Notebook

December 24, 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)
```

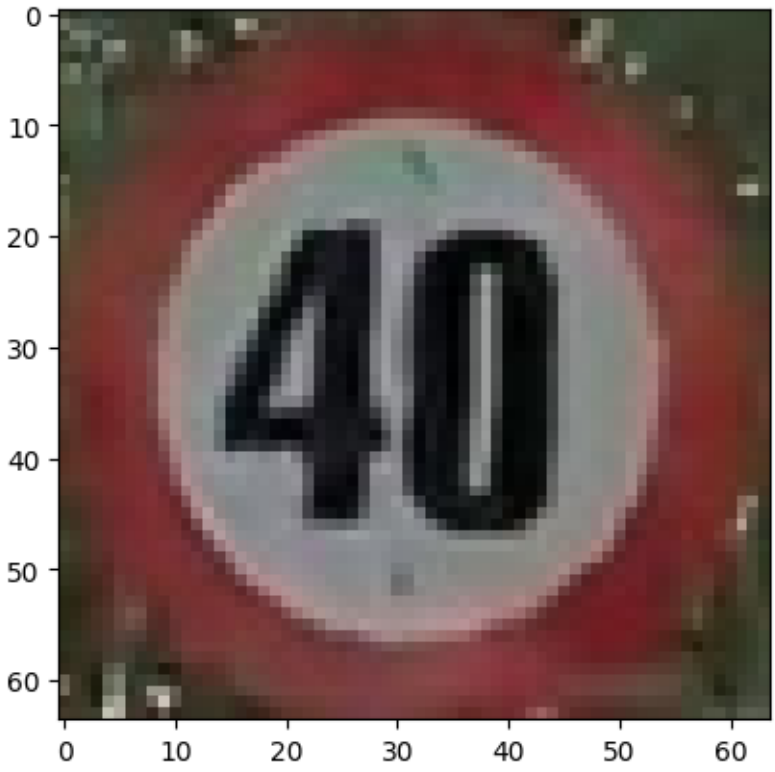
```
label_encoder = LabelEncoder()
train_labels_encoded = label_encoder.fit_transform(train_labels)
test_labels_encoded = label_encoder.transform(test_labels)
```

```
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')
```

```
['d:\\ASUS\\Deploy-Traffic-Sign-Classification-through-
Images\\joblib\\label_encoder.joblib']
```

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

```
<matplotlib.image.AxesImage at 0x18afa90f2e0>
```




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

```
<matplotlib.image.AxesImage at 0x18afba4abc0>
```

3 Extract features

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

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

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

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

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

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

```
def color_histogram(image):
    # image = cv2.cvtColor(image, cv2.COLOR_RGB2LUV)
```

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

```
# def plot_color_histogram(image):

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

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

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

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

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

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

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

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

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

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

```
def extract_features(images):
    # blurred_images = [blur_image(image) for image in tqdm(images, desc="Blur Images")]
    color_features = [color_histogram(image) for image in tqdm(images, desc="Extracting Color Features")]
    hog_features = [hog(image) for image in tqdm(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')
```

```
Extracting Color Features: 100%|      | 1416/1416 [00:00<00:00, 1659.56it/s]
Extracting HOG Features: 100%|      | 1416/1416 [00:24<00:00, 58.94it/s]
Combining Features: 1416it [00:00, 17486.66it/s]

['d:\\ASUS\\Deploy-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')
```

```
Extracting Color Features: 100%|      | 149/149 [00:00<00:00, 3067.05it/s]
Extracting HOG Features: 100%|      | 149/149 [00:03<00:00, 41.87it/s]
Combining Features: 149it [00:00, 7813.26it/s]

['d:\\ASUS\\Deploy-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 0x0000018AF8164B80>, n_neighbors=3,
weights=uniform;, score=0.877 total time=  15.0s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=3,
weights=uniform;, score=0.829 total time=  12.0s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=3,
weights=uniform;, score=0.822 total time=  16.0s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=3,
weights=distance;, score=0.883 total time=  14.8s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=3,
weights=distance;, score=0.837 total time=  16.0s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=3,
weights=distance;, score=0.834 total time=  15.5s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=4,
weights=uniform;, score=0.859 total time=  13.8s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=4,
weights=uniform;, score=0.825 total time=  16.3s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=4,
weights=uniform;, score=0.794 total time=  16.1s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=4,
weights=distance;, score=0.899 total time=  14.9s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=4,
weights=distance;, score=0.839 total time=  17.1s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=4,
weights=distance;, score=0.831 total time=  12.2s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=5,
weights=uniform;, score=0.845 total time=  12.5s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=5,
weights=uniform;, score=0.823 total time=  15.0s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=5,
weights=uniform;, score=0.789 total time=  14.8s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=5,
weights=distance;, score=0.872 total time=  11.9s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=5,
weights=distance;, score=0.833 total time=  13.9s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=5,
weights=distance;, score=0.829 total time=  12.0s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=6,
weights=uniform;, score=0.829 total time=  12.1s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=6,
weights=uniform;, score=0.812 total time=  11.5s
```

```
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=6,
weights=uniform;, score=0.755 total time=  10.4s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=6,
weights=distance;, score=0.866 total time=  14.4s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=6,
weights=distance;, score=0.843 total time=  13.1s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=6,
weights=distance;, score=0.796 total time=  14.2s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=7,
weights=uniform;, score=0.845 total time=  11.2s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=7,
weights=uniform;, score=0.802 total time=  13.0s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=7,
weights=uniform;, score=0.758 total time=  20.1s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=7,
weights=distance;, score=0.866 total time=  17.8s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=7,
weights=distance;, score=0.812 total time=  12.0s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=7,
weights=distance;, score=0.792 total time=  10.4s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=10,
weights=uniform;, score=0.832 total time=  10.1s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=10,
weights=uniform;, score=0.794 total time=   9.9s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=10,
weights=uniform;, score=0.737 total time=  12.2s
[CV 1/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=10,
weights=distance;, score=0.861 total time=  11.6s
[CV 2/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=10,
weights=distance;, score=0.809 total time=  11.9s
[CV 3/3] END metric=<function cityblock at 0x0000018AF8164B80>, n_neighbors=10,
weights=distance;, score=0.767 total time=  10.4s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=3,
weights=uniform;, score=0.875 total time=  15.0s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=3,
weights=uniform;, score=0.805 total time=  14.5s
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=3,
weights=uniform;, score=0.784 total time=  12.7s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=3,
weights=distance;, score=0.875 total time=  16.8s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=3,
weights=distance;, score=0.801 total time=  19.0s
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=3,
weights=distance;, score=0.788 total time=  13.3s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=4,
weights=uniform;, score=0.833 total time=   7.8s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=4,
weights=uniform;, score=0.801 total time=   5.9s
```

```
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=4,
weights=uniform;, score=0.757 total time=   6.6s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=4,
weights=distance;, score=0.883 total time=   6.3s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=4,
weights=distance;, score=0.808 total time=   6.5s
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=4,
weights=distance;, score=0.779 total time=   6.0s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=5,
weights=uniform;, score=0.837 total time=   5.3s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=5,
weights=uniform;, score=0.800 total time=   5.3s
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=5,
weights=uniform;, score=0.760 total time=   6.3s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=5,
weights=distance;, score=0.857 total time=   5.6s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=5,
weights=distance;, score=0.796 total time=   6.1s
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=5,
weights=distance;, score=0.772 total time=   6.7s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=6,
weights=uniform;, score=0.806 total time=   7.3s
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weights=uniform;, score=0.775 total time=   7.5s
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weights=uniform;, score=0.727 total time=   6.8s
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weights=distance;, score=0.852 total time=   6.0s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=6,
weights=distance;, score=0.807 total time=   5.9s
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weights=distance;, score=0.770 total time=   6.6s
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weights=uniform;, score=0.823 total time=   6.1s
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weights=uniform;, score=0.782 total time=   6.1s
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=7,
weights=uniform;, score=0.724 total time=   6.2s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=7,
weights=distance;, score=0.847 total time=   5.8s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=7,
weights=distance;, score=0.785 total time=   5.7s
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weights=distance;, score=0.747 total time=   6.8s
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weights=uniform;, score=0.793 total time=   6.0s
[CV 2/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=10,
weights=uniform;, score=0.757 total time=   5.6s
```

```
[CV 3/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=10,
weights=uniform;, score=0.699 total time=   5.5s
[CV 1/3] END metric=<function euclidean at 0x0000018AF8164700>, n_neighbors=10,
weights=distance;, score=0.820 total time=   6.0s
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weights=distance;, score=0.768 total time=   5.5s
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weights=distance;, score=0.729 total time=   5.9s
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weights=uniform;, score=0.875 total time=  11.7s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=3,
weights=uniform;, score=0.807 total time=  11.3s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=3,
weights=uniform;, score=0.789 total time=  11.9s
[CV 1/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=3,
weights=distance;, score=0.877 total time=  11.1s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=3,
weights=distance;, score=0.808 total time=  11.1s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=3,
weights=distance;, score=0.797 total time=  11.3s
[CV 1/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=4,
weights=uniform;, score=0.836 total time=  11.4s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=4,
weights=uniform;, score=0.798 total time=  11.3s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=4,
weights=uniform;, score=0.766 total time=  11.9s
[CV 1/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=4,
weights=distance;, score=0.883 total time=  11.4s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=4,
weights=distance;, score=0.813 total time=  12.6s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=4,
weights=distance;, score=0.789 total time=  12.2s
[CV 1/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=5,
weights=uniform;, score=0.838 total time=  11.8s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=5,
weights=uniform;, score=0.798 total time=  14.3s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=5,
weights=uniform;, score=0.771 total time=  12.4s
[CV 1/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=5,
weights=distance;, score=0.866 total time=  11.9s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=5,
weights=distance;, score=0.800 total time=  11.7s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=5,
weights=distance;, score=0.785 total time=  12.8s
[CV 1/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=6,
weights=uniform;, score=0.809 total time=  13.7s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=6,
weights=uniform;, score=0.775 total time=  12.8s
```

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[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=6,
weights=uniform;, score=0.728 total time=  12.2s
[CV 1/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=6,
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[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=6,
weights=distance;, score=0.810 total time=  12.2s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=6,
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[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=7,
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weights=distance;, score=0.861 total time=  11.8s
[CV 2/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=7,
weights=distance;, score=0.791 total time=  11.2s
[CV 3/3] END metric=<function cosine at 0x0000018AF81648B0>, n_neighbors=7,
weights=distance;, score=0.757 total time=  11.9s
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weights=uniform;, score=0.805 total time=   4.3s
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weights=distance;, score=0.808 total time=   3.9s
[CV 3/3] END metric=<function sqeuclidean at 0x0000018AF8164790>, n_neighbors=3,
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weights=uniform;, score=0.801 total time=   4.6s
```

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[CV 3/3] END metric=<function sqeuclidean at 0x0000018AF8164790>, n_neighbors=4,
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[CV 3/3] END metric=<function sqeuclidean at 0x0000018AF8164790>, n_neighbors=4,
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[CV 2/3] END metric=<function sqeuclidean at 0x0000018AF8164790>, n_neighbors=6,
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weights=distance;, score=0.808 total time=   4.5s
[CV 3/3] END metric=<function sqeuclidean at 0x0000018AF8164790>, n_neighbors=6,
weights=distance;, score=0.776 total time=   4.5s
[CV 1/3] END metric=<function sqeuclidean at 0x0000018AF8164790>, n_neighbors=7,
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[CV 3/3] END metric=<function sqeuclidean at 0x0000018AF8164790>, n_neighbors=7,
weights=uniform;, score=0.724 total time=   5.0s
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weights=distance;, score=0.863 total time=   4.9s
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weights=distance;, score=0.759 total time=   4.1s
[CV 1/3] END metric=<function sqeuclidean at 0x0000018AF8164790>,
n_neighbors=10, weights=uniform;, score=0.793 total time=   3.9s
[CV 2/3] END metric=<function sqeuclidean at 0x0000018AF8164790>,
n_neighbors=10, weights=uniform;, score=0.757 total time=   4.2s
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[CV 3/3] END metric=<function sqeuclidean at 0x0000018AF8164790>,
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[CV 3/3] END metric=<function sqeuclidean at 0x0000018AF8164790>,
n_neighbors=10, weights=distance;, score=0.746 total time=   4.3s
[CV 1/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=3, weights=uniform;, score=0.731 total time=   4.7s
[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=3, weights=uniform;, score=0.716 total time=   4.6s
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=3, weights=uniform;, score=0.745 total time=   4.6s
[CV 1/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=3, weights=distance;, score=0.754 total time=   4.5s
[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=3, weights=distance;, score=0.732 total time=   5.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=3, weights=distance;, score=0.766 total time=   4.6s
[CV 1/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=4, weights=uniform;, score=0.735 total time=   4.6s
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n_neighbors=4, weights=uniform;, score=0.705 total time=   4.8s
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=4, weights=uniform;, score=0.732 total time=   5.4s
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[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
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[CV 1/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=5, weights=uniform;, score=0.736 total time=   4.9s
[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=5, weights=uniform;, score=0.701 total time=   7.4s
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=5, weights=uniform;, score=0.724 total time=   5.6s
[CV 1/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=5, weights=distance;, score=0.751 total time=   5.3s
[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=5, weights=distance;, score=0.724 total time=   6.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=5, weights=distance;, score=0.757 total time=   4.7s
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n_neighbors=6, weights=uniform;, score=0.718 total time=   4.7s
[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=6, weights=uniform;, score=0.701 total time=   4.7s
```

```
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=6, weights=uniform;, score=0.736 total time=   4.5s
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n_neighbors=6, weights=distance;, score=0.752 total time=   4.4s
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[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=6, weights=distance;, score=0.764 total time=   4.5s
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n_neighbors=7, weights=uniform;, score=0.728 total time=   4.5s
[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=7, weights=uniform;, score=0.717 total time=   4.6s
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=7, weights=uniform;, score=0.735 total time=   4.5s
[CV 1/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=7, weights=distance;, score=0.755 total time=   4.4s
[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=7, weights=distance;, score=0.750 total time=   4.3s
[CV 3/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=7, weights=distance;, score=0.759 total time=   4.6s
[CV 1/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
n_neighbors=10, weights=uniform;, score=0.709 total time=   4.8s
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[CV 2/3] END metric=<function chi_square_distance at 0x0000018AFDBDC3A0>,
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n_neighbors=3, weights=uniform;, score=0.863 total time=   3.9s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=3, weights=uniform;, score=0.765 total time=   4.0s
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n_neighbors=3, weights=uniform;, score=0.746 total time=   3.9s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
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[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=3, weights=distance;, score=0.777 total time=   4.0s
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n_neighbors=3, weights=distance;, score=0.750 total time=   4.0s
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```

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n_neighbors=4, weights=distance;, score=0.880 total time=   4.2s
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n_neighbors=4, weights=distance;, score=0.785 total time=   3.9s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=4, weights=distance;, score=0.763 total time=   3.9s
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[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=5, weights=uniform;, score=0.765 total time=   3.9s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=5, weights=uniform;, score=0.742 total time=   3.9s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=5, weights=distance;, score=0.848 total time=   3.9s
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n_neighbors=5, weights=distance;, score=0.773 total time=   3.9s
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n_neighbors=5, weights=distance;, score=0.749 total time=   3.9s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=6, weights=uniform;, score=0.832 total time=   3.9s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=6, weights=uniform;, score=0.747 total time=   3.9s
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n_neighbors=6, weights=distance;, score=0.858 total time=   3.9s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=6, weights=distance;, score=0.776 total time=   3.9s
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[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=7, weights=uniform;, score=0.823 total time=   3.9s
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n_neighbors=7, weights=uniform;, score=0.708 total time=   4.2s
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n_neighbors=7, weights=distance;, score=0.834 total time=   3.9s
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n_neighbors=7, weights=distance;, score=0.753 total time=   3.9s
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n_neighbors=7, weights=distance;, score=0.727 total time=   3.9s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=10, weights=uniform;, score=0.812 total time=   3.9s
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n_neighbors=10, weights=uniform;, score=0.723 total time=   3.9s
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```
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n_neighbors=10, weights=distance;, score=0.829 total time=   3.9s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
n_neighbors=10, weights=distance;, score=0.735 total time=   3.9s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000018AFDBDD480>,
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n_neighbors=3, weights=uniform;, score=0.736 total time=   3.5s
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n_neighbors=3, weights=uniform;, score=0.704 total time=   3.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=3, weights=uniform;, score=0.623 total time=   3.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=3, weights=distance;, score=0.075 total time=   3.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
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[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
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[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=4, weights=uniform;, score=0.745 total time=   3.6s
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n_neighbors=4, weights=uniform;, score=0.727 total time=   3.7s
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n_neighbors=5, weights=uniform;, score=0.732 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=5, weights=uniform;, score=0.708 total time=   3.6s
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[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=5, weights=distance;, score=0.075 total time=   3.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=5, weights=distance;, score=0.075 total time=   3.4s
[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=6, weights=uniform;, score=0.716 total time=   3.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=6, weights=uniform;, score=0.668 total time=   3.7s
```

```
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=6, weights=uniform;, score=0.620 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=6, weights=distance;, score=0.075 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=6, weights=distance;, score=0.075 total time=   3.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=6, weights=distance;, score=0.075 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=7, weights=uniform;, score=0.720 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=7, weights=uniform;, score=0.665 total time=   3.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=7, weights=uniform;, score=0.605 total time=   3.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=7, weights=distance;, score=0.075 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=7, weights=distance;, score=0.075 total time=   3.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=7, weights=distance;, score=0.075 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=10, weights=uniform;, score=0.700 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=10, weights=uniform;, score=0.635 total time=   3.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=10, weights=uniform;, score=0.607 total time=   3.6s
[CV 1/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=10, weights=distance;, score=0.075 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=10, weights=distance;, score=0.075 total time=   3.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000018AFDBDD240>,
n_neighbors=10, weights=distance;, score=0.075 total time=   3.6s

GridSearchCV(cv=3, estimator=KNeighborsClassifier(),
             param_grid={'metric': [<function cityblock at 0x0000018AF8164B80>,
                                    <function euclidean at 0x0000018AF8164700>,
                                    <function cosine at 0x0000018AF81648B0>,
                                    <function sqeuclidean at
0x0000018AF8164790>,
                                    <function chi_square_distance at
0x0000018AFDBDC3A0>,
                                    <function bhattacharyya_distance at
0x0000018AFDBDD480>,
                                    <function intersection_distance at
0x0000018AFDBDD240>],
                         '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 0x0000018AF8164B80>,
'n_neighbors': 4, 'weights': 'distance'}
Thuật toán sử dụng: auto
```

```
['d:\\ASUS\\Deploy-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=0.569 total time=
1.3s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.552 total time=
```

```
1.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.535 total time=
1.1s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.827 total
time=   0.5s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.754 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.751 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.689 total time=
0.7s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.467 total
time=   1.0s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.500 total
time=   1.1s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.473 total
time=   1.0s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.9s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.9s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.427 total time=
1.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.452 total time=
```

```
1.6s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.389 total time=
1.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.836 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.827 total time=
0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.800 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.889 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.858 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.835 total time=
0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.123 total
time=   1.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.106 total
time=   1.0s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.097 total
time=   1.0s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.482 total time=
1.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.509 total time=
1.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.509 total time=
1.2s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.442 total time=
0.9s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.461 total time=
1.0s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.451 total time=
0.9s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.450 total
time=   1.0s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.466 total
time=   0.9s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.462 total
time=   0.9s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.075 total time=
```

```
1.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.569 total time=
1.0s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.552 total time=
1.0s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.535 total time=
1.2s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.804 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.791 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.749 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.467 total
time=   0.8s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.500 total
time=   1.0s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.473 total
time=   0.8s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
```

```
1.4s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.6s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.427 total time=
1.3s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.452 total time=
1.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.389 total time=
1.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.836 total time=
0.3s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.827 total time=
0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.800 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.901 total time=
0.6s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.876 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.834 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.123 total
time=   1.0s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.106 total
time=   1.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.097 total
time=   1.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.482 total time=
1.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.509 total time=
```

```
1.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.509 total time=
1.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.800 total
time=   0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.093 total time=
0.9s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.450 total
time=   0.9s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.466 total
time=   1.0s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.462 total
time=   0.9s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.569 total time=
1.0s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.552 total time=
```

```
1.0s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.535 total time=
1.1s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.836 total
time=   0.5s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.871 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.849 total time=
0.6s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.794 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.467 total
time=   0.8s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.500 total
time=   0.8s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.473 total
time=   0.9s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.2s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.827 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.427 total time=
1.3s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.452 total time=
```

```
1.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.389 total time=
1.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.836 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.827 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.800 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.893 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.878 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.831 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.123 total
time=   1.0s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.106 total
time=   1.0s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.097 total
time=   1.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.482 total time=
1.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.509 total time=
1.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.509 total time=
1.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.800 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.450 total
time=   0.9s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.466 total
time=   0.9s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.462 total
time=   1.0s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.075 total time=
```

```
1.2s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.2s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.836 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.800 total
time=   0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.633 total time=
1.0s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.615 total time=
1.0s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.631 total time=
0.9s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.798 total time=
0.6s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.775 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.759 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.521 total
time=   0.7s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.534 total
time=   0.7s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.531 total
time=   0.7s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
```

```
1.3s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.860 total
time=   0.3s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.460 total time=
1.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.478 total time=
1.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.452 total time=
1.2s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.860 total time=
0.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.824 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.785 total time=
0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.895 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.856 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.829 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.339 total
time=   1.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.318 total
time=   1.0s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.286 total
time=   1.0s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.563 total time=
1.0s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.558 total time=
```

```
0.9s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.542 total time=
1.0s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.464 total time=
0.8s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.491 total time=
0.8s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.494 total time=
0.8s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.7s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.529 total
time=   0.8s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.518 total
time=   0.7s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.395 total time=
1.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.417 total time=
1.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.368 total time=
1.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.633 total time=
1.1s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.615 total time=
```

```
1.0s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.631 total time=
0.9s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.869 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.837 total time=
0.6s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.791 total time=
0.6s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.521 total
time=   0.8s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.534 total
time=   0.8s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.531 total
time=   0.7s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.460 total time=
1.2s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.478 total time=
```

```
1.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.452 total time=
1.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.860 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.824 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.785 total time=
0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.901 total time=
0.6s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.876 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.834 total time=
0.6s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.339 total
time=   1.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.318 total
time=   1.0s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.286 total
time=   1.0s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.563 total time=
0.9s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.558 total time=
1.0s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.542 total time=
0.9s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.860 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.439 total time=
1.0s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.458 total time=
1.0s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.437 total time=
1.0s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.7s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.529 total
time=   0.8s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.518 total
time=   0.8s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.395 total time=
1.3s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.417 total time=
```

```
1.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.368 total time=
1.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.860 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.633 total time=
0.9s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.615 total time=
0.9s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.631 total time=
0.9s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.890 total time=
0.7s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.869 total time=
0.6s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.828 total time=
0.7s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.521 total
time=   0.7s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.534 total
time=   0.8s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.531 total
time=   0.8s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.5s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
```

```
1.3s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.860 total
time=   0.3s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.460 total time=
1.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.478 total time=
1.2s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.452 total time=
1.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.860 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.824 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.785 total time=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.893 total time=
0.8s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.878 total time=
0.6s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.831 total time=
0.6s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.339 total
time=   1.0s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.318 total
time=   1.0s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.286 total
time=   1.0s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.563 total time=
1.0s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.558 total time=
```

```
0.9s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.542 total time=
0.9s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.9s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
1.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.7s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.529 total
time=   0.8s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.518 total
time=   0.8s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.395 total time=
1.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.417 total time=
1.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.368 total time=
1.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.860 total
time=   0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.824 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.785 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.9s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.753 total time=
1.0s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.740 total time=
```

```
1.0s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.689 total time=
0.9s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.823 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.799 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.781 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.540 total
time=   0.7s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.546 total
time=   0.7s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.564 total
time=   0.6s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.366 total time=
1.3s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.336 total time=
1.3s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.269 total time=
1.3s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.577 total time=
1.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.564 total time=
```

```
1.2s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.518 total time=
1.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.858 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.829 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.787 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.897 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.856 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.824 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.392 total
time=   0.9s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.378 total
time=   1.0s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.399 total
time=   1.0s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.612 total time=
0.8s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.590 total time=
0.9s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.8s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.551 total time=
0.9s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.544 total time=
0.7s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.525 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.553 total
time=   0.7s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.545 total
time=   0.7s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.544 total
time=   0.6s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.439 total time=
1.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.461 total time=
```

```
1.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.452 total time=
1.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.829 total
time=   0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.346 total
time=   1.0s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.229 total
time=   1.0s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.216 total
time=   1.0s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.753 total time=
0.9s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.740 total time=
0.9s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.689 total time=
0.9s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.858 total
time=   0.5s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.892 total time=
0.6s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.864 total time=
0.6s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.826 total time=
0.6s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.540 total
time=   0.7s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.546 total
time=   0.7s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.564 total
time=   0.6s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.366 total time=
1.3s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.336 total time=
```

```
1.3s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.269 total time=
1.5s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.577 total time=
1.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.564 total time=
1.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.518 total time=
1.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.858 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.829 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.787 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.901 total time=
0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.876 total time=
0.6s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.834 total time=
0.6s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.392 total
time=   1.0s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.378 total
time=   1.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.399 total
time=   1.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.612 total time=
0.9s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.590 total time=
```

```
1.0s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.9s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.458 total time=
0.9s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.472 total time=
0.9s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.456 total time=
0.9s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.553 total
time=   0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.545 total
time=   0.7s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.544 total
time=   0.8s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.439 total time=
1.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.461 total time=
1.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.452 total time=
1.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.829 total
time=   0.5s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.346 total
time=   0.9s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.229 total
time=   1.0s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.216 total
time=   1.1s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.753 total time=
0.9s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.740 total time=
```

```
0.9s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.689 total time=
0.9s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.893 total time=
0.8s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.876 total time=
0.7s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.831 total time=
0.6s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.540 total
time=   0.6s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.546 total
time=   0.7s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.564 total
time=   0.7s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.366 total time=
1.4s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.336 total time=
1.3s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.269 total time=
1.3s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.9s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.577 total time=
1.2s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.564 total time=
```

```
1.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.518 total time=
1.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.858 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.829 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.787 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.893 total time=
0.7s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.878 total time=
0.7s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.831 total time=
0.7s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.392 total
time=   0.9s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.378 total
time=   1.0s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.399 total
time=   0.9s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.612 total time=
0.8s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.590 total time=
0.9s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.621 total time=
1.0s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.290 total time=
1.0s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.193 total time=
0.9s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.246 total time=
1.0s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.553 total
time=   0.7s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.545 total
time=   0.7s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.544 total
time=   0.7s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.439 total time=
1.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.461 total time=
```

```
1.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.452 total time=
1.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.829 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.787 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.346 total
time=   1.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.229 total
time=   0.9s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.216 total
time=   1.0s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.775 total time=
0.9s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.752 total time=
0.9s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.701 total time=
0.9s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.858 total
time=   0.5s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.846 total time=
0.5s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.831 total time=
0.5s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.790 total time=
0.5s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.593 total
time=   0.6s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.607 total
time=   0.6s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.635 total
time=   0.6s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.413 total time=
1.3s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.429 total time=
```

```
1.2s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.398 total time=
1.3s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.9s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.623 total time=
1.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.621 total time=
1.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.605 total time=
1.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.858 total time=
0.5s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.827 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.790 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.895 total time=
0.5s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.854 total time=
0.5s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.824 total time=
0.6s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.420 total
time=   0.9s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   1.0s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.412 total
time=   0.9s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.702 total time=
0.9s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.705 total time=
```

```
0.9s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.660 total time=
0.8s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.568 total time=
0.9s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.553 total time=
0.8s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.542 total time=
0.9s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.576 total
time=   0.7s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.561 total
time=   0.7s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.574 total
time=   0.7s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.450 total time=
1.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.465 total time=
1.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.457 total time=
1.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.404 total
time=   1.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.422 total
time=   1.0s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.380 total
time=   1.0s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.775 total time=
0.8s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.752 total time=
```

```
1.0s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.701 total time=
0.9s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.858 total
time=   0.5s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.899 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.873 total time=
0.7s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.836 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.593 total
time=   0.6s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.607 total
time=   0.6s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.635 total
time=   0.7s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.413 total time=
1.3s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.429 total time=
1.2s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.398 total time=
1.2s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.790 total
time=   0.5s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.623 total time=
1.2s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.621 total time=
```

```
1.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.605 total time=
1.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.858 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.827 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.790 total time=
0.5s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.901 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.876 total time=
0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.834 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.420 total
time=   0.9s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   0.9s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.412 total
time=   1.0s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.702 total time=
0.9s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.705 total time=
0.8s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.660 total time=
0.8s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.461 total time=
0.8s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.474 total time=
0.9s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.463 total time=
0.8s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.576 total
time=   0.7s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.561 total
time=   0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.574 total
time=   0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.450 total time=
1.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.465 total time=
```

```
1.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.457 total time=
1.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.404 total
time=   1.0s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.422 total
time=   1.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.380 total
time=   1.1s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.775 total time=
0.9s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.752 total time=
0.9s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.701 total time=
0.9s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.827 total
time=   0.5s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.893 total time=
0.6s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.878 total time=
0.6s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.831 total time=
0.7s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.593 total
time=   0.7s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.607 total
time=   0.7s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.635 total
time=   0.6s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.413 total time=
1.3s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.429 total time=
```

```
1.3s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.398 total time=
1.4s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.827 total
time=   0.4s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.790 total
time=   0.5s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.0s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.9s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.623 total time=
1.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.621 total time=
1.2s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.605 total time=
1.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.858 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.827 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.790 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.893 total time=
0.7s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.878 total time=
0.7s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.831 total time=
0.7s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.420 total
time=   1.0s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   1.0s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.412 total
time=   0.9s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.702 total time=
0.8s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.705 total time=
```

```
0.9s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.660 total time=
0.8s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.5s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.414 total time=
1.0s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.432 total time=
0.9s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.390 total time=
0.9s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.576 total
time=   0.6s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.561 total
time=   0.7s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.574 total
time=   0.7s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.450 total time=
1.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.465 total time=
1.6s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.457 total time=
1.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.858 total
time=   0.4s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.5s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.790 total
time=   0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.9s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.404 total
time=   1.0s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.422 total
time=   1.0s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.380 total
time=   1.0s

c:\Users\hoang\AppData\Local\Programs\Python\Python310\lib\site-
packages\numpy\ma\core.py:2820: RuntimeWarning: invalid value encountered in
```

```
cast
  _data = np.array(data, dtype=dtype, copy=copy,

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'}

['d:\\ASUS\\Deploy-Traffic-Sign-Classification-through-
Images\\joblib\\best_svm_model.joblib']
```

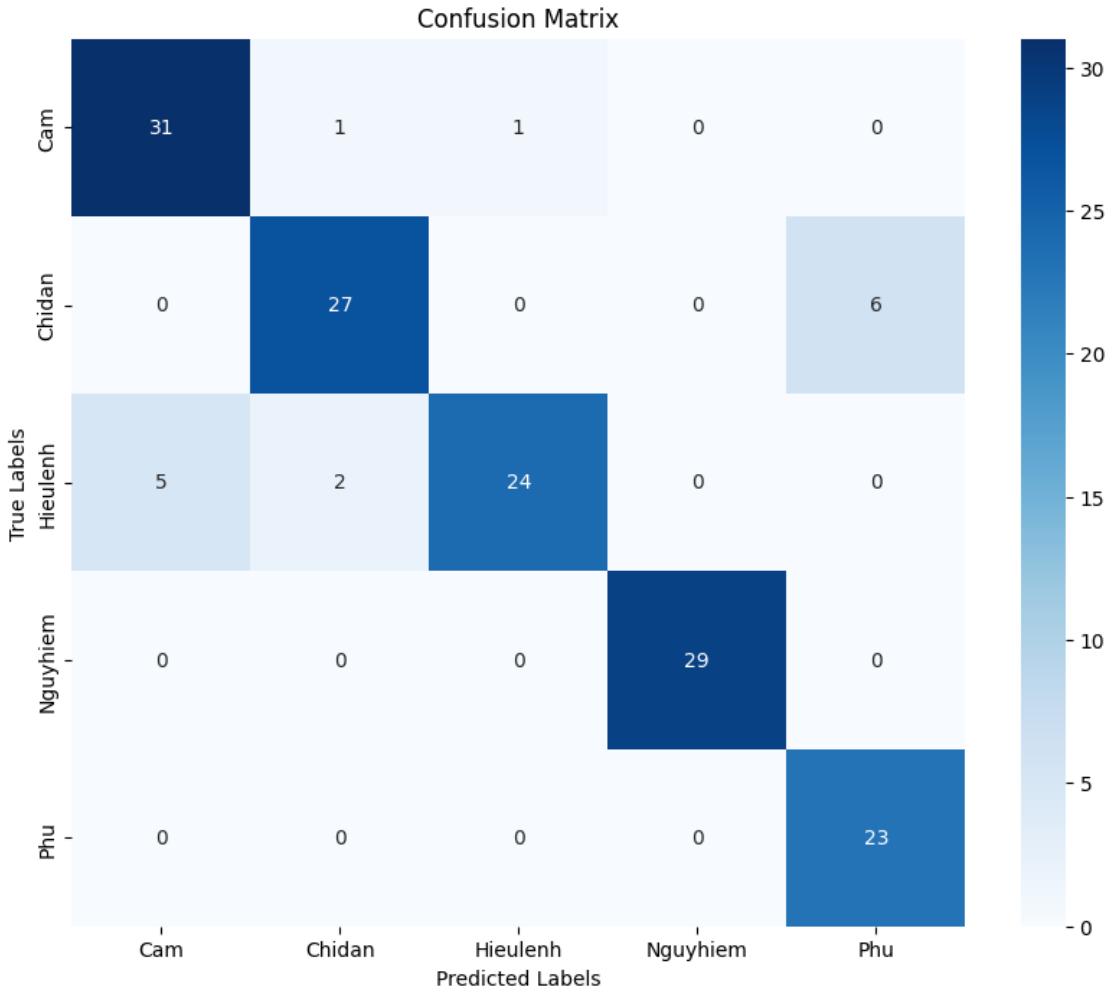
8 Predict on test images for KNN

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

```
              precision    recall  f1-score   support

         Cam       0.86      0.94      0.90        33
      Chidan       0.90      0.82      0.86        33
    Hieulenh       0.96      0.77      0.86        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.79      1.00      0.88        23

    accuracy                           0.90       149
   macro avg       0.90      0.91      0.90       149
weighted avg       0.91      0.90      0.90       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()
```

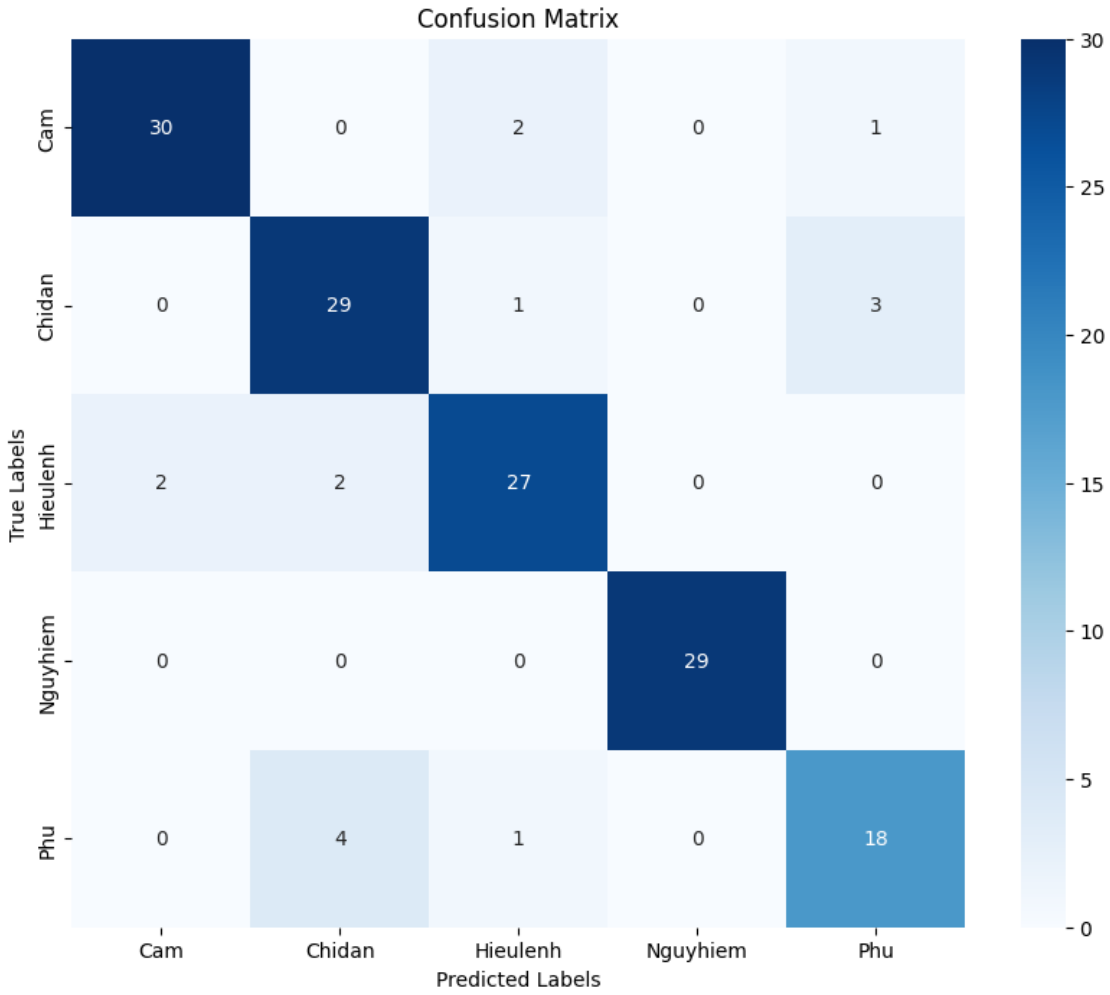

True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Hieulenh
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam
True: Cam Pred: Cam

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      0.91      0.92        33
      Chidan       0.83      0.88      0.85        33
    Hieulenh       0.87      0.87      0.87        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.82      0.78      0.80        23

    accuracy                           0.89       149
   macro avg       0.89      0.89      0.89       149
weighted avg       0.89      0.89      0.89       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)
```

```
---------------------------------------------------------------------------
OSError                                   Traceback (most recent call last)
Cell In[43], line 5
      2 notebook_path = project_dir + "\\model\\main.ipynb"
      3 proj_dir = project_dir + "\\grid_search_results"
```

```
----> 5 export_notebook_to_pdf(notebook_path, proj_dir)

Cell In[39], line 18, in export_notebook_to_pdf(notebook_path, project_dir)
     15 pdf_exporter.template_name = 'classic'
     17 # Chuyển đổi sang PDF
---> 18 pdf_data, resources = pdf_exporter.from_notebook_node(nb)
     20 # Tạo tên file với timestamp
     21 current_time = datetime.now().strftime('%Y-%m-%d_%H_%M_%S')

File c:
 ↪\Users\hoang\AppData\Local\Programs\Python\Python310\lib\site-packages\nbconv ↪rt\exporters\
 ↪py:197, in PDFExporter.from_notebook_node(self, nb, resources, **kw)
    195 tex_file = self.writer.write(latex, resources,␣
 ↪notebook_name=notebook_name)
    196 self.log.info("Building PDF")
--> 197 self.run_latex(tex_file)
    198 if self.run_bib(tex_file):
    199     self.run_latex(tex_file)

File c:
 ↪\Users\hoang\AppData\Local\Programs\Python\Python310\lib\site-packages\nbconv ↪rt\exporters\
 ↪py:166, in PDFExporter.run_latex(self, filename, raise_on_failure)
    163 def log_error(command, out):
    164     self.log.critical("%s failed: %s\n%s", command[0], command, out)
--> 166 return self.run_command(
    167␣
 ↪    self.latex_command, filename, self.latex_count, log_error, raise_on_failu ↪e
    168 )

File c:
 ↪\Users\hoang\AppData\Local\Programs\Python\Python310\lib\site-packages\nbconv ↪rt\exporters\
 ↪py:120, in PDFExporter.run_command(self, command_list, filename, count,␣
 ↪log_function, raise_on_failure)
    114     link = "https://nbconvert.readthedocs.io/en/latest/install.
 ↪html#installing-tex"
    115     msg = (
    116         f"{command_list[0]} not found on PATH, if you have not installe␣
 ↪"
    117         f"{command_list[0]} you may need to do so. Find further␣
 ↪instructions "
    118         f"at {link}."
    119     )
--> 120     raise OSError(msg)
    122 times = "time" if count == 1 else "times"
    123 self.log.info("Running %s %i %s: %s", command_list[0], count, times,␣
 ↪command)
```

```
OSError: xelatex not found on PATH, if you have not installed xelatex you may␣
↪need to do so. Find further instructions at https://nbconvert.readthedocs.io/
↪en/latest/install.html#installing-tex.
```

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’}