 total time=
0.2s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.413 total
time=   0.3s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.454 total
time=   0.3s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.472 total
time=   0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.622 total time=
0.3s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.3s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.452 total time=
0.3s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.468 total time=
0.3s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.448 total time=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.543 total
time=   0.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.5s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.5s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.460 total time=
0.5s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[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=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.420 total
time=   0.3s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.434 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.409 total
time=   0.3s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.717 total time=
0.3s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.748 total time=
0.3s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.715 total time=
0.3s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.889 total time=
0.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.857 total time=
0.2s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.584 total
time=   0.2s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.609 total
time=   0.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.612 total
time=   0.2s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.429 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.442 total time=
0.5s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.437 total time=
0.5s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[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=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.477 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.499 total time=
0.5s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.480 total time=
0.5s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.850 total time=
0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.816 total time=
0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.413 total
time=   0.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.454 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.472 total
time=   0.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.622 total time=
0.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.816 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.363 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.292 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.305 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.543 total
time=   0.2s
```

```
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.537 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.2s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.5s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.460 total time=
0.5s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.816 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=0.420 total
time=   0.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.434 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.409 total
time=   0.3s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.802 total time=
0.3s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.775 total time=
0.3s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.748 total time=
0.3s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.879 total time=
0.1s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.867 total time=
0.1s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.817 total time=
0.1s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.641 total
time=   0.1s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.674 total
time=   0.2s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.630 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.441 total time=
0.5s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.461 total time=
0.5s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.454 total time=
0.5s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.318 total
time=   0.3s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.256 total
time=   0.3s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.211 total
time=   0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.587 total time=
0.5s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.595 total time=
0.5s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.602 total time=
0.5s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.845 total time=
0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.820 total time=
0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.906 total time=
0.1s
[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=0.845 total time=
0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   0.3s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.473 total
time=   0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.690 total time=
0.3s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.726 total time=
0.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.685 total time=
0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.569 total time=
0.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.556 total time=
0.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.547 total time=
0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.585 total
time=   0.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.585 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.449 total time=
0.5s
[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=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[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=0.441 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.461 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.453 total
time=   0.3s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.802 total time=
0.3s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.775 total time=
0.3s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.748 total time=
0.3s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.919 total time=
0.2s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.878 total time=
0.2s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.861 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.641 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.674 total
time=   0.2s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.630 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.441 total time=
0.5s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.461 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.454 total time=
0.5s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[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=
0.3s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.318 total
time=   0.3s
```

```
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.256 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.211 total
time=   0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.587 total time=
0.5s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.595 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.602 total time=
0.5s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.845 total time=
0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.820 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=0.887 total time=
0.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.859 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.473 total
time=   0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.690 total time=
0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.726 total time=
0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.685 total time=
0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.454 total time=
0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.475 total time=
0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.463 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.2s
```

```
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.585 total
time=   0.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.585 total
time=   0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.449 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.469 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.461 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.820 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=
0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.441 total
time=   0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.461 total
time=   0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.453 total
time=   0.3s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.802 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.775 total time=
0.3s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.748 total time=
0.3s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.859 total time=
0.2s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.641 total
time=   0.1s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.674 total
time=   0.2s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.630 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.441 total time=
0.5s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.461 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.454 total time=
0.5s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.3s
[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=0.318 total
time=   0.4s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.256 total
time=   0.4s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.211 total
time=   0.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.587 total time=
0.5s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.595 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.602 total time=
0.5s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.845 total time=
0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.820 total time=
0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.3s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   0.3s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.473 total
time=   0.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.690 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.726 total time=
0.3s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.685 total time=
0.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.417 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.433 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.401 total time=
0.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.585 total
time=   0.2s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.585 total
time=   0.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.449 total time=
0.5s
[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=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.845 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.820 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.3s
[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=
0.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.441 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.461 total
time=   0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.453 total
time=   0.3s

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': 0.4, 'degree': 4, 'gamma': 'scale', 'kernel': 'poly'}

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

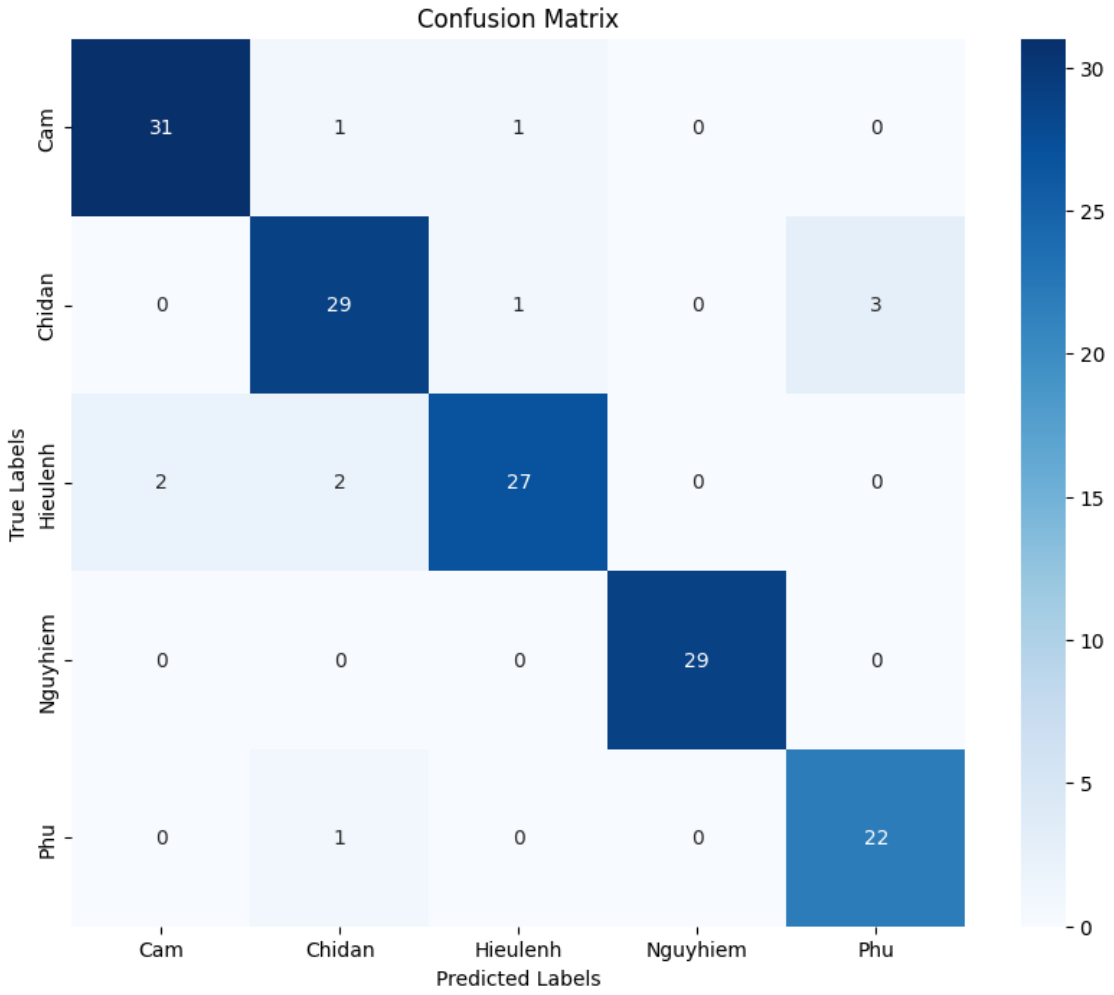
8 Predict on test images for KNN

```
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      0.88      0.88        33
    Hieulenh       0.93      0.87      0.90        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.88      0.96      0.92        23

    accuracy                           0.93       149
   macro avg       0.93      0.93      0.93       149
weighted avg       0.93      0.93      0.93       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
```

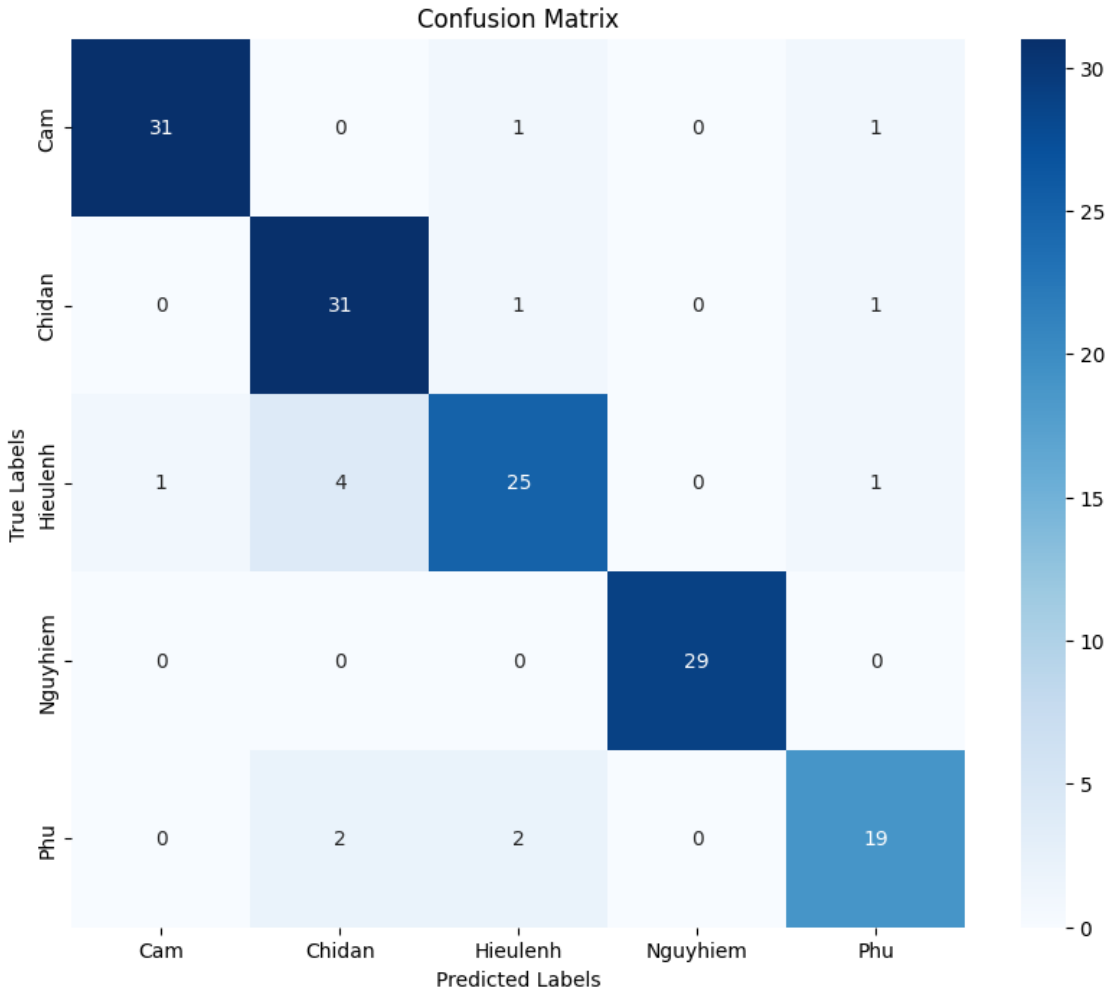
```
    axes[row, col].imshow(image)
    axes[row, col].set_title(f'True: {label_encoder.classes_[true_label]}\nPred:
 ↪ {label_encoder.classes_[pred_label]}')
    axes[row, col].axis('off')

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       0.84      0.94      0.89        33
    Hieulenh       0.86      0.81      0.83        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.86      0.83      0.84        23

    accuracy                           0.91       149
   macro avg       0.91      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_2024-12-16_21_33_57.pdf

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

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

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

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

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