Notebook

December 10, 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
```

2 Load data

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

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

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

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

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

train_images = []
test_images = []

train_labels = []
test_labels = []

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

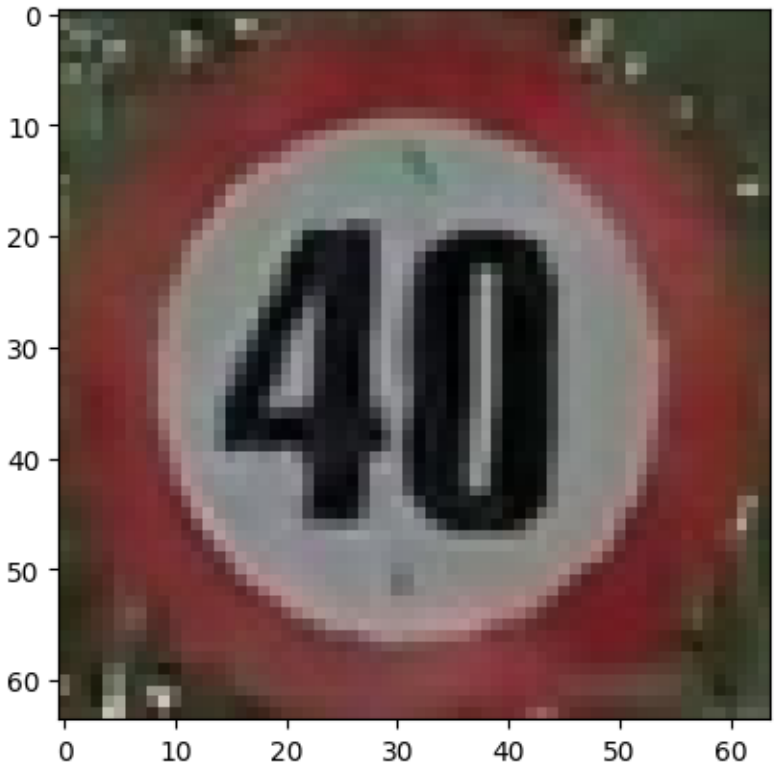
```
label_encoder = LabelEncoder()
train_labels_encoded = label_encoder.fit_transform(train_labels)
test_labels_encoded = label_encoder.transform(test_labels)
```

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

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

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

```
<matplotlib.image.AxesImage at 0x2560f8ca600>
```




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

```
<matplotlib.image.AxesImage at 0x2560f88bda0>
```

3 Extract features

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

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

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

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

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

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

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

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

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

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

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

```
def extract_features(images):
    blurred_images = [blur_image(image) for image in tqdm(images, desc="Blur␣
 ↪Images")]
    color_features = [color_histogram(image) for image in tqdm(blurred_images,␣
 ↪desc="Extracting Color Features")]
    hog_features = [hog(image) for image in tqdm(blurred_images,␣
 ↪desc="Extracting HOG Features")]
    combined_features = [np.concatenate((color_feature, hog_feature))
                         for color_feature, hog_feature in␣
 ↪tqdm(zip(color_features, hog_features), desc="Combining Features")]

    return combined_features
```

```
train_features = extract_features(train_images)
joblib.dump(train_features, project_dir + '\\joblib\\train_features.joblib')
```

```
Blur Images: 100%|      | 1415/1415 [00:00<00:00, 15321.67it/s]
Extracting Color Features: 100%|      | 1415/1415 [00:00<00:00,
17417.54it/s]
Extracting HOG Features: 100%|      | 1415/1415 [00:02<00:00, 509.81it/s]
Combining Features: 1415it [00:00, 99494.40it/s]

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

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

```
Blur Images: 100%|      | 150/150 [00:00<00:00, 30174.85it/s]
Extracting Color Features: 100%|      | 150/150 [00:00<00:00, 11496.07it/s]
Extracting HOG Features: 100%|      | 150/150 [00:00<00:00, 520.98it/s]
Combining Features: 150it [00:00, ?it/s]
```

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

4 Distance metrics KNN

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

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

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

5 Load Best Model

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

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

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

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

6 Gridsearch KNN

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

```
param_grid = {
    'n_neighbors': [3, 4, 5, 6, 7, 10],
    'weights': ['uniform', 'distance'],
    'metric': [
        cityblock,
        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 72 candidates, totalling 216 fits
[CV 1/3] END metric=<function cityblock at 0x000002567F2D4180>, n_neighbors=3,
weights=uniform;, score=0.880 total time=   2.8s
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[CV 3/3] END metric=<function cityblock at 0x000002567F2D4180>, n_neighbors=4,
weights=uniform;, score=0.814 total time=   2.5s
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```

```
weights=distance;, score=0.828 total time=   2.5s
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weights=uniform;, score=0.860 total time=   2.6s
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weights=uniform;, score=0.831 total time=   2.5s
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weights=uniform;, score=0.825 total time=   2.7s
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weights=distance;, score=0.881 total time=   2.6s
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weights=distance;, score=0.831 total time=   2.4s
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weights=uniform;, score=0.854 total time=   2.6s
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weights=uniform;, score=0.808 total time=   2.5s
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weights=uniform;, score=0.803 total time=   2.6s
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weights=distance;, score=0.847 total time=   2.6s
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weights=uniform;, score=0.837 total time=   2.6s
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weights=uniform;, score=0.807 total time=   2.5s
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weights=uniform;, score=0.800 total time=   2.6s
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weights=distance;, score=0.876 total time=   2.5s
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weights=distance;, score=0.819 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x000002567F2D4180>, n_neighbors=10,
weights=uniform;, score=0.814 total time=   2.6s
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```

```
weights=distance;, score=0.802 total time=   2.4s
[CV 1/3] END metric=<function cosine at 0x000002567F2AFE20>, n_neighbors=3,
weights=uniform;, score=0.850 total time=   3.5s
[CV 2/3] END metric=<function cosine at 0x000002567F2AFE20>, n_neighbors=3,
weights=uniform;, score=0.812 total time=   3.7s
[CV 3/3] END metric=<function cosine at 0x000002567F2AFE20>, n_neighbors=3,
weights=uniform;, score=0.799 total time=   3.5s
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weights=distance;, score=0.871 total time=   3.7s
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weights=distance;, score=0.814 total time=   3.7s
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weights=distance;, score=0.817 total time=   3.5s
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weights=uniform;, score=0.844 total time=   3.6s
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[CV 3/3] END metric=<function cosine at 0x000002567F2AFE20>, n_neighbors=6,
```

```
weights=distance;, score=0.772 total time=   3.5s
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[CV 2/3] END metric=<function cosine at 0x000002567F2AFE20>, n_neighbors=7,
weights=uniform;, score=0.781 total time=   3.7s
[CV 3/3] END metric=<function cosine at 0x000002567F2AFE20>, n_neighbors=7,
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[CV 2/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=4,
weights=distance;, score=0.819 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=4,
```

```
weights=distance;, score=0.797 total time=   2.3s
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[CV 2/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=5,
weights=uniform;, score=0.799 total time=   2.4s
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weights=uniform;, score=0.783 total time=   2.4s
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weights=uniform;, score=0.740 total time=   2.5s
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weights=distance;, score=0.870 total time=   2.6s
[CV 2/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=6,
weights=distance;, score=0.823 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=6,
weights=distance;, score=0.772 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=7,
weights=uniform;, score=0.838 total time=   2.3s
[CV 2/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=7,
weights=uniform;, score=0.780 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=7,
weights=uniform;, score=0.741 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=7,
weights=distance;, score=0.865 total time=   2.2s
[CV 2/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=7,
weights=distance;, score=0.789 total time=   2.2s
[CV 3/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>, n_neighbors=7,
weights=distance;, score=0.768 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>,
n_neighbors=10, weights=uniform;, score=0.800 total time=   2.2s
[CV 2/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>,
n_neighbors=10, weights=uniform;, score=0.743 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>,
n_neighbors=10, weights=uniform;, score=0.723 total time=   2.3s
[CV 1/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>,
n_neighbors=10, weights=distance;, score=0.833 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>,
n_neighbors=10, weights=distance;, score=0.789 total time=   2.3s
[CV 3/3] END metric=<function sqeuclidean at 0x000002567F2AFCE0>,
```

```
n_neighbors=10, weights=distance;, score=0.743 total time=   2.4s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=3, weights=uniform;, score=0.717 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=3, weights=uniform;, score=0.694 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=3, weights=uniform;, score=0.694 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=3, weights=distance;, score=0.747 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=3, weights=distance;, score=0.710 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=3, weights=distance;, score=0.719 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=4, weights=uniform;, score=0.703 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=4, weights=uniform;, score=0.681 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=4, weights=uniform;, score=0.691 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=4, weights=distance;, score=0.769 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=4, weights=distance;, score=0.720 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=4, weights=distance;, score=0.727 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=5, weights=uniform;, score=0.703 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=5, weights=uniform;, score=0.705 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=5, weights=uniform;, score=0.685 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=5, weights=distance;, score=0.743 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=5, weights=distance;, score=0.741 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=5, weights=distance;, score=0.720 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=6, weights=uniform;, score=0.712 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=6, weights=uniform;, score=0.686 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=6, weights=uniform;, score=0.690 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=6, weights=distance;, score=0.760 total time=   3.0s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=6, weights=distance;, score=0.735 total time=   3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
```

```
n_neighbors=6, weights=distance;, score=0.734 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=7, weights=uniform;, score=0.714 total time=   2.9s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=7, weights=uniform;, score=0.689 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=7, weights=uniform;, score=0.675 total time=   2.9s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=7, weights=distance;, score=0.736 total time=   3.2s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=7, weights=distance;, score=0.739 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=7, weights=distance;, score=0.735 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=10, weights=uniform;, score=0.684 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=10, weights=uniform;, score=0.664 total time=   3.0s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=10, weights=uniform;, score=0.658 total time=   3.0s
[CV 1/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=10, weights=distance;, score=0.746 total time=   2.9s
[CV 2/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=10, weights=distance;, score=0.713 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000025613C098A0>,
n_neighbors=10, weights=distance;, score=0.725 total time=   3.0s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=3, weights=uniform;, score=0.854 total time=   3.0s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=3, weights=uniform;, score=0.779 total time=   3.0s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=3, weights=uniform;, score=0.741 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=3, weights=distance;, score=0.867 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=3, weights=distance;, score=0.794 total time=   3.2s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=3, weights=distance;, score=0.747 total time=   2.9s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=4, weights=uniform;, score=0.820 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=4, weights=uniform;, score=0.768 total time=   2.9s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=4, weights=uniform;, score=0.722 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=4, weights=distance;, score=0.864 total time=   3.0s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=4, weights=distance;, score=0.789 total time=   3.0s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
```

```
n_neighbors=4, weights=distance;, score=0.732 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=5, weights=uniform;, score=0.840 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=5, weights=uniform;, score=0.767 total time=   3.7s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=5, weights=uniform;, score=0.725 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=5, weights=distance;, score=0.850 total time=   3.0s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=5, weights=distance;, score=0.772 total time=   2.9s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=5, weights=distance;, score=0.730 total time=   3.0s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=6, weights=uniform;, score=0.834 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=6, weights=uniform;, score=0.751 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=6, weights=uniform;, score=0.706 total time=   3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=6, weights=distance;, score=0.868 total time=   3.0s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=6, weights=distance;, score=0.783 total time=   3.0s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=6, weights=distance;, score=0.718 total time=   3.1s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=7, weights=uniform;, score=0.815 total time=   3.1s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=7, weights=uniform;, score=0.756 total time=   3.0s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=7, weights=uniform;, score=0.689 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=7, weights=distance;, score=0.833 total time=   3.4s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=7, weights=distance;, score=0.745 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=7, weights=distance;, score=0.706 total time=   3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=10, weights=uniform;, score=0.777 total time=   3.3s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=10, weights=uniform;, score=0.735 total time=   3.2s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=10, weights=uniform;, score=0.685 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=10, weights=distance;, score=0.808 total time=   3.6s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
n_neighbors=10, weights=distance;, score=0.735 total time=   3.6s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000025613C09E40>,
```

```
n_neighbors=10, weights=distance;, score=0.691 total time=   3.1s
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n_neighbors=3, weights=uniform;, score=0.763 total time=   2.3s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=3, weights=uniform;, score=0.716 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=3, weights=uniform;, score=0.653 total time=   2.8s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=3, weights=distance;, score=0.076 total time=   2.7s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=3, weights=distance;, score=0.076 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=3, weights=distance;, score=0.076 total time=   2.3s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=4, weights=uniform;, score=0.773 total time=   2.3s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=4, weights=uniform;, score=0.707 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=4, weights=uniform;, score=0.650 total time=   2.3s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=4, weights=distance;, score=0.076 total time=   2.3s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=4, weights=distance;, score=0.076 total time=   2.3s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=4, weights=distance;, score=0.076 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=5, weights=uniform;, score=0.757 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=5, weights=uniform;, score=0.695 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=5, weights=uniform;, score=0.647 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=5, weights=distance;, score=0.076 total time=   2.3s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=5, weights=distance;, score=0.076 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=5, weights=distance;, score=0.076 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=6, weights=uniform;, score=0.737 total time=   2.3s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=6, weights=uniform;, score=0.680 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=6, weights=uniform;, score=0.615 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=6, weights=distance;, score=0.076 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=6, weights=distance;, score=0.076 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
```

```
n_neighbors=6, weights=distance;, score=0.076 total time=   2.3s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=7, weights=uniform;, score=0.737 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=7, weights=uniform;, score=0.670 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=7, weights=uniform;, score=0.605 total time=   2.4s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=7, weights=distance;, score=0.076 total time=   2.3s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=7, weights=distance;, score=0.076 total time=   2.3s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=7, weights=distance;, score=0.076 total time=   2.3s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=10, weights=uniform;, score=0.700 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=10, weights=uniform;, score=0.644 total time=   2.3s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=10, weights=uniform;, score=0.589 total time=   2.3s
[CV 1/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=10, weights=distance;, score=0.076 total time=   2.3s
[CV 2/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=10, weights=distance;, score=0.076 total time=   2.4s
[CV 3/3] END metric=<function intersection_distance at 0x0000025613C08FE0>,
n_neighbors=10, weights=distance;, score=0.076 total time=   2.3s

GridSearchCV(cv=3, estimator=KNeighborsClassifier(),
             param_grid={'metric': [<function cityblock at 0x000002567F2D4180>,
                                    <function cosine at 0x000002567F2AFE20>,
                                    <function sqeuclidean at
0x000002567F2AFCE0>,
                                    <function chi_square_distance at
0x0000025613C098A0>,
                                    <function bhattacharyya_distance at
0x0000025613C09E40>,
                                    <function intersection_distance at
0x0000025613C08FE0>],
                         'n_neighbors': [3, 4, 5, 6, 7, 10],
                         'weights': ['uniform', 'distance']},
             scoring='f1_macro', verbose=3)
```

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

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

y_pred_knn = best_knn.predict(test_features)
```

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

```
Best Params: {'metric': <function cityblock at 0x000002567F2D4180>,
'n_neighbors': 4, 'weights': 'distance'}
Thuật toán sử dụng: auto

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

7 Gridsearch SVM

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

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

svm_model = SVC()

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

grid_search_svm.fit(train_features, train_labels_encoded)
```

```
Fitting 3 folds for each of 240 candidates, totalling 720 fits
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.542 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.551 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.513 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.716 total time=
0.2s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.729 total time=
0.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.670 total time=
0.2s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.491 total
time=   0.2s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   0.3s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.3s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.076 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.076 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.076 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.3s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.427 total time=
0.7s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.373 total time=
0.7s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.872 total time=
0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.793 total time=
```

```
0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.904 total time=
0.2s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.876 total time=
0.2s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.823 total time=
0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.393 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.395 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.385 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.506 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.508 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.480 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.430 total time=
0.3s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.459 total time=
0.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.403 total time=
0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.447 total
time=   0.2s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.484 total
time=   0.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.420 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.076 total time=
0.6s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.125 total time=
0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.542 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.551 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.513 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.807 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.772 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.730 total time=
0.2s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.491 total
time=   0.3s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   0.2s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.2s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.076 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.3s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.3s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.427 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.373 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.872 total time=
0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.913 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.873 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.836 total time=
0.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.393 total
time=   0.3s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.395 total
time=   0.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.385 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.506 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.508 total time=
0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.480 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.076 total time=
0.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.145 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.484 total
time=   0.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.420 total
time=   0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.076 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.125 total time=
0.6s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.793 total
time=   0.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.542 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.551 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.513 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.862 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.834 total time=
0.2s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.766 total time=
0.2s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.491 total
time=   0.3s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.497 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.6s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.076 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.390 total time=
0.8s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.427 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.373 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.872 total time=
0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.835 total time=
0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.793 total time=
```

```
0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.850 total time=
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.393 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.395 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.385 total
time=   0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.506 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.508 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.480 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.447 total
time=   0.3s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.484 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.420 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.076 total time=
0.6s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.076 total time=
0.6s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.125 total time=
0.6s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.872 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.835 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.613 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.612 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.614 total time=
0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.820 total time=
0.2s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.790 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.744 total time=
0.2s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.532 total
time=   0.2s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.544 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.525 total
time=   0.2s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.219 total time=
0.6s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.128 total time=
0.6s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.192 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.3s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.6s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.7s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.408 total time=
0.8s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.433 total time=
0.7s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.383 total time=
0.7s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.838 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.904 total time=
0.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.872 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.821 total time=
0.2s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.411 total
time=   0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.445 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.433 total
time=   0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.563 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.553 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.542 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.458 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.496 total time=
0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.460 total time=
0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.520 total
time=   0.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.520 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.503 total
time=   0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.429 total time=
0.7s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.6s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.417 total time=
0.6s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.142 total
time=   0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.183 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.613 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.612 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.614 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.887 total time=
0.2s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.854 total time=
0.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.801 total time=
0.2s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.532 total
time=   0.2s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.544 total
time=   0.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.525 total
time=   0.2s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.219 total time=
0.7s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.128 total time=
0.6s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.192 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.3s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.408 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.433 total time=
0.6s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.383 total time=
0.6s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.838 total time=
0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.793 total time=
```

```
0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.913 total time=
0.3s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.873 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.836 total time=
0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.411 total
time=   0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.445 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.433 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.563 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.553 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.542 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.417 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.440 total time=
0.6s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.391 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.520 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.520 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.503 total
time=   0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.429 total time=
0.9s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.9s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.417 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.793 total
```

```
time=   0.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.142 total
time=   0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.183 total
time=   0.5s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.613 total time=
0.6s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.612 total time=
0.6s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.614 total time=
0.6s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.793 total
time=   0.2s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.902 total time=
0.3s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.869 total time=
0.3s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.823 total time=
0.3s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.532 total
time=   0.2s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.544 total
time=   0.2s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.525 total
time=   0.3s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.219 total time=
0.7s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.128 total time=
0.8s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.192 total time=
1.0s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.857 total
time=   0.2s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.838 total
time=   0.2s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.793 total
```

```
time=   0.2s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.6s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.408 total time=
0.7s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.433 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.383 total time=
0.7s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.838 total time=
0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.793 total time=
0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.850 total time=
0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.411 total
time=   0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.445 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.433 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.563 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.553 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.542 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.793 total
```

```
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.520 total
time=   0.3s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.520 total
time=   0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.503 total
time=   0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.429 total time=
0.8s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.417 total time=
0.8s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.838 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.793 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.142 total
time=   0.5s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.076 total
time=   0.6s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.183 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.720 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.743 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.678 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.848 total
time=   0.2s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.833 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.798 total
```

```
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.872 total time=
0.2s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.835 total time=
0.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.781 total time=
0.2s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.568 total
time=   0.3s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.614 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.590 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.401 total time=
0.8s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.412 total time=
0.7s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.380 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.451 total time=
0.6s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.493 total time=
0.7s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.425 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.848 total time=
0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.798 total time=
```

```
0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.900 total time=
0.2s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.874 total time=
0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.818 total time=
0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.411 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.448 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.450 total
time=   0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.601 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.617 total time=
0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.601 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.534 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.533 total time=
0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.504 total time=
0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.547 total
time=   0.2s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.542 total
time=   0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.528 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.435 total time=
0.8s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.461 total time=
0.7s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.416 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.798 total
```

```
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.390 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.402 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.364 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.720 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.743 total time=
0.5s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.678 total time=
0.5s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.906 total time=
0.2s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.866 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.822 total time=
0.2s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.568 total
time=   0.2s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.614 total
time=   0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.590 total
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.401 total time=
0.7s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.412 total time=
0.7s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.380 total time=
0.7s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.798 total
```

```
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.5s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.451 total time=
0.7s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.493 total time=
0.7s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.425 total time=
0.7s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.848 total time=
0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.798 total time=
0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.913 total time=
0.3s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.873 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.836 total time=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.411 total
time=   0.3s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.448 total
time=   0.3s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.450 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.601 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.617 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.601 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.798 total
```

```
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.435 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.465 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.399 total time=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.547 total
time=   0.3s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.542 total
time=   0.3s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.528 total
time=   0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.435 total time=
0.7s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.461 total time=
0.7s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.416 total time=
0.7s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.390 total
time=   0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.402 total
time=   0.5s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.364 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.720 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.743 total time=
0.5s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.678 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.798 total
```

```
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.904 total time=
0.3s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.871 total time=
0.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.834 total time=
0.3s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.568 total
time=   0.2s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.614 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.590 total
time=   0.2s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.401 total time=
0.8s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.412 total time=
0.7s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.380 total time=
0.7s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.076 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.451 total time=
0.7s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.493 total time=
0.7s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.425 total time=
0.7s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.848 total time=
0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.798 total time=
```

```
0.2s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.870 total time=
0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.850 total time=
0.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.411 total
time=   0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.448 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.450 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.601 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.617 total time=
0.5s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.601 total time=
0.5s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.798 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.298 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.109 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.213 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.547 total
time=   0.2s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.542 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.528 total
time=   0.2s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.435 total time=
0.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.461 total time=
0.6s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.416 total time=
0.6s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.848 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.798 total
```

```
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.390 total
time=   0.5s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.402 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.364 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.788 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.763 total time=
0.5s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.727 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.794 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.889 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.849 total time=
0.2s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.801 total time=
0.2s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.640 total
time=   0.2s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.668 total
time=   0.3s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.619 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.433 total time=
0.8s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.452 total time=
0.8s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.415 total time=
0.7s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.794 total
```

```
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.242 total
time=   0.5s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.190 total
time=   0.5s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.192 total
time=   0.5s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.583 total time=
0.7s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.588 total time=
0.9s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.550 total time=
0.8s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.846 total time=
0.3s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.833 total time=
0.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.794 total time=
0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.900 total time=
0.3s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.874 total time=
0.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.818 total time=
0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.412 total
time=   0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.463 total
time=   0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.684 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.698 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.663 total time=
0.5s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.794 total
```

```
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.563 total time=
0.3s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.554 total time=
0.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.525 total time=
0.3s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.566 total
time=   0.3s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.570 total
time=   0.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.572 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.440 total time=
0.7s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.7s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.418 total time=
0.6s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.794 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.434 total
time=   0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.447 total
time=   0.5s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.416 total
time=   0.5s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.788 total time=
0.5s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.763 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.727 total time=
0.5s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.794 total
```

```
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.913 total time=
0.3s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.869 total time=
0.3s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.825 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.640 total
time=   0.2s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.668 total
time=   0.3s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.619 total
time=   0.2s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.433 total time=
0.7s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.452 total time=
0.7s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.415 total time=
0.7s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.794 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.242 total
time=   0.5s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.190 total
time=   0.5s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.192 total
time=   0.5s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.583 total time=
0.7s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.588 total time=
0.7s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.550 total time=
0.7s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.846 total time=
0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.794 total time=
```

```
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.913 total time=
0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.873 total time=
0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.836 total time=
0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.412 total
time=   0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.463 total
time=   0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.684 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.698 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.663 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.794 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.441 total time=
0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.463 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.412 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.566 total
time=   0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.570 total
time=   0.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.572 total
time=   0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.440 total time=
0.7s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.418 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.794 total
```

```
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.434 total
time=   0.5s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.447 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.416 total
time=   0.5s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.788 total time=
0.5s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.763 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.727 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.794 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.873 total time=
0.3s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.845 total time=
0.3s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.640 total
time=   0.2s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.668 total
time=   0.2s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.619 total
time=   0.2s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.433 total time=
0.7s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.452 total time=
0.8s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.415 total time=
0.8s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.794 total
```

```
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.5s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.242 total
time=   0.5s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.190 total
time=   0.5s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.192 total
time=   0.5s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.583 total time=
0.7s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.588 total time=
0.7s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.550 total time=
0.7s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.846 total time=
0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.833 total time=
0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.794 total time=
0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.906 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.870 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.850 total time=
0.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.412 total
time=   0.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.3s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.463 total
time=   0.3s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.684 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.698 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.663 total time=
0.5s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.846 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.794 total
```

```
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.397 total time=
0.5s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.411 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.365 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.566 total
time=   0.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.570 total
time=   0.3s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.572 total
time=   0.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.440 total time=
0.7s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.418 total time=
0.6s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.846 total
time=   0.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.833 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.794 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.5s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.076 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.434 total
time=   0.5s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.447 total
time=   0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.416 total
time=   0.4s
```

```
c:\Users\Legion 5 Pro\AppData\Local\Programs\Python\Python312\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': 4, 'gamma': 0.1, 'kernel': 'poly'}
```

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

8 Predict on test images for KNN

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

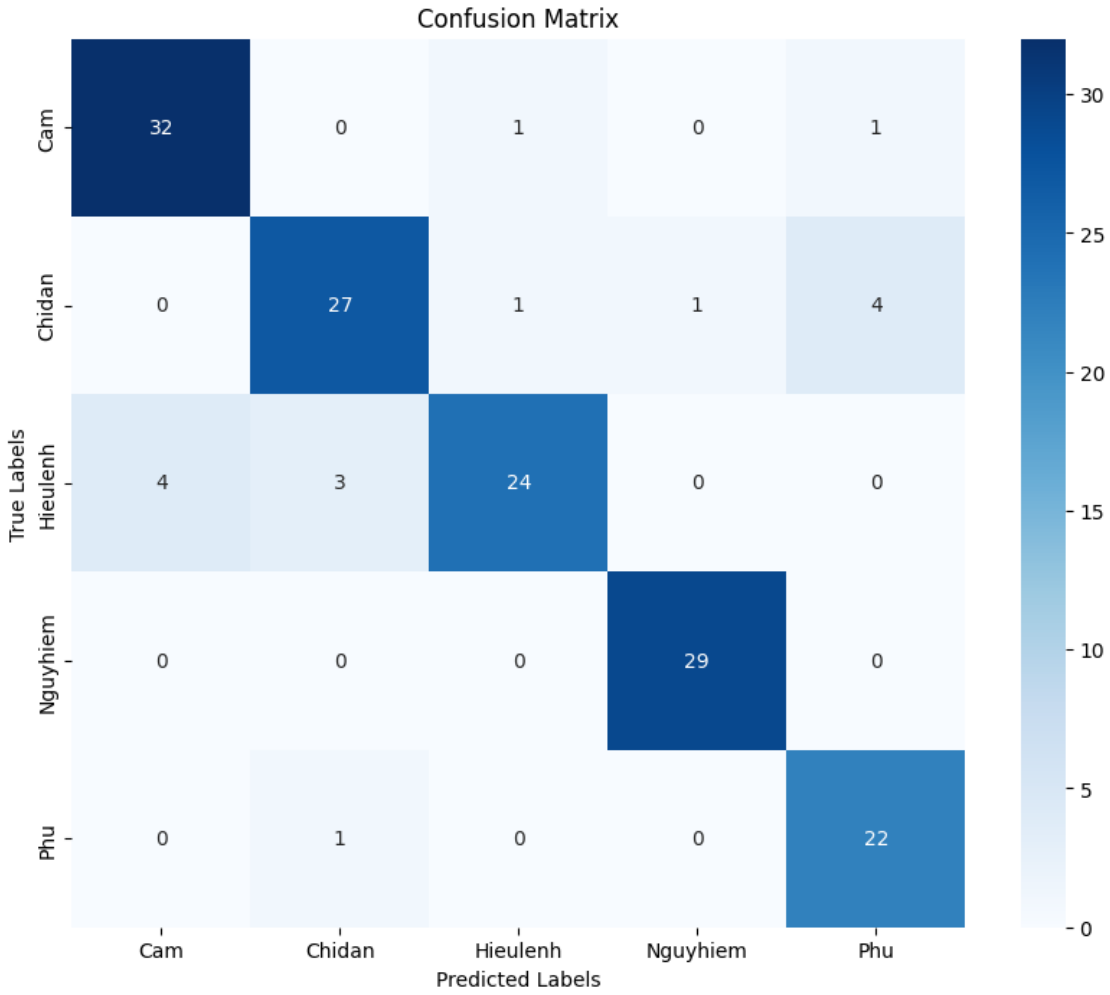
```
              precision    recall  f1-score   support

         Cam       0.89      0.94      0.91        34
      Chidan       0.87      0.82      0.84        33
    Hieulenh       0.92      0.77      0.84        31
    Nguyhiem       0.97      1.00      0.98        29
         Phu       0.81      0.96      0.88        23

    accuracy                           0.89       150
   macro avg       0.89      0.90      0.89       150
weighted avg       0.90      0.89      0.89       150
```

```
heatmap_label_knn = confusion_matrix(test_labels_encoded, y_pred_knn)

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




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

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

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

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

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

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

9 Predict on test images for SVM

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

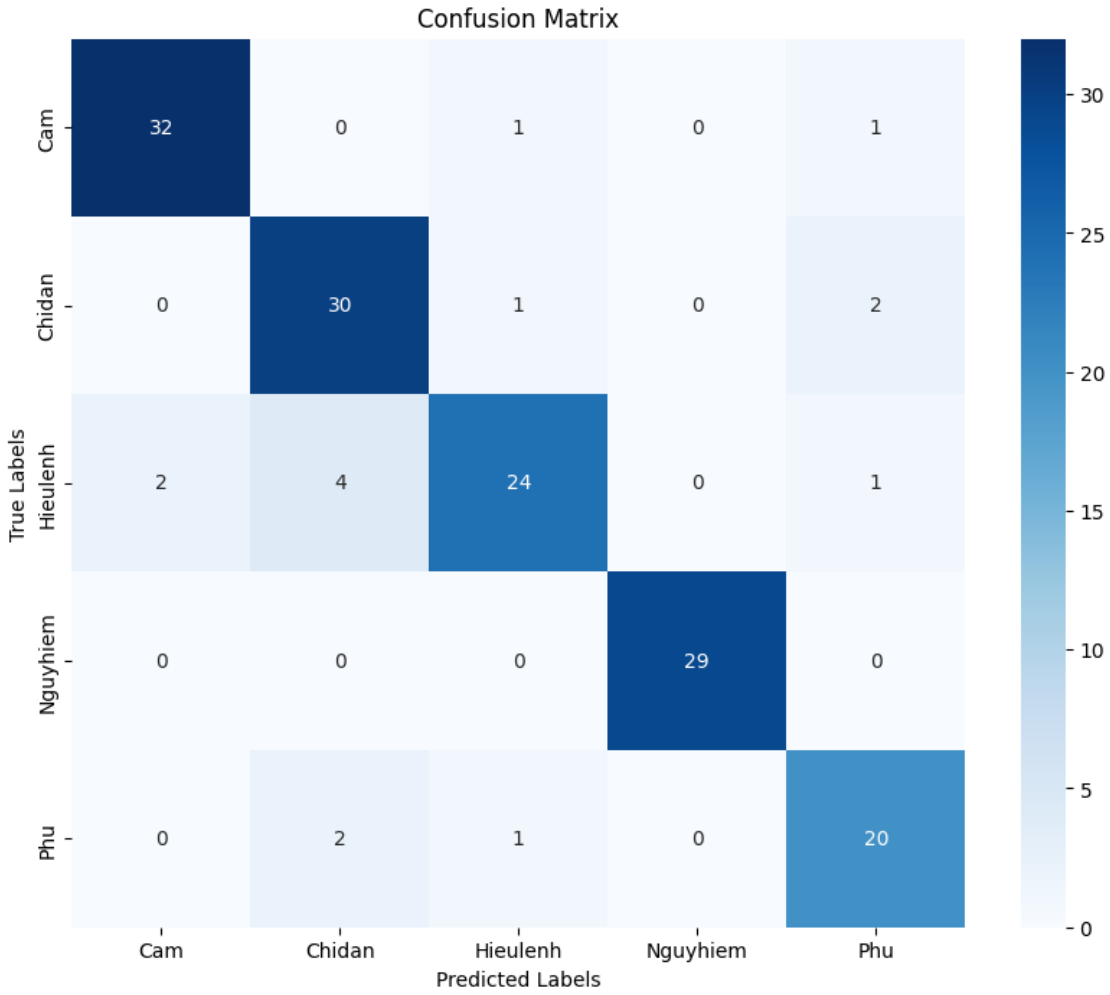
```
              precision    recall  f1-score   support

         Cam       0.94      0.94      0.94        34
      Chidan       0.83      0.91      0.87        33
    Hieulenh       0.89      0.77      0.83        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.83      0.87      0.85        23

    accuracy                           0.90       150
   macro avg       0.90      0.90      0.90       150
weighted avg       0.90      0.90      0.90       150
```

```
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()
```


True: Cam Pred: Cam
True: Cam Pred: Hieulenh
True: Cam Pred: Phu
True: Chidan Pred: Chidan
True: Chidan Pred: Phu
True: Chidan Pred: Hieulenh
True: Hieulenh Pred: Hieulenh
True: Hieulenh Pred: Chidan
True: Hieulenh Pred: Cam
True: Hieulenh Pred: Phu
True: Nguyhiem Pred: Nguyhiem
True: Phu Pred: Phu
True: Phu Pred: Chidan
True: Phu Pred: Hieulenh

10 Save grid search results

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

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

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

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

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

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

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

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

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

export_notebook_to_pdf(notebook_path, proj_dir)
```

```
Đã xuất file PDF thành công: e:\Documents\CS231\project\Traffic-Sign-
Classification-through-
Images\grid_search_results\notebook_export_2024-12-10_08_45_31.pdf
```

```
'e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\grid_search_results\\notebook_export_2024-12-10_08_45_31.pdf'
```