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)
```

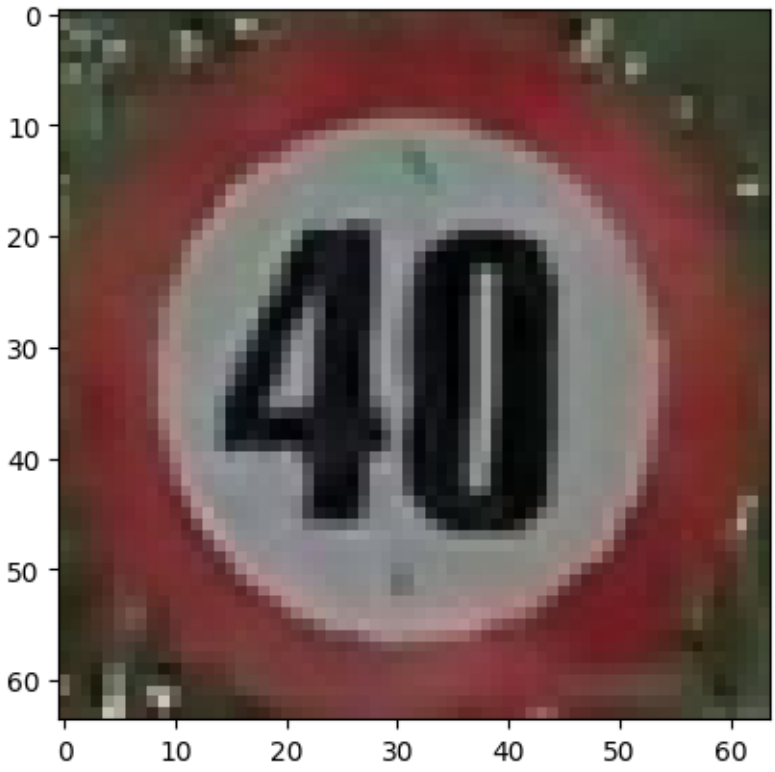
```
label_encoder = LabelEncoder()
train_labels_encoded = label_encoder.fit_transform(train_labels)
test_labels_encoded = label_encoder.transform(test_labels)
```

```
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 0x241fec9f3d0>
```




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

```
<matplotlib.image.AxesImage at 0x241800bf160>
```

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 sharpen_image(image):
    sharpening_kernel=np.array([[0,-1,0],
                                [-1,5,-1],
                                [0,-1,0]])
    sharpened_image=cv2.filter2D(image,-1, sharpening_kernel)
    return sharpened_image
```

```
# 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):
    sharpen_images = [sharpen_image(image) for image in tqdm(images,␣
 ↪desc="Sharpening Images")]
    color_features = [color_histogram(image) for image in tqdm(sharpen_images,␣
 ↪desc="Extracting Color Features")]
    hog_features = [hog(image) for image in tqdm(sharpen_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')
```

```
Sharpening Images: 100%|      | 1416/1416 [00:00<00:00, 22626.65it/s]
Extracting Color Features: 100%|      | 1416/1416 [00:00<00:00,
14676.09it/s]
Extracting HOG Features: 100%|      | 1416/1416 [00:06<00:00, 209.84it/s]
Combining Features: 1416it [00:00, 31116.45it/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')
```

```
Sharpening Images: 100%|      | 149/149 [00:00<00:00, 23263.52it/s]
Extracting Color Features: 100%|      | 149/149 [00:00<00:00, 11528.13it/s]
Extracting HOG Features: 100%|      | 149/149 [00:00<00:00, 164.90it/s]
Combining Features: 149it [00:00, 27511.50it/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 0x00000241FC4F4B80>, n_neighbors=3,
weights=uniform;, score=0.806 total time=   4.7s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=3,
weights=uniform;, score=0.789 total time=   4.3s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=3,
weights=uniform;, score=0.779 total time=   4.4s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=3,
weights=distance;, score=0.820 total time=   4.0s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=3,
weights=distance;, score=0.795 total time=   3.7s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=3,
weights=distance;, score=0.791 total time=   3.7s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=4,
weights=uniform;, score=0.783 total time=   3.8s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=4,
weights=uniform;, score=0.761 total time=   3.7s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=4,
weights=uniform;, score=0.755 total time=   3.7s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=4,
weights=distance;, score=0.831 total time=   3.6s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=4,
weights=distance;, score=0.804 total time=   3.8s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=4,
weights=distance;, score=0.789 total time=   3.6s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=5,
weights=uniform;, score=0.778 total time=   3.7s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=5,
weights=uniform;, score=0.775 total time=   3.6s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=5,
```

```
weights=uniform;, score=0.760 total time=   3.7s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=5,
weights=distance;, score=0.815 total time=   3.6s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=5,
weights=distance;, score=0.788 total time=   3.6s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=5,
weights=distance;, score=0.767 total time=   3.6s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=6,
weights=uniform;, score=0.777 total time=   3.6s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=6,
weights=uniform;, score=0.774 total time=   3.6s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=6,
weights=uniform;, score=0.744 total time=   3.9s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=6,
weights=distance;, score=0.810 total time=   3.6s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=6,
weights=distance;, score=0.808 total time=   3.7s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=6,
weights=distance;, score=0.785 total time=   3.8s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=7,
weights=uniform;, score=0.764 total time=   3.6s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=7,
weights=uniform;, score=0.775 total time=   3.8s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=7,
weights=uniform;, score=0.741 total time=   3.8s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=7,
weights=distance;, score=0.785 total time=   3.7s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=7,
weights=distance;, score=0.787 total time=   3.7s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=7,
weights=distance;, score=0.765 total time=   4.0s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=10,
weights=uniform;, score=0.766 total time=   3.6s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=10,
weights=uniform;, score=0.732 total time=   3.7s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=10,
weights=uniform;, score=0.726 total time=   3.8s
[CV 1/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=10,
weights=distance;, score=0.794 total time=   4.5s
[CV 2/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=10,
weights=distance;, score=0.762 total time=   4.6s
[CV 3/3] END metric=<function cityblock at 0x00000241FC4F4B80>, n_neighbors=10,
weights=distance;, score=0.756 total time=   3.7s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=3,
weights=uniform;, score=0.815 total time=   5.2s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=3,
weights=uniform;, score=0.780 total time=   4.8s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=3,
```

```
weights=uniform;, score=0.759 total time=   4.8s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=3,
weights=distance;, score=0.824 total time=   5.0s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=3,
weights=distance;, score=0.799 total time=   5.3s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=3,
weights=distance;, score=0.757 total time=   4.7s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=4,
weights=uniform;, score=0.788 total time=   4.8s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=4,
weights=uniform;, score=0.759 total time=   4.8s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=4,
weights=uniform;, score=0.725 total time=   4.7s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=4,
weights=distance;, score=0.844 total time=   4.7s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=4,
weights=distance;, score=0.796 total time=   5.0s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=4,
weights=distance;, score=0.767 total time=   4.9s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=5,
weights=uniform;, score=0.793 total time=   4.8s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=5,
weights=uniform;, score=0.764 total time=   5.0s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=5,
weights=uniform;, score=0.736 total time=   5.2s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=5,
weights=distance;, score=0.826 total time=   5.0s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=5,
weights=distance;, score=0.769 total time=   4.9s
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weights=distance;, score=0.743 total time=   4.8s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=6,
weights=uniform;, score=0.779 total time=   4.8s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=6,
weights=uniform;, score=0.733 total time=   5.1s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=6,
weights=uniform;, score=0.725 total time=   5.0s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=6,
weights=distance;, score=0.820 total time=   5.1s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=6,
weights=distance;, score=0.772 total time=   5.1s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=6,
weights=distance;, score=0.753 total time=   5.0s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=7,
weights=uniform;, score=0.767 total time=   5.1s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=7,
weights=uniform;, score=0.753 total time=   5.3s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=7,
```

```
weights=uniform;, score=0.734 total time=   5.0s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=7,
weights=distance;, score=0.806 total time=   5.1s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=7,
weights=distance;, score=0.765 total time=   5.7s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=7,
weights=distance;, score=0.733 total time=   5.4s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=10,
weights=uniform;, score=0.752 total time=   6.1s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=10,
weights=uniform;, score=0.708 total time=   5.0s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=10,
weights=uniform;, score=0.700 total time=   4.8s
[CV 1/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=10,
weights=distance;, score=0.783 total time=   4.9s
[CV 2/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=10,
weights=distance;, score=0.759 total time=   5.4s
[CV 3/3] END metric=<function euclidean at 0x00000241FC4F4700>, n_neighbors=10,
weights=distance;, score=0.729 total time=   5.2s
[CV 1/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=3,
weights=uniform;, score=0.812 total time=   9.5s
[CV 2/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=3,
weights=uniform;, score=0.780 total time=   9.4s
[CV 3/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=3,
weights=uniform;, score=0.751 total time=   9.6s
[CV 1/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=3,
weights=distance;, score=0.825 total time=   9.3s
[CV 2/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=3,
weights=distance;, score=0.802 total time=   9.3s
[CV 3/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=3,
weights=distance;, score=0.759 total time=   9.2s
[CV 1/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=4,
weights=uniform;, score=0.785 total time=   9.7s
[CV 2/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=4,
weights=uniform;, score=0.759 total time=  10.0s
[CV 3/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=4,
weights=uniform;, score=0.729 total time=  10.2s
[CV 1/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=4,
weights=distance;, score=0.843 total time=   9.6s
[CV 2/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=4,
weights=distance;, score=0.800 total time=  10.3s
[CV 3/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=4,
weights=distance;, score=0.772 total time=  10.4s
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weights=uniform;, score=0.741 total time=   9.6s
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[CV 2/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=5,
weights=distance;, score=0.779 total time=   9.8s
[CV 3/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=5,
weights=distance;, score=0.757 total time=   9.5s
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weights=uniform;, score=0.756 total time=   9.2s
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weights=distance;, score=0.774 total time=   9.3s
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weights=uniform;, score=0.752 total time=   9.7s
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weights=uniform;, score=0.707 total time=   9.7s
[CV 3/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=10,
weights=uniform;, score=0.694 total time=  10.4s
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weights=distance;, score=0.791 total time=  11.7s
[CV 2/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=10,
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[CV 3/3] END metric=<function cosine at 0x00000241FC4F48B0>, n_neighbors=10,
weights=distance;, score=0.729 total time=   9.5s
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weights=uniform;, score=0.759 total time=   3.8s
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weights=distance;, score=0.802 total time=   3.8s
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weights=distance;, score=0.753 total time=   3.8s
[CV 1/3] END metric=<function sqeuclidean at 0x00000241FC4F4790>, n_neighbors=6,
weights=uniform;, score=0.779 total time=   3.6s
[CV 2/3] END metric=<function sqeuclidean at 0x00000241FC4F4790>, n_neighbors=6,
weights=uniform;, score=0.733 total time=   3.8s
[CV 3/3] END metric=<function sqeuclidean at 0x00000241FC4F4790>, n_neighbors=6,
weights=uniform;, score=0.725 total time=   4.2s
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weights=distance;, score=0.775 total time=   3.9s
[CV 3/3] END metric=<function sqeuclidean at 0x00000241FC4F4790>, n_neighbors=6,
weights=distance;, score=0.753 total time=   4.0s
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weights=uniform;, score=0.767 total time=   3.9s
[CV 2/3] END metric=<function sqeuclidean at 0x00000241FC4F4790>, n_neighbors=7,
weights=uniform;, score=0.753 total time=   3.8s
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weights=uniform;, score=0.734 total time=   3.9s
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weights=distance;, score=0.812 total time=   3.8s
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weights=distance;, score=0.772 total time=   3.8s
[CV 3/3] END metric=<function sqeuclidean at 0x00000241FC4F4790>, n_neighbors=7,
weights=distance;, score=0.738 total time=   3.9s
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n_neighbors=10, weights=uniform;, score=0.752 total time=   3.8s
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[CV 3/3] END metric=<function sqeuclidean at 0x00000241FC4F4790>,
n_neighbors=10, weights=uniform;, score=0.700 total time=   3.9s
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n_neighbors=10, weights=distance;, score=0.792 total time=   3.8s
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n_neighbors=3, weights=uniform;, score=0.729 total time=   4.4s
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n_neighbors=3, weights=distance;, score=0.746 total time=   4.3s
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n_neighbors=3, weights=distance;, score=0.695 total time=   4.7s
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n_neighbors=4, weights=uniform;, score=0.700 total time=   4.5s
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n_neighbors=4, weights=uniform;, score=0.723 total time=   4.4s
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n_neighbors=4, weights=distance;, score=0.749 total time=   4.5s
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n_neighbors=4, weights=distance;, score=0.718 total time=   4.4s
[CV 3/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=4, weights=distance;, score=0.765 total time=   4.4s
[CV 1/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=5, weights=uniform;, score=0.695 total time=   4.4s
[CV 2/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=5, weights=uniform;, score=0.686 total time=   4.6s
[CV 3/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
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n_neighbors=5, weights=uniform;, score=0.706 total time=   4.4s
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n_neighbors=5, weights=distance;, score=0.733 total time=   4.3s
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n_neighbors=5, weights=distance;, score=0.701 total time=   4.4s
[CV 3/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=5, weights=distance;, score=0.742 total time=   4.6s
[CV 1/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=6, weights=uniform;, score=0.683 total time=   4.7s
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n_neighbors=6, weights=uniform;, score=0.687 total time=   5.1s
[CV 3/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=6, weights=uniform;, score=0.699 total time=   4.7s
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n_neighbors=6, weights=distance;, score=0.738 total time=   4.6s
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n_neighbors=6, weights=distance;, score=0.705 total time=   4.6s
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n_neighbors=6, weights=distance;, score=0.735 total time=   4.5s
[CV 1/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=7, weights=uniform;, score=0.687 total time=   4.4s
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n_neighbors=7, weights=uniform;, score=0.703 total time=   4.5s
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n_neighbors=7, weights=uniform;, score=0.709 total time=   4.3s
[CV 1/3] END metric=<function chi_square_distance at 0x00000241822811B0>,
n_neighbors=7, weights=distance;, score=0.725 total time=   4.3s
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n_neighbors=7, weights=distance;, score=0.727 total time=   4.4s
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n_neighbors=7, weights=distance;, score=0.742 total time=   4.3s
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n_neighbors=10, weights=uniform;, score=0.697 total time=   4.4s
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n_neighbors=3, weights=distance;, score=0.769 total time=   3.8s
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n_neighbors=3, weights=distance;, score=0.738 total time=   3.8s
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[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000024182280940>,
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n_neighbors=4, weights=uniform;, score=0.700 total time=   3.9s
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n_neighbors=4, weights=distance;, score=0.780 total time=   3.9s
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n_neighbors=5, weights=uniform;, score=0.700 total time=   4.0s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000024182280940>,
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n_neighbors=6, weights=uniform;, score=0.712 total time=   3.8s
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[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000024182280940>,
n_neighbors=6, weights=distance;, score=0.742 total time=   3.9s
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n_neighbors=7, weights=uniform;, score=0.718 total time=   3.9s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000024182280940>,
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n_neighbors=7, weights=uniform;, score=0.703 total time=   4.0s
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[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000024182280940>,
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n_neighbors=10, weights=uniform;, score=0.711 total time=   4.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000024182280940>,
n_neighbors=10, weights=uniform;, score=0.707 total time=   3.8s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000024182280940>,
n_neighbors=10, weights=uniform;, score=0.686 total time=   4.0s
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n_neighbors=10, weights=distance;, score=0.733 total time=   4.0s
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n_neighbors=4, weights=distance;, score=0.075 total time=   3.4s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=5, weights=uniform;, score=0.671 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=5, weights=uniform;, score=0.691 total time=   3.6s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
```

```
n_neighbors=5, weights=uniform;, score=0.646 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=5, weights=distance;, score=0.075 total time=   3.6s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=5, weights=distance;, score=0.075 total time=   3.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=5, weights=distance;, score=0.075 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=6, weights=uniform;, score=0.660 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=6, weights=uniform;, score=0.664 total time=   3.7s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=6, weights=uniform;, score=0.632 total time=   3.7s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=6, weights=distance;, score=0.075 total time=   3.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=6, weights=distance;, score=0.075 total time=   3.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=6, weights=distance;, score=0.075 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=7, weights=uniform;, score=0.657 total time=   3.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=7, weights=uniform;, score=0.667 total time=   3.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=7, weights=uniform;, score=0.624 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=7, weights=distance;, score=0.075 total time=   3.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=7, weights=distance;, score=0.075 total time=   3.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=7, weights=distance;, score=0.075 total time=   3.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=10, weights=uniform;, score=0.649 total time=   3.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=10, weights=uniform;, score=0.641 total time=   3.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=10, weights=uniform;, score=0.605 total time=   3.4s
[CV 1/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=10, weights=distance;, score=0.075 total time=   3.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=10, weights=distance;, score=0.075 total time=   3.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000024182280EE0>,
n_neighbors=10, weights=distance;, score=0.075 total time=   3.5s

GridSearchCV(cv=3, estimator=KNeighborsClassifier(),
             param_grid={'metric': [<function cityblock at 0x00000241FC4F4B80>,
                                    <function euclidean at 0x00000241FC4F4700>,
```

```
                                    <function cosine at 0x00000241FC4F48B0>,
                                    <function sqeuclidean at
0x00000241FC4F4790>,
                                    <function chi_square_distance at
0x00000241822811B0>,
                                    <function bhattacharyya_distance at
0x0000024182280940>,
                                    <function intersection_distance at
0x0000024182280EE0>],
                         '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 0x00000241FC4F4B80>,
'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=0.513 total time=
1.3s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.531 total time=
1.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.489 total time=
1.2s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.807 total
time=   0.5s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.748 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.731 total time=
0.7s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.707 total time=
0.7s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.408 total
time=   1.0s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.433 total
time=   1.1s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.396 total
time=   0.9s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[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=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.807 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[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=
0.9s
[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=   1.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.415 total time=
1.5s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.453 total time=
1.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.371 total time=
1.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.793 total time=
0.5s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.807 total time=
0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.782 total time=
0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.826 total time=
0.5s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.822 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.807 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.0s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.421 total time=
1.2s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.454 total time=
1.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.421 total time=
1.2s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.807 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.394 total time=
1.3s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.418 total time=
1.0s
```

```
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.363 total time=
1.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.413 total
time=   1.2s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.444 total
time=   1.2s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.397 total
time=   0.9s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.5s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.6s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.807 total
time=   0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.513 total time=
1.3s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.531 total time=
1.3s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.489 total time=
1.1s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.807 total
time=   0.5s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.808 total time=
0.6s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.787 total time=
0.8s
```

```
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.762 total time=
0.7s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.408 total
time=   1.0s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.433 total
time=   1.0s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.396 total
time=   1.1s
[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=
1.3s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.807 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.2s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[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=   1.2s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.415 total time=
1.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.453 total time=
1.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.371 total time=
1.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.793 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.807 total time=
0.7s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.782 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.864 total time=
0.9s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.838 total time=
0.7s
```

```
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.815 total time=
0.8s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.421 total time=
1.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.454 total time=
1.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.421 total time=
1.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.807 total
time=   0.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.782 total
time=   0.5s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.075 total time=
1.0s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.075 total time=
1.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.413 total
time=   1.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.444 total
time=   1.0s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.397 total
time=   1.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.3s
[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=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.807 total
time=   0.7s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
```

```
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.0s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.4s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.513 total time=
1.3s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.531 total time=
1.2s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.489 total time=
1.2s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.807 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.851 total time=
0.8s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.824 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.804 total time=
0.8s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.408 total
time=   0.9s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.433 total
time=   1.0s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.396 total
time=   1.0s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.5s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.5s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.807 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.782 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
```

```
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.3s
[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=   1.4s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.415 total time=
1.5s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.453 total time=
1.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.371 total time=
1.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.793 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.807 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.782 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.866 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.832 total time=
0.8s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.809 total time=
0.8s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.2s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.0s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.079 total
time=   1.2s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.421 total time=
1.2s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.454 total time=
1.2s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.421 total time=
1.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.807 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.782 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=
1.1s
```

```
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
1.2s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.413 total
time=   1.0s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.444 total
time=   0.9s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.397 total
time=   1.0s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.5s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.793 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.807 total
time=   0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.782 total
time=   0.4s
[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=
1.1s
[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=   1.2s
[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=0.648 total time=
1.0s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.583 total time=
1.2s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.629 total time=
1.1s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.795 total
time=   0.4s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.784 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.797 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.777 total time=
0.6s
```

```
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.746 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.435 total
time=   0.9s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.473 total
time=   0.9s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.472 total
time=   0.9s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[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=0.795 total
time=   0.4s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.802 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.784 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=
1.2s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[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=   1.1s
[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=0.463 total time=
1.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.483 total time=
1.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.438 total time=
1.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.795 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.802 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.784 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.842 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.825 total time=
0.5s
```

```
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.811 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.106 total
time=   1.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.093 total
time=   1.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.096 total
time=   1.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.524 total time=
1.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.526 total time=
1.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.506 total time=
1.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.795 total
time=   0.6s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.802 total
time=   0.7s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.784 total
time=   0.8s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.417 total time=
1.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.454 total time=
1.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.413 total time=
1.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.433 total
time=   1.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.488 total
time=   1.0s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   1.0s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.138 total time=
1.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.117 total time=
1.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.146 total time=
1.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.784 total
time=   0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
```

```
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[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=0.648 total time=
1.1s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.583 total time=
1.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.629 total time=
1.2s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.795 total
time=   0.6s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.784 total
time=   0.7s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.839 total time=
0.7s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.828 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.800 total time=
0.8s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.435 total
time=   1.0s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.473 total
time=   1.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.472 total
time=   1.1s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.5s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.5s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.784 total
time=   0.5s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
```

```
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.463 total time=
1.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.483 total time=
1.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.438 total time=
1.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.795 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.802 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.784 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.864 total time=
0.8s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.838 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.815 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.106 total
time=   1.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.093 total
time=   1.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.096 total
time=   1.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.524 total time=
1.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.526 total time=
1.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.506 total time=
1.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.784 total
time=   0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.393 total time=
1.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.412 total time=
1.6s
```

```
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.341 total time=
1.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.433 total
time=   1.0s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.488 total
time=   1.0s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.9s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.138 total time=
1.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.117 total time=
1.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.146 total time=
1.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.784 total
time=   0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.648 total time=
1.1s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.583 total time=
1.3s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.629 total time=
1.2s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.784 total
time=   0.6s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.864 total time=
0.9s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.833 total time=
1.0s
```

```
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.816 total time=
0.8s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.435 total
time=   0.9s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.473 total
time=   1.0s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.472 total
time=   0.9s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.802 total
time=   0.6s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.784 total
time=   0.5s
[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=
1.1s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.463 total time=
1.7s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.483 total time=
1.7s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.438 total time=
1.7s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.795 total time=
0.6s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.802 total time=
0.6s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.784 total time=
0.9s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.866 total time=
0.9s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.832 total time=
0.8s
```

```
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.809 total time=
0.8s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.106 total
time=   1.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.093 total
time=   1.2s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.096 total
time=   1.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.524 total time=
1.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.526 total time=
1.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.506 total time=
1.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.802 total
time=   0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.784 total
time=   0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
1.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.433 total
time=   1.0s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.488 total
time=   1.0s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   1.0s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.138 total time=
1.6s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.117 total time=
1.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.146 total time=
1.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.795 total
time=   0.5s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.802 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.784 total
time=   0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[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=
1.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[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=0.724 total time=
1.1s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.723 total time=
1.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.686 total time=
1.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.798 total
time=   0.8s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.790 total
time=   0.5s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.765 total
time=   0.5s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.802 total time=
0.6s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.795 total time=
0.6s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.794 total time=
0.6s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.471 total
time=   0.9s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.505 total
time=   0.9s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.495 total
time=   1.0s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.3s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.079 total time=
1.4s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.798 total
time=   0.5s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.790 total
time=   0.5s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.765 total
time=   0.6s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.0s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
```

```
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[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=   1.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.591 total time=
1.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.567 total time=
1.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.551 total time=
1.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.798 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.790 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.765 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.840 total time=
0.6s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.810 total time=
0.6s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.808 total time=
0.6s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.235 total
time=   1.2s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.174 total
time=   1.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.128 total
time=   1.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.604 total time=
1.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.550 total time=
1.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.611 total time=
1.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.798 total
time=   0.6s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.790 total
time=   0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.765 total
time=   0.7s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.461 total time=
1.0s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.503 total time=
1.0s
```

```
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.473 total time=
1.0s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.500 total
time=   0.9s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.518 total
time=   1.0s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.489 total
time=   0.9s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.385 total time=
1.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.402 total time=
1.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.342 total time=
1.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.798 total
time=   0.5s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.790 total
time=   0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.765 total
time=   0.5s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.2s
[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=
1.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.724 total time=
1.1s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.723 total time=
1.1s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.686 total time=
1.0s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.798 total
time=   0.6s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.790 total
time=   0.7s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.765 total
time=   0.6s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.853 total time=
0.7s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.832 total time=
0.9s
```

```
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.811 total time=
0.7s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.471 total
time=   0.9s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.505 total
time=   1.1s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.495 total
time=   0.9s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.6s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
1.4s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.079 total time=
1.6s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.798 total
time=   0.7s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.790 total
time=   0.7s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.765 total
time=   0.8s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.4s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.591 total time=
1.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.567 total time=
1.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.551 total time=
1.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.798 total time=
0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.790 total time=
0.7s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.765 total time=
0.6s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.864 total time=
0.9s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.838 total time=
0.8s
```

```
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.815 total time=
0.8s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.235 total
time=   1.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.174 total
time=   1.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.128 total
time=   1.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.604 total time=
1.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.550 total time=
1.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.611 total time=
1.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.798 total
time=   0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.790 total
time=   0.5s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.765 total
time=   0.5s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.410 total time=
1.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.451 total time=
1.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.399 total time=
1.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.500 total
time=   1.0s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.518 total
time=   0.9s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.489 total
time=   1.0s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.385 total time=
1.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.402 total time=
1.5s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.342 total time=
1.6s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.798 total
time=   0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.790 total
time=   0.6s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.765 total
time=   0.7s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.3s
```

```
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.724 total time=
1.1s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.723 total time=
1.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.686 total time=
1.2s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.798 total
time=   0.7s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.790 total
time=   0.6s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.765 total
time=   0.6s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.866 total time=
0.9s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.832 total time=
1.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.809 total time=
1.3s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.471 total
time=   1.2s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.505 total
time=   1.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.495 total
time=   0.9s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
2.5s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
1.6s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.079 total time=
1.7s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.798 total
time=   0.8s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.790 total
time=   0.7s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.765 total
time=   0.7s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.4s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.6s
```

```
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.5s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.591 total time=
1.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.567 total time=
1.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.551 total time=
1.5s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.798 total time=
0.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.790 total time=
0.8s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.765 total time=
0.7s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.866 total time=
1.0s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.832 total time=
0.9s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.809 total time=
0.8s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.235 total
time=   1.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.174 total
time=   1.2s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.128 total
time=   1.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.604 total time=
1.2s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.550 total time=
1.8s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.611 total time=
1.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.798 total
time=   0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.790 total
time=   0.6s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.765 total
time=   0.6s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.149 total time=
1.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.083 total time=
1.2s
```

```
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.160 total time=
1.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.500 total
time=   0.9s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.518 total
time=   1.0s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.489 total
time=   0.9s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.385 total time=
1.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.402 total time=
1.7s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.342 total time=
1.5s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.798 total
time=   0.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.790 total
time=   0.5s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.765 total
time=   0.6s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   1.5s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.745 total time=
1.1s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.744 total time=
1.1s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.700 total time=
1.2s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.800 total
time=   0.5s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.784 total
time=   0.5s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.753 total
time=   0.5s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.815 total time=
0.6s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.813 total time=
0.8s
```

```
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.789 total time=
0.7s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   1.0s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.518 total
time=   1.0s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.592 total
time=   1.0s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.267 total time=
1.4s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.226 total time=
1.5s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.216 total time=
1.5s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.800 total
time=   0.6s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.753 total
time=   0.6s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.7s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.2s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.5s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.680 total time=
1.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.621 total time=
1.6s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.657 total time=
1.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.800 total time=
0.7s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.784 total time=
0.7s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.753 total time=
0.8s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.840 total time=
0.7s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.810 total time=
0.6s
```

```
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.808 total time=
0.7s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.268 total
time=   1.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.220 total
time=   1.5s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.206 total
time=   1.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.677 total time=
1.0s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.655 total time=
1.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.639 total time=
1.0s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.800 total
time=   0.7s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.753 total
time=   0.6s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.517 total time=
1.0s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.526 total time=
1.0s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.497 total time=
1.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.527 total
time=   1.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   1.0s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.9s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.409 total time=
1.6s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.441 total time=
1.5s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.393 total time=
1.8s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.800 total
time=   0.7s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.753 total
time=   0.8s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.3s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.2s
```

```
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.191 total
time=   1.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.167 total
time=   1.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.188 total
time=   1.2s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.745 total time=
1.1s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.744 total time=
1.3s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.700 total time=
1.1s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.800 total
time=   0.6s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.753 total
time=   0.7s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.857 total time=
0.9s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.837 total time=
1.0s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.811 total time=
0.9s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   0.9s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.518 total
time=   1.1s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.592 total
time=   0.9s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.267 total time=
1.7s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.226 total time=
1.6s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.216 total time=
1.5s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.800 total
time=   0.9s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.784 total
time=   0.5s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.753 total
time=   0.6s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.4s
```

```
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
1.2s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.5s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.2s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.680 total time=
1.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.621 total time=
1.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.657 total time=
1.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.800 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.784 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.753 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.864 total time=
0.8s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.838 total time=
0.7s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.815 total time=
0.8s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.268 total
time=   1.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.220 total
time=   1.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.206 total
time=   1.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.677 total time=
1.0s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.655 total time=
1.0s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.639 total time=
1.0s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.800 total
time=   0.6s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.784 total
time=   0.7s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.753 total
time=   0.8s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.415 total time=
1.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.457 total time=
1.1s
```

```
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.408 total time=
1.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.527 total
time=   0.9s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.9s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.8s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.409 total time=
1.5s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.441 total time=
1.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.393 total time=
1.5s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.800 total
time=   0.6s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.753 total
time=   0.7s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
1.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.191 total
time=   1.2s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.167 total
time=   1.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.188 total
time=   1.4s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.745 total time=
1.1s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.744 total time=
1.1s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.700 total time=
1.1s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.800 total
time=   0.6s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.753 total
time=   0.6s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.866 total time=
0.9s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.832 total time=
0.8s
```

```
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.809 total time=
0.8s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   0.9s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.518 total
time=   0.9s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.592 total
time=   0.9s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.267 total time=
1.4s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.226 total time=
1.4s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.216 total time=
1.6s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.800 total
time=   0.5s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.753 total
time=   0.5s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.2s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.3s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
1.1s
[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=   1.4s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   1.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.680 total time=
1.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.621 total time=
1.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.657 total time=
1.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.800 total time=
0.6s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.784 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.753 total time=
0.7s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.866 total time=
0.9s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.832 total time=
0.8s
```

```
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.809 total time=
0.8s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.268 total
time=   1.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.220 total
time=   1.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.206 total
time=   1.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.677 total time=
1.0s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.655 total time=
1.2s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.639 total time=
1.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.800 total
time=   0.6s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.784 total
time=   0.6s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.753 total
time=   0.5s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.366 total time=
1.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.388 total time=
1.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.303 total time=
1.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.527 total
time=   0.9s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.530 total
time=   0.9s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   1.0s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.409 total time=
1.6s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.441 total time=
1.6s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.393 total time=
1.6s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.800 total
time=   0.5s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.784 total
time=   0.5s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.753 total
time=   0.6s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
```

```
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
1.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.191 total
time=   1.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.167 total
time=   1.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.188 total
time=   1.2s
```

```
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']
```

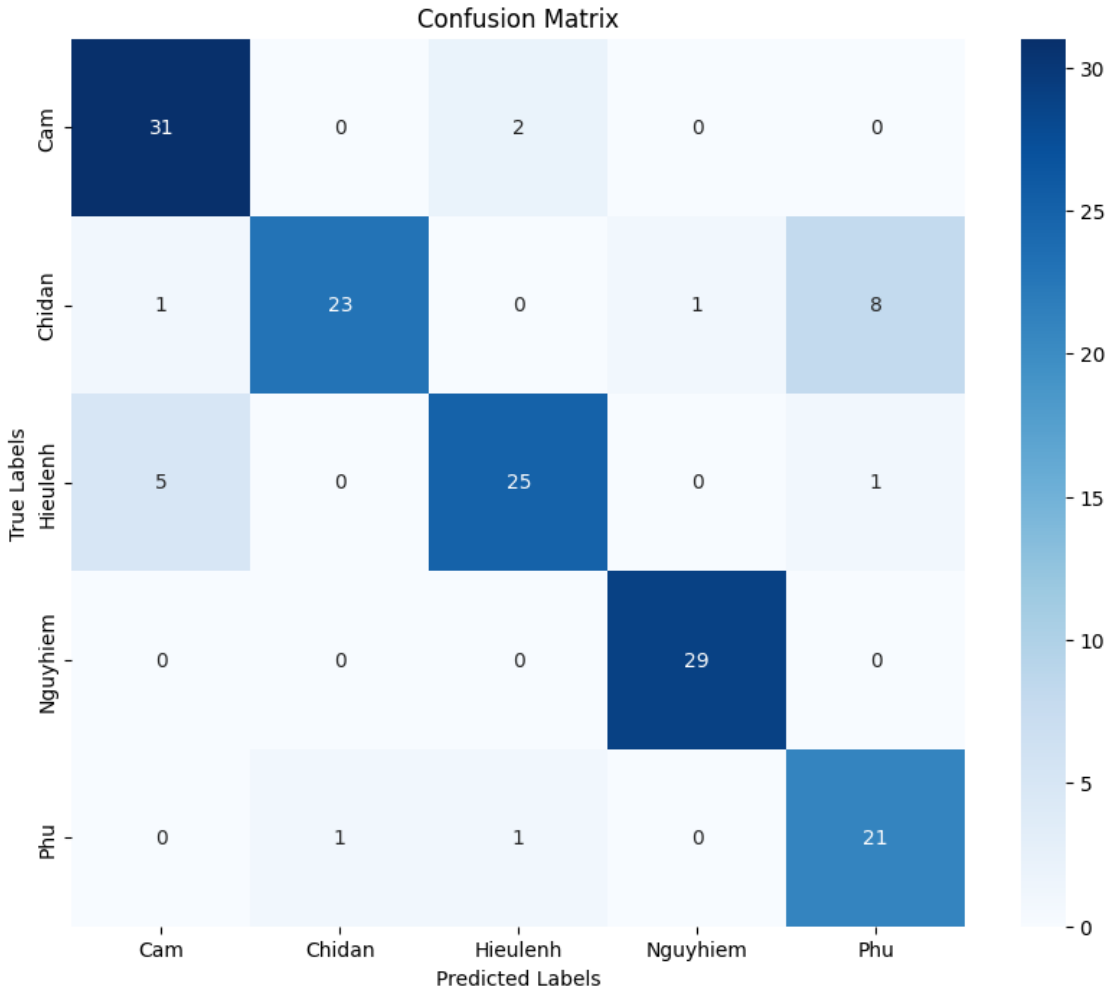
8 Predict on test images for KNN

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

```
              precision    recall  f1-score   support

         Cam       0.84      0.94      0.89        33
      Chidan       0.96      0.70      0.81        33
    Hieulenh       0.89      0.81      0.85        31
    Nguyhiem       0.97      1.00      0.98        29
         Phu       0.70      0.91      0.79        23

    accuracy                           0.87       149
   macro avg       0.87      0.87      0.86       149
```

```
weighted avg       0.88      0.87      0.86       149
```

```
heatmap_label_knn = confusion_matrix(test_labels_encoded, y_pred_knn)

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




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

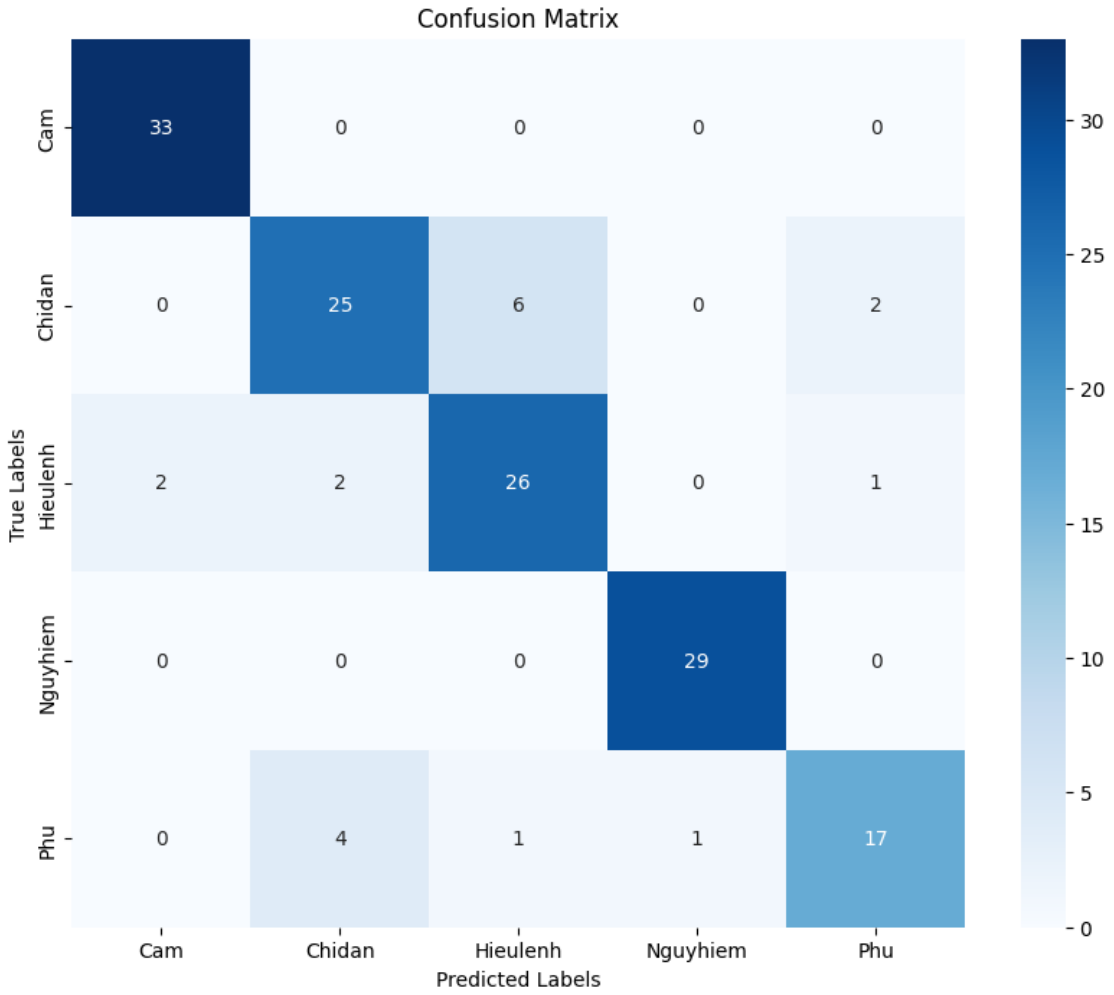
```
fig, axes = plt.subplots(n_rows, n_columns, figsize=(30, n_rows * 3))

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

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

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

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

9 Predict on test images for SVM

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

```
              precision    recall  f1-score   support

         Cam       0.94      1.00      0.97        33
      Chidan       0.81      0.76      0.78        33
    Hieulenh       0.79      0.84      0.81        31
    Nguyhiem       0.97      1.00      0.98        29
         Phu       0.85      0.74      0.79        23

    accuracy                           0.87       149
   macro avg       0.87      0.87      0.87       149
weighted avg       0.87      0.87      0.87       149
```

```
heatmap_label_svm = confusion_matrix(test_labels_encoded, y_pred_svm)

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




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

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

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

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

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

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

10 Save grid search results

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

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

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

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

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

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

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

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

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

export_notebook_to_pdf(notebook_path, proj_dir)
```

```
Đã xuất file PDF thành công: d:\ASUS\Deploy-Traffic-Sign-Classification-through-Images\grid_search_results\notebook_export_2024-12-24_08_50_11.pdf
```

```
'd:\\ASUS\\Deploy-Traffic-Sign-Classification-through-
Images\\grid_search_results\\notebook_export_2024-12-24_08_50_11.pdf'
```

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

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

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

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