Notebook

December 23, 2024

1 Import libraries

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

2 Load data

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

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

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

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

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

train_images = []
test_images = []

train_labels = []
test_labels = []

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

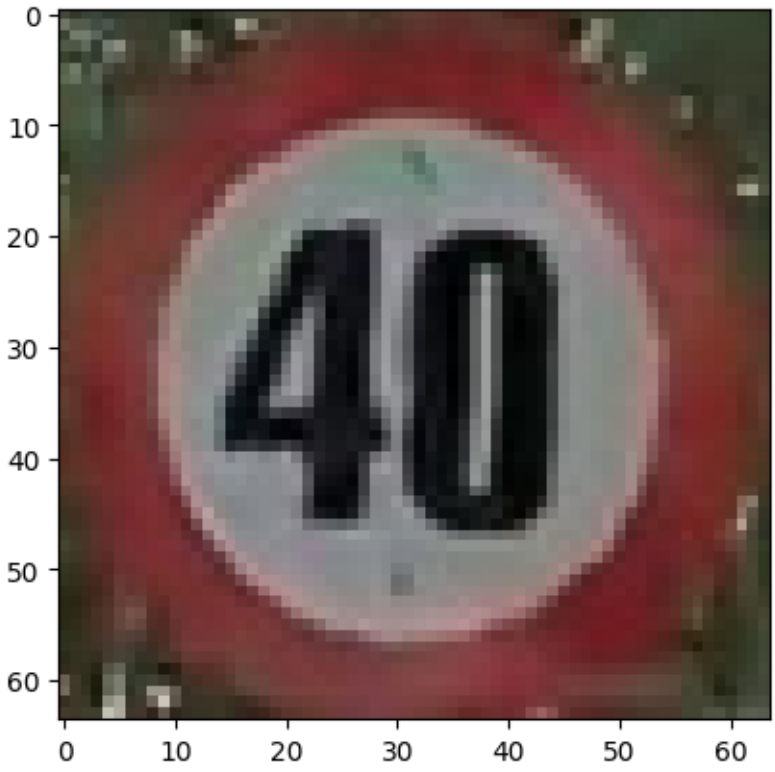
```
label_encoder = LabelEncoder()
train_labels_encoded = label_encoder.fit_transform(train_labels)
test_labels_encoded = label_encoder.transform(test_labels)
```

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

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

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

```
<matplotlib.image.AxesImage at 0x12a2f3dafb0>
```




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

```
<matplotlib.image.AxesImage at 0x12a32dd10c0>
```

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=False, 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, 53297.81it/s]
Extracting Color Features: 100%|      | 1416/1416 [00:00<00:00,
31940.10it/s]
Extracting HOG Features: 100%|      | 1416/1416 [00:02<00:00, 697.76it/s]
Combining Features: 1416it [00:00, 80790.26it/s]

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

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

```
Blur Images: 100%|      | 149/149 [00:00<00:00, 49725.60it/s]
Extracting Color Features: 100%|      | 149/149 [00:00<00:00, 29123.04it/s]
Extracting HOG Features: 100%|      | 149/149 [00:00<00:00, 608.17it/s]
Combining Features: 149it [00:00, 74443.28it/s]

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

4 Distance metrics KNN

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

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

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

5 Load Best Model

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

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

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

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

6 Gridsearch KNN

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

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

```
    ]
}

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

grid_search_knn.fit(train_features, train_labels_encoded)
```

```
Fitting 3 folds for each of 84 candidates, totalling 252 fits
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;, score=0.873 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;, score=0.844 total time=   2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;, score=0.841 total time=   2.9s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;, score=0.881 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;, score=0.849 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;, score=0.847 total time=   2.4s
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weights=uniform;, score=0.858 total time=   2.4s
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weights=uniform;, score=0.829 total time=   2.5s
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weights=uniform;, score=0.823 total time=   2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;, score=0.893 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;, score=0.860 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;, score=0.851 total time=   2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;, score=0.854 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;, score=0.832 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;, score=0.817 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=distance;, score=0.875 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
```

```
weights=distance;, score=0.848 total time=   2.3s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=distance;, score=0.830 total time=   2.3s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;, score=0.837 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;, score=0.824 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;, score=0.804 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;, score=0.883 total time=   2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;, score=0.841 total time=   2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;, score=0.835 total time=   2.7s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=uniform;, score=0.831 total time=   2.6s
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weights=uniform;, score=0.821 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=uniform;, score=0.799 total time=   2.6s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=distance;, score=0.857 total time=   2.7s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=distance;, score=0.830 total time=   2.8s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=7,
weights=distance;, score=0.826 total time=   2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=uniform;, score=0.805 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=uniform;, score=0.791 total time=   2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=uniform;, score=0.751 total time=   2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;, score=0.845 total time=   2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;, score=0.818 total time=   2.6s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;, score=0.793 total time=   2.5s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;, score=0.858 total time=   3.5s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;, score=0.804 total time=   3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;, score=0.775 total time=   3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=distance;, score=0.860 total time=   3.5s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
```

```
weights=distance;, score=0.810 total time=   3.5s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=distance;, score=0.783 total time=   3.4s
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weights=uniform;, score=0.850 total time=   3.5s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=uniform;, score=0.792 total time=   3.6s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=uniform;, score=0.761 total time=   3.6s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;, score=0.884 total time=   3.6s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;, score=0.810 total time=   3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;, score=0.769 total time=   3.5s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=uniform;, score=0.845 total time=   3.5s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=uniform;, score=0.802 total time=   3.5s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=uniform;, score=0.757 total time=   3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=distance;, score=0.859 total time=   3.4s
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weights=distance;, score=0.807 total time=   3.3s
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weights=distance;, score=0.761 total time=   3.4s
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weights=uniform;, score=0.816 total time=   3.4s
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weights=uniform;, score=0.769 total time=   3.4s
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weights=distance;, score=0.858 total time=   3.4s
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[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=6,
weights=distance;, score=0.752 total time=   3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=uniform;, score=0.817 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=uniform;, score=0.785 total time=   3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=uniform;, score=0.731 total time=   3.5s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=distance;, score=0.837 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
```

```
weights=distance;, score=0.794 total time=   3.4s
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weights=distance;, score=0.746 total time=   3.4s
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weights=uniform;, score=0.769 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=uniform;, score=0.757 total time=   3.4s
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weights=uniform;, score=0.720 total time=   3.5s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=distance;, score=0.804 total time=   3.4s
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[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;, score=0.860 total time=   6.7s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;, score=0.804 total time=   7.0s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;, score=0.779 total time=   6.6s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
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[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=distance;, score=0.810 total time=   6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=distance;, score=0.799 total time=   6.8s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;, score=0.850 total time=   6.7s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;, score=0.790 total time=   6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;, score=0.761 total time=   6.7s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;, score=0.884 total time=   6.8s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;, score=0.810 total time=   6.8s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;, score=0.774 total time=   6.8s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=uniform;, score=0.845 total time=   6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=uniform;, score=0.800 total time=   6.7s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=uniform;, score=0.753 total time=   6.7s
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[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
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weights=distance;, score=0.807 total time=   6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
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[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
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weights=distance;, score=0.862 total time=   6.7s
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weights=distance;, score=0.805 total time=   6.7s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
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[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
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weights=distance;, score=0.814 total time=   6.6s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=distance;, score=0.777 total time=   6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=distance;, score=0.755 total time=   6.6s
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weights=distance;, score=0.812 total time=   2.4s
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weights=distance;, score=0.790 total time=   2.4s
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[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
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[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
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[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=5,
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weights=uniform;, score=0.816 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
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weights=uniform;, score=0.730 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;, score=0.862 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;, score=0.805 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;, score=0.759 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=uniform;, score=0.817 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
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weights=uniform;, score=0.731 total time=   2.5s
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[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
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weights=distance;, score=0.802 total time=   2.4s
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[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=uniform;, score=0.769 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=uniform;, score=0.757 total time=   2.4s
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n_neighbors=10, weights=uniform;, score=0.720 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=distance;, score=0.814 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=distance;, score=0.777 total time=   2.4s
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n_neighbors=3, weights=uniform;, score=0.736 total time=   3.2s
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[CV 1/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=3, weights=distance;, score=0.752 total time=   3.1s
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n_neighbors=3, weights=distance;, score=0.749 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=3, weights=distance;, score=0.710 total time=   3.2s
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n_neighbors=4, weights=uniform;, score=0.704 total time=   3.2s
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n_neighbors=4, weights=uniform;, score=0.689 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=4, weights=uniform;, score=0.685 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=4, weights=distance;, score=0.759 total time=   3.2s
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n_neighbors=4, weights=distance;, score=0.740 total time=   3.2s
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n_neighbors=4, weights=distance;, score=0.702 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=5, weights=uniform;, score=0.712 total time=   3.2s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=5, weights=uniform;, score=0.700 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=5, weights=uniform;, score=0.688 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=5, weights=distance;, score=0.749 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
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n_neighbors=5, weights=distance;, score=0.734 total time=   3.3s
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n_neighbors=5, weights=distance;, score=0.708 total time=   3.1s
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n_neighbors=6, weights=uniform;, score=0.703 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=6, weights=uniform;, score=0.674 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=6, weights=uniform;, score=0.693 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=6, weights=distance;, score=0.752 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=6, weights=distance;, score=0.737 total time=   3.3s
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n_neighbors=6, weights=distance;, score=0.731 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=7, weights=uniform;, score=0.711 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=7, weights=uniform;, score=0.686 total time=   3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=7, weights=uniform;, score=0.689 total time=   3.2s
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n_neighbors=7, weights=distance;, score=0.729 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=7, weights=distance;, score=0.731 total time=   3.2s
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n_neighbors=10, weights=uniform;, score=0.683 total time=   3.2s
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[CV 1/3] END metric=<function chi_square_distance at 0x0000012A336B36D0>,
n_neighbors=10, weights=distance;, score=0.729 total time=   3.2s
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n_neighbors=10, weights=distance;, score=0.731 total time=   3.1s
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n_neighbors=10, weights=distance;, score=0.721 total time=   3.2s
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n_neighbors=3, weights=uniform;, score=0.852 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=3, weights=uniform;, score=0.797 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=3, weights=uniform;, score=0.736 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=3, weights=distance;, score=0.871 total time=   3.2s
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n_neighbors=3, weights=distance;, score=0.743 total time=   3.2s
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n_neighbors=4, weights=uniform;, score=0.833 total time=   3.2s
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[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=4, weights=distance;, score=0.865 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=4, weights=distance;, score=0.808 total time=   3.2s
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[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=5, weights=uniform;, score=0.723 total time=   3.3s
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n_neighbors=5, weights=distance;, score=0.851 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=5, weights=distance;, score=0.782 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=5, weights=distance;, score=0.722 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=6, weights=uniform;, score=0.808 total time=   3.2s
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n_neighbors=6, weights=uniform;, score=0.710 total time=   3.3s
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[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=6, weights=distance;, score=0.790 total time=   3.6s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=6, weights=distance;, score=0.731 total time=   3.6s
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n_neighbors=7, weights=distance;, score=0.743 total time=   3.4s
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n_neighbors=7, weights=distance;, score=0.701 total time=   3.4s
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n_neighbors=10, weights=uniform;, score=0.756 total time=   3.5s
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[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=10, weights=distance;, score=0.795 total time=   3.7s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A31E2B2E0>,
n_neighbors=10, weights=distance;, score=0.715 total time=   3.5s
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n_neighbors=3, weights=uniform;, score=0.777 total time=   2.8s
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[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
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n_neighbors=3, weights=distance;, score=0.075 total time=   2.9s
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[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.8s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.9s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=5, weights=uniform;, score=0.754 total time=   2.7s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=5, weights=uniform;, score=0.677 total time=   2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=5, weights=uniform;, score=0.648 total time=   2.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=5, weights=distance;, score=0.075 total time=   2.8s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
```

```
n_neighbors=5, weights=distance;, score=0.075 total time=   2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=5, weights=distance;, score=0.075 total time=   2.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=6, weights=uniform;, score=0.740 total time=   2.9s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=6, weights=uniform;, score=0.666 total time=   2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=6, weights=uniform;, score=0.618 total time=   2.9s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=7, weights=uniform;, score=0.728 total time=   2.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=7, weights=uniform;, score=0.641 total time=   2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=7, weights=uniform;, score=0.623 total time=   2.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.7s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=10, weights=uniform;, score=0.678 total time=   2.7s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=10, weights=uniform;, score=0.600 total time=   2.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=10, weights=uniform;, score=0.576 total time=   2.8s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A31E2AA70>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.6s

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

```
0x0000012A336B36D0>,
                                    <function bhattacharyya_distance at
0x0000012A31E2B2E0>,
                                    <function intersection_distance at
0x0000012A31E2AA70>],
                          'n_neighbors': [3, 4, 5, 6, 7, 10],
                          'weights': ['uniform', 'distance']},
             scoring='f1_macro', verbose=3)
```

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

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

y_pred_knn = best_knn.predict(test_features)

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

```
Best Params: {'metric': <function cityblock at 0x0000012A22EB4EE0>,
'n_neighbors': 4, 'weights': 'distance'}
Thuật toán sử dụng: auto
```

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

7 Gridsearch SVM

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

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

svm_model = SVC()

grid_search_svm = GridSearchCV(
    estimator=svm_model,
    param_grid=param_grid,
    cv=3,
    scoring='f1_macro',
    verbose=3,
)
```

```
grid_search_svm.fit(train_features, train_labels_encoded)
```

```
Fitting 3 folds for each of 240 candidates, totalling 720 fits
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.552 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.555 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.541 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.861 total
time=   0.2s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.842 total
time=   0.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.821 total
time=   0.2s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.710 total time=
0.3s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.721 total time=
0.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.694 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.487 total
time=   0.3s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.498 total
time=   0.3s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.3s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.8s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.5s
```

```
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.389 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.440 total time=
0.9s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.379 total time=
0.9s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.861 total time=
0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.842 total time=
0.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.821 total time=
0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.899 total time=
0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.883 total time=
0.2s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.850 total time=
0.2s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.434 total
time=   0.5s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.432 total
time=   0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.448 total
time=   0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.518 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.516 total time=
0.7s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.447 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.463 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.455 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.5s
```

```
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.479 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.469 total
time=   0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.188 total time=
1.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.080 total time=
1.0s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.183 total time=
0.8s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[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=
0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.6s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.552 total time=
0.6s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.555 total time=
0.7s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.541 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.800 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.778 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.749 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.487 total
time=   0.3s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.498 total
time=   0.3s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.3s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.8s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.8s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.821 total
time=   0.2s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.6s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.8s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.6s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.389 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.440 total time=
0.9s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.379 total time=
0.9s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.861 total time=
0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.842 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.821 total time=
0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.903 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.844 total time=
0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.434 total
time=   0.5s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.432 total
time=   0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.448 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.518 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.516 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.249 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.182 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.479 total
time=   0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.469 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.188 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.080 total time=
0.7s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.183 total time=
0.7s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.5s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.6s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.552 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.555 total time=
0.6s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.541 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.861 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.842 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.821 total
time=   0.2s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.841 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.818 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.776 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.487 total
time=   0.5s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.498 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.5s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.5s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.861 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.842 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.821 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.8s
```

```
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.8s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.7s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.389 total time=
0.9s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.440 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.379 total time=
0.9s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.861 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.842 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.821 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.897 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.888 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.846 total time=
0.8s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.434 total
time=   0.7s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.432 total
time=   0.6s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.448 total
time=   0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.518 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.516 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.479 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.469 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.188 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.080 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.183 total time=
0.9s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.861 total
time=   0.2s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.842 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.821 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.7s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.627 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.615 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.635 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.850 total
time=   0.2s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.839 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.824 total
time=   0.2s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.818 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.797 total time=
0.3s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.754 total time=
0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.523 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.526 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.6s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.299 total time=
1.0s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.237 total time=
1.1s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.200 total time=
1.0s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.850 total
time=   0.3s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.839 total
time=   0.2s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.824 total
time=   0.2s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.6s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.8s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.6s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.424 total time=
0.7s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.457 total time=
0.6s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.392 total time=
0.7s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.850 total time=
0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.839 total time=
0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.901 total time=
0.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.884 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.845 total time=
0.2s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.423 total
time=   0.5s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.455 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.471 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.558 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.545 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.544 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.2s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.469 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.503 total time=
0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.510 total time=
0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.517 total
time=   0.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.524 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.524 total
time=   0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.7s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.462 total time=
0.7s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.455 total time=
0.7s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.267 total
time=   0.5s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.178 total
time=   0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.6s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.627 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.615 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.635 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.864 total time=
0.2s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.850 total time=
0.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.802 total time=
0.2s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.523 total
time=   0.2s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.526 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.299 total time=
0.7s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.237 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.200 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.824 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=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.6s
```

```
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[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=0.424 total time=
0.6s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.457 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.392 total time=
0.6s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.850 total time=
0.2s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.839 total time=
0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.903 total time=
0.2s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.844 total time=
0.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.423 total
time=   0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.455 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.471 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.558 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.545 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.544 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.438 total time=
0.6s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.461 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.437 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.517 total
time=   0.3s
```

```
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.524 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.524 total
time=   0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.7s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.462 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.455 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.824 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=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.6s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.267 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.178 total
time=   0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.6s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.627 total time=
0.6s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.615 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.635 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.888 total time=
0.3s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.877 total time=
0.3s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.827 total time=
0.3s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.523 total
time=   0.3s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.526 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.3s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.299 total time=
0.7s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.237 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.200 total time=
0.7s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[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=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.6s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.6s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.424 total time=
0.8s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.457 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.392 total time=
0.7s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.850 total time=
0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.839 total time=
0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.897 total time=
0.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.888 total time=
0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.846 total time=
0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.423 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.455 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.471 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.558 total time=
0.5s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.545 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.544 total time=
0.6s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.824 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=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.517 total
time=   0.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.524 total
time=   0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.524 total
time=   0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.7s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.462 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.455 total time=
0.6s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.839 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[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=0.267 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.178 total
time=   0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.6s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.724 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.730 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.711 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.854 total time=
0.2s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.823 total time=
0.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.796 total time=
0.2s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.584 total
time=   0.3s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.601 total
time=   0.3s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.598 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.434 total time=
0.7s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.439 total time=
0.7s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.432 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[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=   0.7s
```

```
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.461 total time=
0.6s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.483 total time=
0.6s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.6s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.852 total time=
0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.901 total time=
0.2s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.885 total time=
0.2s
[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=0.417 total
time=   0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.455 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.469 total
time=   0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.622 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.635 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.544 total time=
0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.544 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.535 total time=
0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.532 total
time=   0.3s
```

```
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.448 total time=
0.6s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.6s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.835 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[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=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.418 total
time=   0.5s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.435 total
time=   0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.414 total
time=   0.5s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.724 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.730 total time=
0.5s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.711 total time=
0.6s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.889 total time=
0.2s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.879 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.827 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=0.601 total
time=   0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.598 total
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.434 total time=
0.7s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.439 total time=
0.7s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.432 total time=
0.7s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[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=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.461 total time=
0.8s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.483 total time=
0.6s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.6s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.852 total time=
0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.903 total time=
0.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.844 total time=
0.2s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.417 total
time=   0.3s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.455 total
time=   0.5s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.469 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.622 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.635 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.454 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.467 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.449 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.532 total
time=   0.3s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.448 total time=
0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.6s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.824 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=
0.5s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.418 total
time=   0.4s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.435 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.414 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.724 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.730 total time=
0.5s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.711 total time=
0.5s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.895 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.888 total time=
0.3s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.844 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=0.601 total
time=   0.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.598 total
time=   0.2s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.434 total time=
0.7s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.439 total time=
0.7s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.432 total time=
0.6s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.5s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.461 total time=
0.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.483 total time=
0.7s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.7s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.852 total time=
0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.824 total time=
0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.897 total time=
0.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.888 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.846 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.417 total
time=   0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.455 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.469 total
time=   0.5s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.622 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.635 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.357 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.224 total time=
0.6s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.269 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.532 total
time=   0.2s
```

```
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.448 total time=
0.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.6s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.852 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.824 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=
0.4s
[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=0.418 total
time=   0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.435 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.414 total
time=   0.6s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.786 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.764 total time=
0.5s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.747 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.865 total time=
0.2s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.850 total time=
0.2s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.813 total time=
0.2s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.648 total
time=   0.2s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.668 total
time=   0.2s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.653 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.446 total time=
0.6s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.462 total time=
0.7s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.458 total time=
0.6s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.326 total
time=   0.5s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.258 total
time=   0.5s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.215 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.566 total time=
0.6s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.571 total time=
0.6s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.574 total time=
0.7s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.850 total time=
0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.826 total time=
0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.901 total time=
0.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.885 total time=
0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.845 total time=
0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.428 total
time=   0.3s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.457 total
time=   0.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.468 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.691 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.703 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.687 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.558 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=0.538 total time=
0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.575 total
time=   0.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.577 total
time=   0.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.572 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.448 total time=
0.6s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.469 total time=
0.6s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.464 total time=
0.7s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.826 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.446 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.463 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.457 total
time=   0.4s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.786 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.764 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.747 total time=
0.5s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.902 total time=
0.2s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.838 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.648 total
time=   0.2s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.668 total
time=   0.2s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.653 total
time=   0.2s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.446 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.462 total time=
0.8s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.458 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.326 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.258 total
time=   0.5s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.215 total
time=   0.5s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.566 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.571 total time=
0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.574 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.850 total time=
0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.826 total time=
0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.903 total time=
0.2s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.844 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.428 total
time=   0.5s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.457 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.468 total
time=   0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.691 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.703 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.687 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.455 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.470 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.465 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.575 total
time=   0.3s
```

```
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.577 total
time=   0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.572 total
time=   0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.448 total time=
0.7s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.469 total time=
0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.464 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.7s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.446 total
time=   0.5s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.463 total
time=   0.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.457 total
time=   0.4s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.786 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.764 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.747 total time=
0.5s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.897 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.888 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.848 total time=
0.3s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.648 total
time=   0.2s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.668 total
time=   0.2s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.653 total
time=   0.2s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.446 total time=
0.7s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.462 total time=
0.9s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.458 total time=
0.7s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.850 total
time=   0.2s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.5s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.326 total
time=   0.4s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.258 total
time=   0.5s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.215 total
time=   0.5s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.566 total time=
0.7s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.571 total time=
0.8s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.574 total time=
0.7s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.850 total time=
0.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.826 total time=
0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.897 total time=
0.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.888 total time=
0.2s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.846 total time=
0.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.428 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.457 total
time=   0.3s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.468 total
time=   0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.691 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.703 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.687 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.413 total time=
0.4s
[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=0.398 total time=
0.5s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.575 total
time=   0.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.577 total
time=   0.2s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.572 total
time=   0.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.448 total time=
0.6s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.469 total time=
0.6s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.464 total time=
0.6s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.850 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.826 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.446 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.463 total
time=   0.5s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.457 total
time=   0.4s

GridSearchCV(cv=3, estimator=SVC(),
             param_grid={'C': [0.1, 0.2, 0.3, 0.4], 'degree': [2, 3, 4],
                         'gamma': ['scale', 'auto', 0.1, 0.01, 0.001],
                         'kernel': ['rbf', 'linear', 'poly', 'sigmoid']},
             scoring='f1_macro', verbose=3)
```

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

y_pred_svm = best_svm.predict(test_features)

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

```
Best parameters: {'C': 0.1, 'degree': 3, 'gamma': 0.1, 'kernel': 'poly'}

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

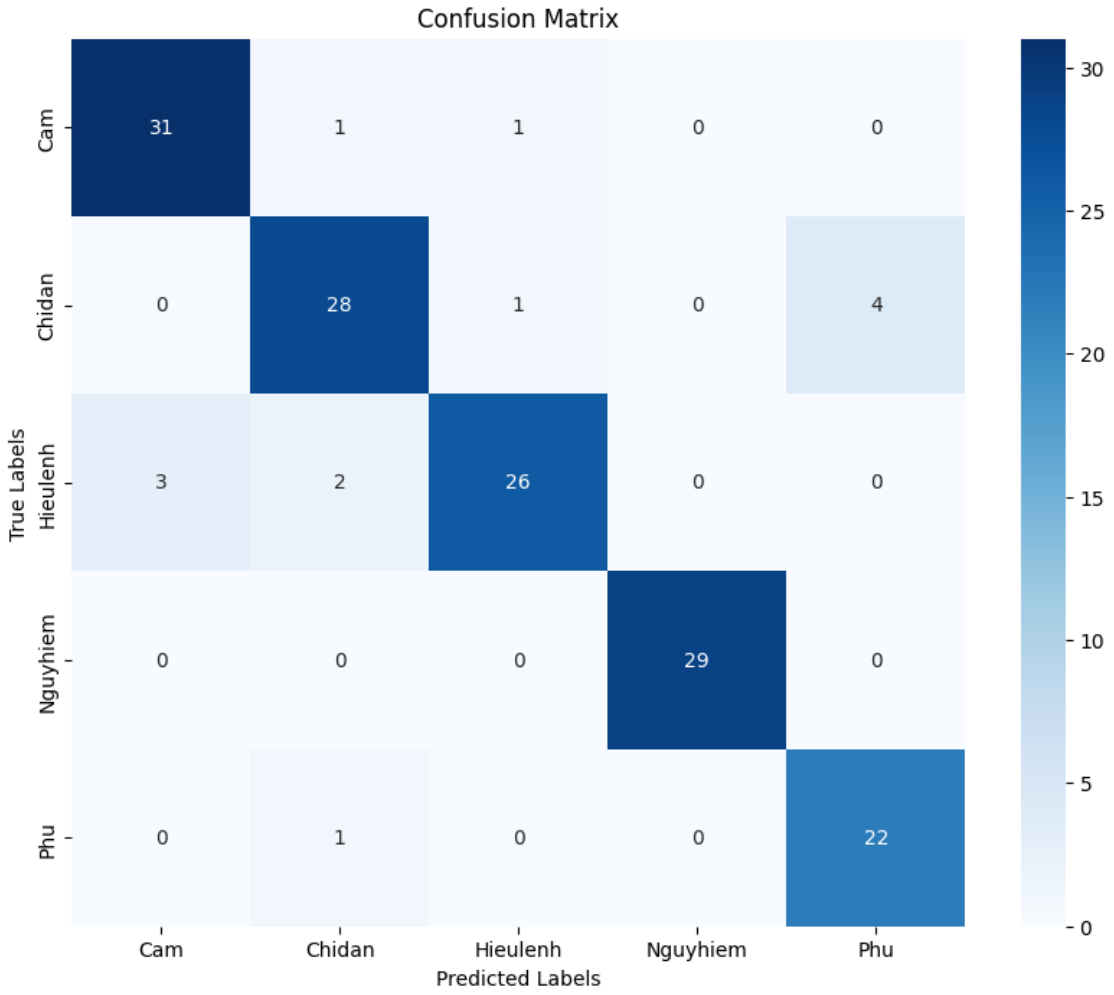
8 Predict on test images for KNN

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

```
              precision    recall  f1-score   support

         Cam       0.91      0.94      0.93        33
      Chidan       0.88      0.85      0.86        33
    Hieulenh       0.93      0.84      0.88        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.85      0.96      0.90        23

    accuracy                           0.91       149
   macro avg       0.91      0.92      0.91       149
weighted avg       0.91      0.91      0.91       149
```

```
heatmap_label_knn = confusion_matrix(test_labels_encoded, y_pred_knn)

plt.figure(figsize=(10, 8))
sns.heatmap(heatmap_label_knn, annot=True, fmt='d', cmap='Blues',␣
  ↪xticklabels=label_encoder.classes_, yticklabels=label_encoder.classes_)
```

```
plt.title('Confusion Matrix')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()
```




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

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

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

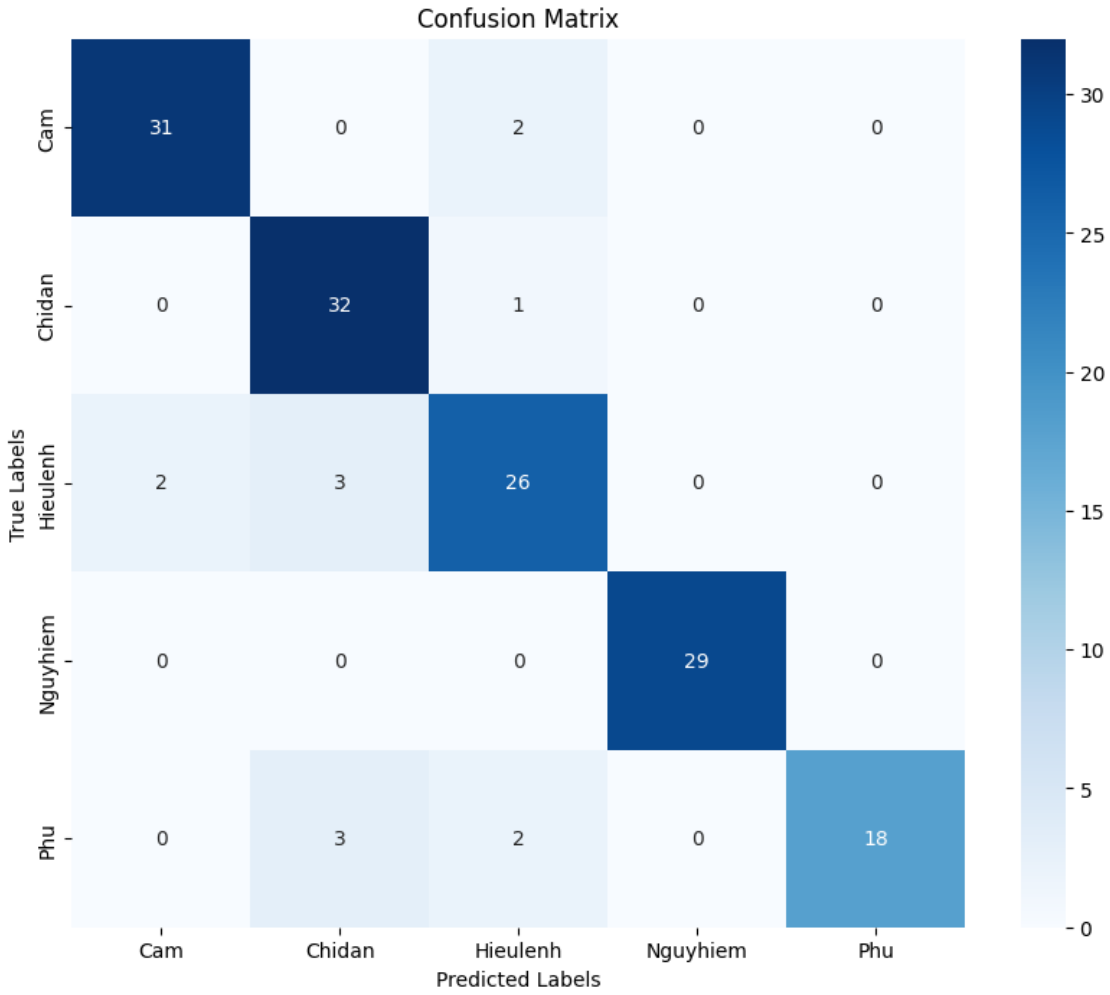
```
    axes[row, col].imshow(image)
    axes[row, col].set_title(f'True: {label_encoder.classes_[true_label]}\nPred:
 ↪ {label_encoder.classes_[pred_label]}')
    axes[row, col].axis('off')

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

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

9 Predict on test images for SVM

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

```
              precision    recall  f1-score   support

         Cam       0.94      0.94      0.94        33
      Chidan       0.84      0.97      0.90        33
    Hieulenh       0.84      0.84      0.84        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       1.00      0.78      0.88        23

    accuracy                           0.91       149
   macro avg       0.92      0.91      0.91       149
weighted avg       0.92      0.91      0.91       149
```

```
heatmap_label_svm = confusion_matrix(test_labels_encoded, y_pred_svm)

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




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

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

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

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

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

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

10 Save grid search results

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

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

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

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

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

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

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

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

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

export_notebook_to_pdf(notebook_path, proj_dir)
```

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

```
Images\grid_search_results\notebook_export_2024-12-23_21_24_48.pdf

'e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\grid_search_results\\notebook_export_2024-12-23_21_24_48.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’: ‘scale’, ‘kernel’: ‘poly’}