Notebook

December 23, 2024

1 Import libraries

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

2 Load data

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

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

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

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

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

train_images = []
test_images = []

train_labels = []
test_labels = []

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

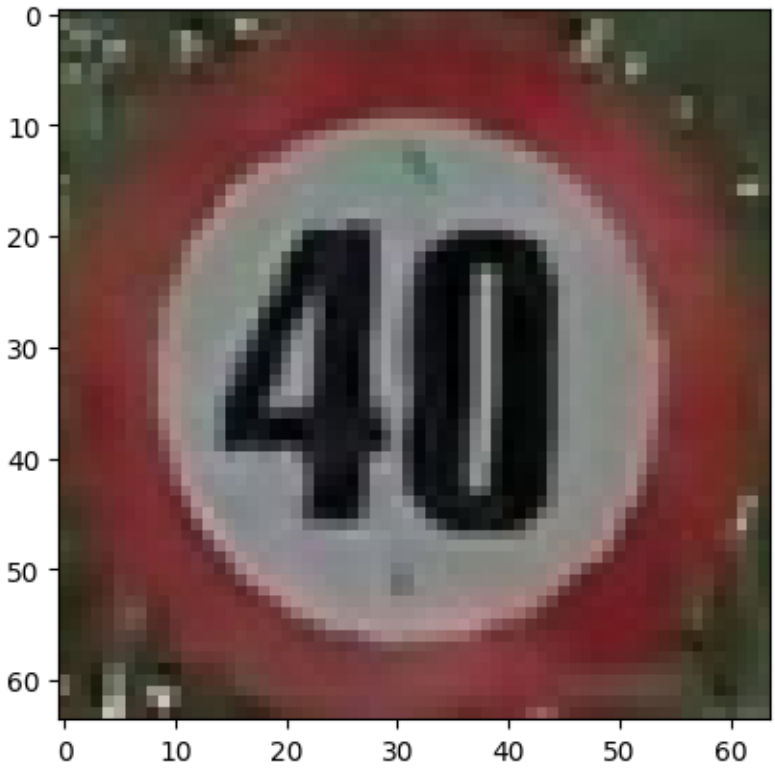
```
label_encoder = LabelEncoder()
train_labels_encoded = label_encoder.fit_transform(train_labels)
test_labels_encoded = label_encoder.transform(test_labels)
```

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

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

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

```
<matplotlib.image.AxesImage at 0x12a2600f460>
```




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

```
<matplotlib.image.AxesImage at 0x12a27123100>
```

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, [64], [0, 256]))
        histogram = histogram / size
        feature.extend(histogram)
    return feature
```

```
# def plot_color_histogram(image):

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

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

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

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

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

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

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

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

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

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

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

    return combined_features
```

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

```
Blur Images: 100%|      | 1416/1416 [00:00<00:00, 49663.71it/s]
Extracting Color Features: 100%|      | 1416/1416 [00:00<00:00,
28316.38it/s]
Extracting HOG Features: 100%|      | 1416/1416 [00:02<00:00, 696.90it/s]
Combining Features: 1416it [00:00, 61560.11it/s]

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

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

```
Blur Images: 100%|      | 149/149 [00:00<00:00, 49662.37it/s]
Extracting Color Features: 100%|      | 149/149 [00:00<00:00, 37192.84it/s]
Extracting HOG Features: 100%|      | 149/149 [00:00<00:00, 679.35it/s]
Combining Features: 149it [00:00, 74514.28it/s]

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

4 Distance metrics KNN

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

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

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

5 Load Best Model

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

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

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

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

6 Gridsearch KNN

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

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

```
    ]
}

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

grid_search_knn.fit(train_features, train_labels_encoded)
```

```
Fitting 3 folds for each of 84 candidates, totalling 252 fits
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;, score=0.877 total time=   2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;, score=0.856 total time=   2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=uniform;, score=0.839 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;, score=0.887 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=3,
weights=distance;, score=0.868 total time=   2.5s
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weights=distance;, score=0.848 total time=   2.5s
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weights=uniform;, score=0.862 total time=   2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=uniform;, score=0.842 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=uniform;, score=0.835 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;, score=0.896 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;, score=0.875 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=4,
weights=distance;, score=0.851 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;, score=0.862 total time=   2.5s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;, score=0.844 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=uniform;, score=0.832 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=distance;, score=0.883 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
```

```
weights=distance;, score=0.856 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=5,
weights=distance;, score=0.842 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;, score=0.849 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;, score=0.823 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=uniform;, score=0.807 total time=   2.4s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;, score=0.881 total time=   2.4s
[CV 2/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=6,
weights=distance;, score=0.856 total time=   2.4s
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weights=distance;, score=0.845 total time=   2.4s
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weights=uniform;, score=0.846 total time=   2.4s
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weights=uniform;, score=0.827 total time=   2.4s
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weights=uniform;, score=0.798 total time=   2.5s
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weights=distance;, score=0.881 total time=   2.6s
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weights=distance;, score=0.835 total time=   2.5s
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weights=distance;, score=0.817 total time=   2.6s
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weights=uniform;, score=0.813 total time=   2.5s
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weights=uniform;, score=0.808 total time=   2.5s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=uniform;, score=0.757 total time=   2.5s
[CV 1/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;, score=0.856 total time=   2.4s
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weights=distance;, score=0.841 total time=   2.4s
[CV 3/3] END metric=<function cityblock at 0x0000012A22EB4EE0>, n_neighbors=10,
weights=distance;, score=0.808 total time=   2.4s
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weights=uniform;, score=0.856 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;, score=0.823 total time=   3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=uniform;, score=0.791 total time=   3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=distance;, score=0.862 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
```

```
weights=distance;, score=0.824 total time=   3.5s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=3,
weights=distance;, score=0.799 total time=   3.4s
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weights=uniform;, score=0.840 total time=   3.4s
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weights=uniform;, score=0.805 total time=   3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=uniform;, score=0.761 total time=   3.4s
[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;, score=0.878 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;, score=0.832 total time=   3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=4,
weights=distance;, score=0.790 total time=   3.4s
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weights=uniform;, score=0.852 total time=   3.4s
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weights=uniform;, score=0.801 total time=   3.4s
[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=uniform;, score=0.755 total time=   3.4s
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weights=distance;, score=0.863 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=5,
weights=distance;, score=0.809 total time=   3.4s
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weights=uniform;, score=0.788 total time=   3.4s
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[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
weights=distance;, score=0.844 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=7,
```

```
weights=distance;, score=0.796 total time=   3.6s
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weights=distance;, score=0.747 total time=   3.4s
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[CV 1/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=distance;, score=0.811 total time=   3.4s
[CV 2/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
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[CV 3/3] END metric=<function euclidean at 0x0000012A22EB4A60>, n_neighbors=10,
weights=distance;, score=0.756 total time=   3.4s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;, score=0.858 total time=   6.4s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;, score=0.825 total time=   6.5s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=uniform;, score=0.789 total time=   6.5s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
weights=distance;, score=0.868 total time=   6.5s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
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[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=3,
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[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;, score=0.842 total time=   6.5s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;, score=0.803 total time=   6.4s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=uniform;, score=0.761 total time=   6.5s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;, score=0.878 total time=   6.5s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;, score=0.834 total time=   6.4s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=4,
weights=distance;, score=0.795 total time=   6.5s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=5,
weights=uniform;, score=0.852 total time=   6.5s
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weights=uniform;, score=0.799 total time=   6.4s
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weights=uniform;, score=0.755 total time=   6.5s
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weights=distance;, score=0.810 total time=   6.4s
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[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=6,
weights=distance;, score=0.773 total time=   6.4s
[CV 1/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=uniform;, score=0.821 total time=   6.5s
[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=7,
weights=uniform;, score=0.790 total time=   6.6s
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weights=distance;, score=0.799 total time=   6.5s
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weights=distance;, score=0.765 total time=   6.5s
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weights=uniform;, score=0.788 total time=   6.6s
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weights=uniform;, score=0.757 total time=   6.7s
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weights=uniform;, score=0.744 total time=   6.7s
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[CV 2/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=distance;, score=0.794 total time=   6.6s
[CV 3/3] END metric=<function cosine at 0x0000012A22EB4C10>, n_neighbors=10,
weights=distance;, score=0.764 total time=   6.5s
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weights=uniform;, score=0.856 total time=   2.5s
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weights=uniform;, score=0.823 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
weights=uniform;, score=0.791 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
weights=distance;, score=0.866 total time=   2.5s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=3,
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weights=distance;, score=0.826 total time=   2.4s
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weights=distance;, score=0.808 total time=   2.4s
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weights=uniform;, score=0.805 total time=   2.4s
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weights=uniform;, score=0.761 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=4,
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weights=uniform;, score=0.801 total time=   2.4s
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weights=uniform;, score=0.755 total time=   2.4s
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weights=uniform;, score=0.818 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=uniform;, score=0.788 total time=   2.4s
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weights=distance;, score=0.867 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;, score=0.818 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=6,
weights=distance;, score=0.771 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=uniform;, score=0.821 total time=   2.5s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=uniform;, score=0.788 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=uniform;, score=0.736 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
weights=distance;, score=0.850 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>, n_neighbors=7,
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weights=distance;, score=0.801 total time=   2.4s
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weights=distance;, score=0.763 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=uniform;, score=0.793 total time=   2.4s
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n_neighbors=10, weights=uniform;, score=0.754 total time=   2.4s
[CV 3/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=uniform;, score=0.742 total time=   2.4s
[CV 1/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=distance;, score=0.819 total time=   2.4s
[CV 2/3] END metric=<function sqeuclidean at 0x0000012A22EB4AF0>,
n_neighbors=10, weights=distance;, score=0.792 total time=   2.4s
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n_neighbors=10, weights=distance;, score=0.762 total time=   2.4s
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n_neighbors=3, weights=uniform;, score=0.720 total time=   3.1s
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n_neighbors=3, weights=uniform;, score=0.706 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=3, weights=uniform;, score=0.702 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=3, weights=distance;, score=0.738 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=3, weights=distance;, score=0.723 total time=   3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=3, weights=distance;, score=0.723 total time=   3.1s
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n_neighbors=4, weights=uniform;, score=0.710 total time=   3.2s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=4, weights=uniform;, score=0.709 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=4, weights=uniform;, score=0.709 total time=   3.2s
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n_neighbors=4, weights=distance;, score=0.746 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=4, weights=distance;, score=0.743 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=4, weights=distance;, score=0.730 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=5, weights=uniform;, score=0.691 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=5, weights=uniform;, score=0.719 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=5, weights=uniform;, score=0.702 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=5, weights=distance;, score=0.727 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
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n_neighbors=5, weights=distance;, score=0.743 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=5, weights=distance;, score=0.738 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=6, weights=uniform;, score=0.701 total time=   3.1s
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n_neighbors=6, weights=uniform;, score=0.704 total time=   3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=6, weights=uniform;, score=0.697 total time=   3.1s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=6, weights=distance;, score=0.736 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=6, weights=distance;, score=0.742 total time=   3.1s
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n_neighbors=6, weights=distance;, score=0.742 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=7, weights=uniform;, score=0.712 total time=   3.1s
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n_neighbors=7, weights=uniform;, score=0.708 total time=   3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=7, weights=uniform;, score=0.686 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=7, weights=distance;, score=0.719 total time=   3.2s
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n_neighbors=7, weights=distance;, score=0.744 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=7, weights=distance;, score=0.738 total time=   3.2s
[CV 1/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=10, weights=uniform;, score=0.697 total time=   3.1s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=10, weights=uniform;, score=0.696 total time=   3.2s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=10, weights=uniform;, score=0.684 total time=   3.2s
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n_neighbors=10, weights=distance;, score=0.732 total time=   3.2s
[CV 2/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=10, weights=distance;, score=0.735 total time=   3.1s
[CV 3/3] END metric=<function chi_square_distance at 0x0000012A60045B40>,
n_neighbors=10, weights=distance;, score=0.735 total time=   3.2s
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[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=3, weights=uniform;, score=0.797 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=3, weights=uniform;, score=0.751 total time=   3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=3, weights=distance;, score=0.869 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
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n_neighbors=3, weights=distance;, score=0.806 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=3, weights=distance;, score=0.755 total time=   3.3s
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n_neighbors=4, weights=uniform;, score=0.823 total time=   3.3s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=4, weights=uniform;, score=0.785 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=4, weights=uniform;, score=0.737 total time=   3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=4, weights=distance;, score=0.853 total time=   3.3s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=4, weights=distance;, score=0.809 total time=   3.2s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=4, weights=distance;, score=0.742 total time=   3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=5, weights=uniform;, score=0.836 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=5, weights=uniform;, score=0.783 total time=   3.3s
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n_neighbors=5, weights=uniform;, score=0.732 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=5, weights=distance;, score=0.844 total time=   3.3s
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n_neighbors=5, weights=distance;, score=0.784 total time=   3.2s
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[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=6, weights=uniform;, score=0.806 total time=   3.3s
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[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=6, weights=uniform;, score=0.713 total time=   3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=6, weights=distance;, score=0.858 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=6, weights=distance;, score=0.792 total time=   3.2s
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n_neighbors=6, weights=distance;, score=0.722 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=7, weights=uniform;, score=0.802 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=7, weights=uniform;, score=0.764 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=7, weights=uniform;, score=0.703 total time=   3.2s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=7, weights=distance;, score=0.818 total time=   3.2s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
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n_neighbors=7, weights=distance;, score=0.748 total time=   3.2s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=7, weights=distance;, score=0.713 total time=   3.3s
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n_neighbors=10, weights=uniform;, score=0.767 total time=   3.3s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=10, weights=uniform;, score=0.739 total time=   3.3s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=10, weights=uniform;, score=0.684 total time=   3.3s
[CV 1/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=10, weights=distance;, score=0.793 total time=   3.3s
[CV 2/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
n_neighbors=10, weights=distance;, score=0.741 total time=   3.2s
[CV 3/3] END metric=<function bhattacharyya_distance at 0x0000012A2917CA60>,
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n_neighbors=3, weights=uniform;, score=0.763 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=3, weights=uniform;, score=0.737 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
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[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=3, weights=distance;, score=0.075 total time=   2.4s
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n_neighbors=3, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=3, weights=distance;, score=0.075 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=4, weights=uniform;, score=0.769 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=4, weights=uniform;, score=0.736 total time=   2.5s
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[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.4s
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n_neighbors=4, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=4, weights=distance;, score=0.075 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=5, weights=uniform;, score=0.744 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=5, weights=uniform;, score=0.735 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=5, weights=uniform;, score=0.652 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=5, weights=distance;, score=0.075 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
```

```
n_neighbors=5, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=5, weights=distance;, score=0.075 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=6, weights=uniform;, score=0.749 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=6, weights=uniform;, score=0.703 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=6, weights=uniform;, score=0.636 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=6, weights=distance;, score=0.075 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=7, weights=uniform;, score=0.732 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=7, weights=uniform;, score=0.691 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=7, weights=uniform;, score=0.628 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.4s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=7, weights=distance;, score=0.075 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=10, weights=uniform;, score=0.699 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=10, weights=uniform;, score=0.644 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=10, weights=uniform;, score=0.604 total time=   2.5s
[CV 1/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.5s
[CV 2/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.5s
[CV 3/3] END metric=<function intersection_distance at 0x0000012A2917C670>,
n_neighbors=10, weights=distance;, score=0.075 total time=   2.5s

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

```
0x0000012A60045B40>,
                                    <function bhattacharyya_distance at
0x0000012A2917CA60>,
                                    <function intersection_distance at
0x0000012A2917C670>],
                          'n_neighbors': [3, 4, 5, 6, 7, 10],
                          'weights': ['uniform', 'distance']},
             scoring='f1_macro', verbose=3)
```

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

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

y_pred_knn = best_knn.predict(test_features)

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

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

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

7 Gridsearch SVM

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

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

svm_model = SVC()

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

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

```
Fitting 3 folds for each of 240 candidates, totalling 720 fits
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.555 total time=
0.5s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.552 total time=
0.5s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=rbf;, score=0.541 total time=
0.6s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.696 total time=
0.2s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.735 total time=
0.2s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=poly;, score=0.681 total time=
0.2s
[CV 1/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.3s
[CV 2/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.3s
[CV 3/3] END C=0.1, degree=2, gamma=scale, kernel=sigmoid;, score=0.490 total
time=   0.3s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.393 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.438 total time=
0.7s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=rbf;, score=0.372 total time=
0.7s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.861 total time=
0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.849 total time=
0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=linear;, score=0.827 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=0.868 total time=
0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=poly;, score=0.832 total time=
0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.407 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.404 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.1, kernel=sigmoid;, score=0.421 total
time=   0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.515 total time=
0.5s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.510 total time=
0.6s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.5s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.443 total time=
0.3s
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.461 total time=
0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=poly;, score=0.450 total time=
0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.3s
```

```
[CV 2/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.1, degree=2, gamma=0.01, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.203 total time=
0.7s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.088 total time=
0.7s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=rbf;, score=0.179 total time=
0.7s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=2, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.555 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.552 total time=
0.6s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=rbf;, score=0.541 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.799 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.775 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=poly;, score=0.740 total time=
0.2s
[CV 1/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.2s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.3s
[CV 3/3] END C=0.1, degree=3, gamma=scale, kernel=sigmoid;, score=0.490 total
time=   0.3s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.393 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.438 total time=
0.7s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=rbf;, score=0.372 total time=
0.7s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.861 total time=
0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.849 total time=
0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=linear;, score=0.827 total time=
0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.887 total time=
0.2s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=poly;, score=0.854 total time=
0.2s
[CV 1/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.407 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.404 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.1, kernel=sigmoid;, score=0.421 total
time=   0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.515 total time=
0.5s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.510 total time=
0.5s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.298 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.084 total time=
0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=poly;, score=0.186 total time=
0.5s
[CV 1/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 2/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.1, degree=3, gamma=0.01, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.203 total time=
0.7s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.088 total time=
0.7s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=rbf;, score=0.179 total time=
0.7s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=3, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.555 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.552 total time=
0.6s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=rbf;, score=0.541 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.851 total time=
0.2s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.831 total time=
0.2s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=poly;, score=0.784 total time=
0.2s
[CV 1/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.477 total
time=   0.3s
[CV 2/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.493 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=scale, kernel=sigmoid;, score=0.490 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=rbf;, score=0.075 total time=
0.7s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.393 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.438 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=rbf;, score=0.372 total time=
0.7s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.861 total time=
0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.849 total time=
0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=linear;, score=0.827 total time=
0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.407 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.404 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.1, kernel=sigmoid;, score=0.421 total
time=   0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.515 total time=
0.5s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.510 total time=
0.6s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=rbf;, score=0.521 total time=
0.5s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.456 total
time=   0.3s
```

```
[CV 2/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.486 total
time=   0.3s
[CV 3/3] END C=0.1, degree=4, gamma=0.01, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.203 total time=
0.7s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.088 total time=
0.7s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=rbf;, score=0.179 total time=
0.8s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.861 total
time=   0.1s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.849 total
time=   0.1s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=linear;, score=0.827 total
time=   0.1s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.1, degree=4, gamma=0.001, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.619 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.619 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=rbf;, score=0.640 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.813 total time=
0.1s
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.800 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=poly;, score=0.772 total time=
0.2s
[CV 1/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.514 total
time=   0.2s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.2, degree=2, gamma=scale, kernel=sigmoid;, score=0.533 total
time=   0.2s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.247 total time=
0.7s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.189 total time=
0.7s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=rbf;, score=0.186 total time=
0.7s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.439 total time=
0.7s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.7s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=rbf;, score=0.396 total time=
0.7s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.839 total time=
0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=linear;, score=0.807 total time=
0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.900 total time=
0.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.878 total time=
0.2s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=poly;, score=0.836 total time=
0.2s
[CV 1/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.421 total
time=   0.3s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.4s
[CV 3/3] END C=0.2, degree=2, gamma=0.1, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.557 total time=
0.5s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.559 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=rbf;, score=0.549 total time=
0.4s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.469 total time=
0.3s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.503 total time=
0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=poly;, score=0.510 total time=
0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.513 total
time=   0.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.519 total
time=   0.3s
[CV 3/3] END C=0.2, degree=2, gamma=0.01, kernel=sigmoid;, score=0.522 total
time=   0.3s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.443 total time=
0.7s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.7s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=rbf;, score=0.453 total time=
0.8s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.839 total
time=   0.2s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.5s
[CV 1/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.250 total
time=   0.5s
```

```
[CV 2/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.193 total
time=   0.7s
[CV 3/3] END C=0.2, degree=2, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.5s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.619 total time=
0.6s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.619 total time=
0.6s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=rbf;, score=0.640 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.867 total time=
0.2s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.851 total time=
0.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=poly;, score=0.818 total time=
0.2s
[CV 1/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.514 total
time=   0.2s
[CV 2/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.2, degree=3, gamma=scale, kernel=sigmoid;, score=0.533 total
time=   0.2s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.247 total time=
0.7s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.189 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=rbf;, score=0.186 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.439 total time=
0.7s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=rbf;, score=0.396 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.839 total time=
0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=linear;, score=0.807 total time=
0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.887 total time=
0.2s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=poly;, score=0.854 total time=
0.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.421 total
time=   0.3s
[CV 2/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.1, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.557 total time=
0.5s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.559 total time=
0.5s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=rbf;, score=0.549 total time=
0.5s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.434 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.460 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=poly;, score=0.434 total time=
0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.513 total
time=   0.2s
```

```
[CV 2/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.519 total
time=   0.3s
[CV 3/3] END C=0.2, degree=3, gamma=0.01, kernel=sigmoid;, score=0.522 total
time=   0.2s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.443 total time=
0.7s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.7s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=rbf;, score=0.453 total time=
0.7s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.250 total
time=   0.4s
[CV 2/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.193 total
time=   0.4s
[CV 3/3] END C=0.2, degree=3, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.619 total time=
0.5s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.619 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=rbf;, score=0.640 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.899 total time=
0.3s
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.880 total time=
0.2s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=poly;, score=0.842 total time=
0.2s
[CV 1/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.514 total
time=   0.2s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.537 total
time=   0.3s
[CV 3/3] END C=0.2, degree=4, gamma=scale, kernel=sigmoid;, score=0.533 total
time=   0.2s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.247 total time=
0.7s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.189 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=rbf;, score=0.186 total time=
0.7s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.439 total time=
0.7s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.460 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=rbf;, score=0.396 total time=
0.7s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.839 total time=
0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.857 total time=
0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=linear;, score=0.807 total time=
0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.421 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.453 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.1, kernel=sigmoid;, score=0.467 total
time=   0.3s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.557 total time=
0.5s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.559 total time=
0.5s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=rbf;, score=0.549 total time=
0.5s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.513 total
time=   0.2s
[CV 2/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.519 total
time=   0.3s
[CV 3/3] END C=0.2, degree=4, gamma=0.01, kernel=sigmoid;, score=0.522 total
time=   0.2s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.443 total time=
0.8s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.459 total time=
0.7s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=rbf;, score=0.453 total time=
0.7s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.839 total
time=   0.1s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.857 total
time=   0.1s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=linear;, score=0.807 total
time=   0.1s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.250 total
time=   0.4s
```

```
[CV 2/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.193 total
time=   0.4s
[CV 3/3] END C=0.2, degree=4, gamma=0.001, kernel=sigmoid;, score=0.186 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.709 total time=
0.5s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.742 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=rbf;, score=0.710 total time=
0.5s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.855 total time=
0.2s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.831 total time=
0.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=poly;, score=0.795 total time=
0.1s
[CV 1/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.582 total
time=   0.2s
[CV 2/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.609 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=scale, kernel=sigmoid;, score=0.608 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.420 total time=
0.7s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.432 total time=
0.7s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=rbf;, score=0.408 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.3, degree=2, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.478 total time=
0.6s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.499 total time=
0.6s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=rbf;, score=0.483 total time=
0.7s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.841 total time=
0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.853 total time=
0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=linear;, score=0.809 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=0.878 total time=
0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=poly;, score=0.836 total time=
0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.413 total
time=   0.3s
[CV 2/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.454 total
time=   0.3s
[CV 3/3] END C=0.3, degree=2, gamma=0.1, kernel=sigmoid;, score=0.472 total
time=   0.3s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.540 total time=
0.2s
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.542 total time=
0.2s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=poly;, score=0.532 total time=
0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.542 total
time=   0.2s
```

```
[CV 2/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.3, degree=2, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.2s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.6s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=rbf;, score=0.460 total time=
0.6s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.420 total
time=   0.4s
[CV 2/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.432 total
time=   0.5s
[CV 3/3] END C=0.3, degree=2, gamma=0.001, kernel=sigmoid;, score=0.408 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.709 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.742 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=rbf;, score=0.710 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.892 total time=
0.2s
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.875 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=poly;, score=0.839 total time=
0.2s
[CV 1/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.582 total
time=   0.2s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.609 total
time=   0.2s
[CV 3/3] END C=0.3, degree=3, gamma=scale, kernel=sigmoid;, score=0.608 total
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.420 total time=
0.7s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.432 total time=
0.7s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=rbf;, score=0.408 total time=
0.7s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 2/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.478 total time=
0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.499 total time=
0.7s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=rbf;, score=0.483 total time=
0.7s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.841 total time=
0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.853 total time=
0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=linear;, score=0.809 total time=
0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.887 total time=
0.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=poly;, score=0.854 total time=
0.2s
[CV 1/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.413 total
time=   0.3s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.454 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.1, kernel=sigmoid;, score=0.472 total
time=   0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.452 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.467 total time=
0.3s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=poly;, score=0.448 total time=
0.3s
[CV 1/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.542 total
time=   0.2s
[CV 2/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.3, degree=3, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.2s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.6s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=rbf;, score=0.460 total time=
0.6s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.420 total
time=   0.4s
```

```
[CV 2/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.432 total
time=   0.4s
[CV 3/3] END C=0.3, degree=3, gamma=0.001, kernel=sigmoid;, score=0.408 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.709 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.742 total time=
0.5s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=rbf;, score=0.710 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.910 total time=
0.2s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.886 total time=
0.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=poly;, score=0.859 total time=
0.2s
[CV 1/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.582 total
time=   0.2s
[CV 2/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.609 total
time=   0.2s
[CV 3/3] END C=0.3, degree=4, gamma=scale, kernel=sigmoid;, score=0.608 total
time=   0.2s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.420 total time=
0.7s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.432 total time=
0.7s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=rbf;, score=0.408 total time=
0.7s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
```

```
[CV 2/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=auto, kernel=sigmoid;, score=0.075 total
time=   0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.478 total time=
0.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.499 total time=
0.6s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=rbf;, score=0.483 total time=
0.6s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.841 total time=
0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.853 total time=
0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=linear;, score=0.809 total time=
0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.2s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.413 total
time=   0.3s
[CV 2/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.454 total
time=   0.3s
[CV 3/3] END C=0.3, degree=4, gamma=0.1, kernel=sigmoid;, score=0.472 total
time=   0.3s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.621 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=rbf;, score=0.620 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.358 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.266 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=poly;, score=0.296 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.542 total
time=   0.2s
```

```
[CV 2/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.537 total
time=   0.2s
[CV 3/3] END C=0.3, degree=4, gamma=0.01, kernel=sigmoid;, score=0.541 total
time=   0.2s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.445 total time=
0.6s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.463 total time=
0.6s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=rbf;, score=0.460 total time=
0.6s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.841 total
time=   0.1s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.420 total
time=   0.4s
[CV 2/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.432 total
time=   0.4s
[CV 3/3] END C=0.3, degree=4, gamma=0.001, kernel=sigmoid;, score=0.408 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.792 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.769 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=rbf;, score=0.742 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.843 total
time=   0.2s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.867 total time=
0.1s
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.856 total time=
0.1s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=poly;, score=0.813 total time=
0.1s
[CV 1/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.644 total
time=   0.2s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.674 total
time=   0.2s
[CV 3/3] END C=0.4, degree=2, gamma=scale, kernel=sigmoid;, score=0.633 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.441 total time=
0.7s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.461 total time=
0.7s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=rbf;, score=0.454 total time=
0.7s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.268 total
time=   0.4s
[CV 2/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.228 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=auto, kernel=sigmoid;, score=0.190 total
time=   0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.592 total time=
0.6s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.603 total time=
0.6s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=rbf;, score=0.600 total time=
0.6s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.843 total time=
0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.853 total time=
0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=linear;, score=0.809 total time=
0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.900 total time=
0.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.878 total time=
0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=poly;, score=0.836 total time=
0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   0.3s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 3/3] END C=0.4, degree=2, gamma=0.1, kernel=sigmoid;, score=0.475 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=0.716 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=rbf;, score=0.681 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.563 total time=
0.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.556 total time=
0.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=poly;, score=0.547 total time=
0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.2s
[CV 2/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.580 total
time=   0.2s
[CV 3/3] END C=0.4, degree=2, gamma=0.01, kernel=sigmoid;, score=0.577 total
time=   0.2s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.449 total time=
0.6s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.469 total time=
0.6s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=rbf;, score=0.461 total time=
0.6s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.441 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.461 total
time=   0.4s
[CV 3/3] END C=0.4, degree=2, gamma=0.001, kernel=sigmoid;, score=0.453 total
time=   0.4s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.792 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.769 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=rbf;, score=0.742 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.875 total time=
0.2s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=poly;, score=0.855 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.644 total
time=   0.2s
[CV 2/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.674 total
time=   0.2s
[CV 3/3] END C=0.4, degree=3, gamma=scale, kernel=sigmoid;, score=0.633 total
time=   0.2s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.441 total time=
0.7s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.461 total time=
0.7s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=rbf;, score=0.454 total time=
0.7s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.268 total
time=   0.4s
```

```
[CV 2/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.228 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=auto, kernel=sigmoid;, score=0.190 total
time=   0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.592 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.603 total time=
0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=rbf;, score=0.600 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.843 total time=
0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.853 total time=
0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=linear;, score=0.809 total time=
0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.915 total time=
0.2s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.887 total time=
0.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=poly;, score=0.854 total time=
0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.1, kernel=sigmoid;, score=0.475 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=0.716 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=rbf;, score=0.681 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.454 total time=
0.3s
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.471 total time=
0.3s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=poly;, score=0.463 total time=
0.3s
[CV 1/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.2s
```

```
[CV 2/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.580 total
time=   0.2s
[CV 3/3] END C=0.4, degree=3, gamma=0.01, kernel=sigmoid;, score=0.577 total
time=   0.2s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.449 total time=
0.6s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.469 total time=
0.6s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=rbf;, score=0.461 total time=
0.6s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.441 total
time=   0.4s
[CV 2/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.461 total
time=   0.4s
[CV 3/3] END C=0.4, degree=3, gamma=0.001, kernel=sigmoid;, score=0.453 total
time=   0.4s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.792 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.769 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=rbf;, score=0.742 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.910 total time=
0.2s
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.887 total time=
0.3s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=poly;, score=0.852 total time=
0.2s
[CV 1/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.644 total
time=   0.2s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.674 total
time=   0.2s
[CV 3/3] END C=0.4, degree=4, gamma=scale, kernel=sigmoid;, score=0.633 total
time=   0.2s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.441 total time=
0.7s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.461 total time=
0.7s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=rbf;, score=0.454 total time=
0.7s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.268 total
time=   0.4s
[CV 2/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.228 total
time=   0.4s
[CV 3/3] END C=0.4, degree=4, gamma=auto, kernel=sigmoid;, score=0.190 total
time=   0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.592 total time=
0.6s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.603 total time=
0.6s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=rbf;, score=0.600 total time=
0.6s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.843 total time=
0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.853 total time=
0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=linear;, score=0.809 total time=
0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.914 total time=
0.3s
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.891 total time=
0.2s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=poly;, score=0.856 total time=
0.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.416 total
time=   0.3s
```

```
[CV 2/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.456 total
time=   0.3s
[CV 3/3] END C=0.4, degree=4, gamma=0.1, kernel=sigmoid;, score=0.475 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=0.716 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=rbf;, score=0.681 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.414 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.433 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=poly;, score=0.401 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.568 total
time=   0.2s
[CV 2/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.580 total
time=   0.2s
[CV 3/3] END C=0.4, degree=4, gamma=0.01, kernel=sigmoid;, score=0.577 total
time=   0.2s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.449 total time=
0.6s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.469 total time=
0.6s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=rbf;, score=0.461 total time=
0.6s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.843 total
time=   0.1s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.853 total
time=   0.1s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=linear;, score=0.809 total
time=   0.1s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 2/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 3/3] END C=0.4, degree=4, gamma=0.001, kernel=poly;, score=0.075 total time=
0.4s
[CV 1/3] END C=0.4, degree=4, gamma=0.001, kernel=sigmoid;, score=0.441 total
time=   0.4s
```

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

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

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

y_pred_svm = best_svm.predict(test_features)

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

```
Best parameters: {'C': 0.1, 'degree': 4, 'gamma': 0.1, 'kernel': 'poly'}

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

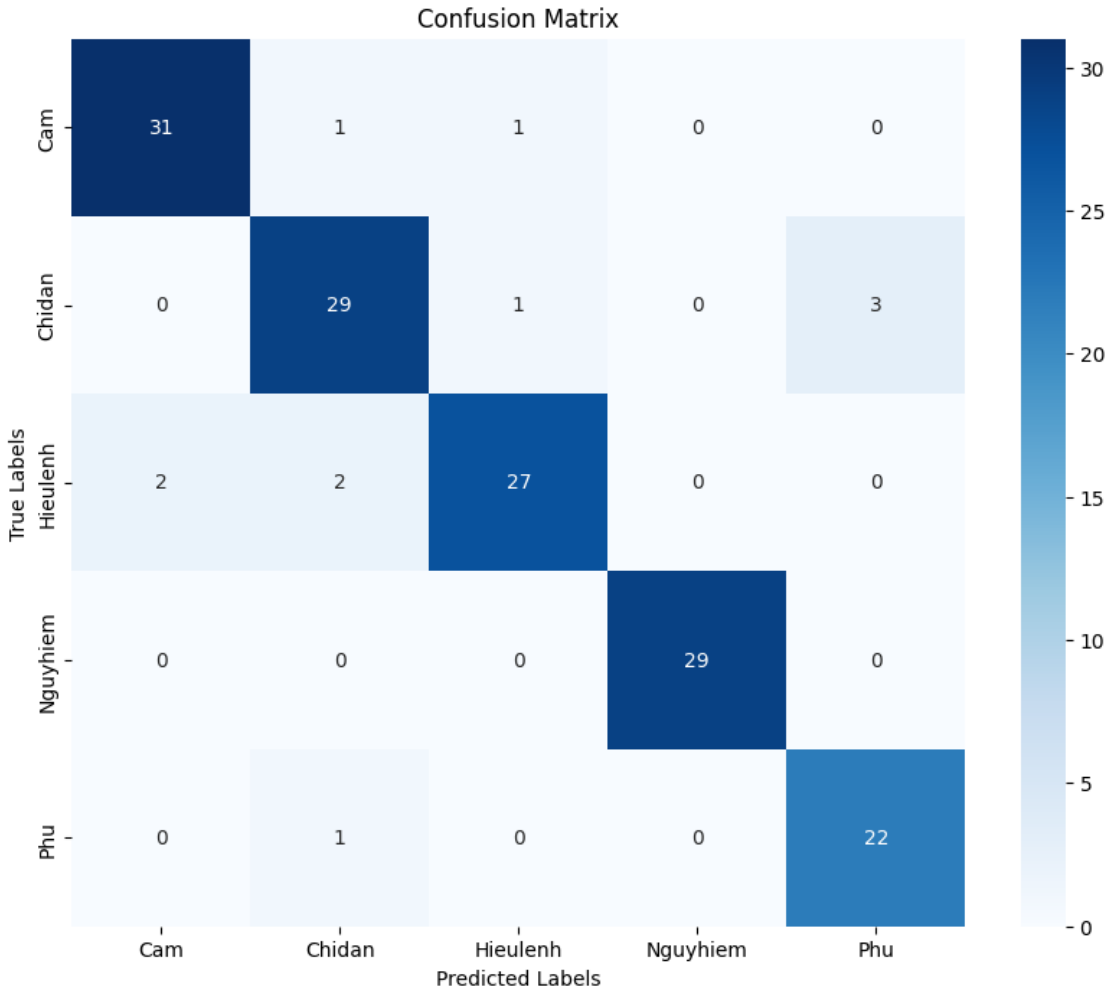
8 Predict on test images for KNN

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

```
              precision    recall  f1-score   support

         Cam       0.94      0.94      0.94        33
      Chidan       0.88      0.88      0.88        33
    Hieulenh       0.93      0.87      0.90        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.88      0.96      0.92        23

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

```
heatmap_label_knn = confusion_matrix(test_labels_encoded, y_pred_knn)

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

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




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

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

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

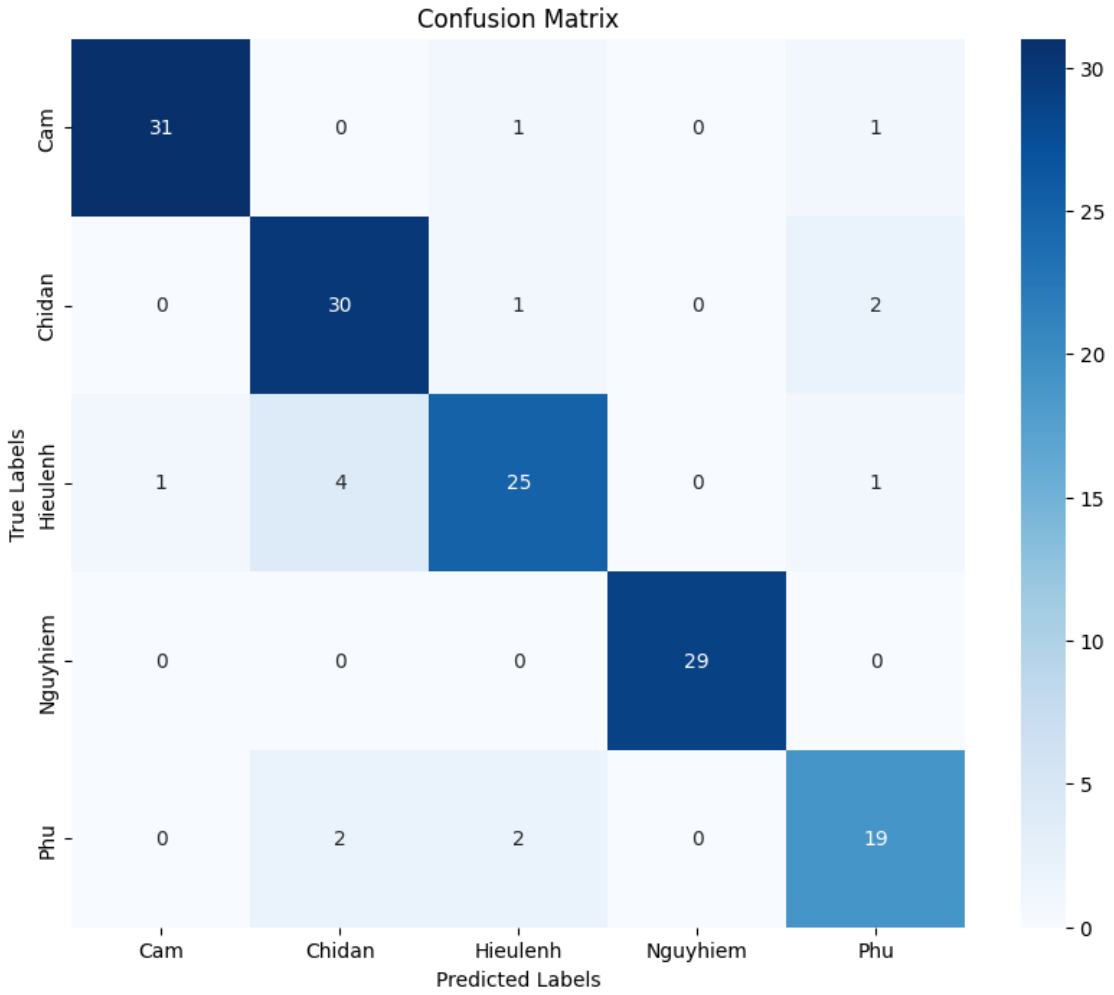
```
    axes[row, col].imshow(image)
    axes[row, col].set_title(f'True: {label_encoder.classes_[true_label]}\nPred:
 ↪ {label_encoder.classes_[pred_label]}')
    axes[row, col].axis('off')

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

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

9 Predict on test images for SVM

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

```
              precision    recall  f1-score   support

         Cam       0.97      0.94      0.95        33
      Chidan       0.83      0.91      0.87        33
    Hieulenh       0.86      0.81      0.83        31
    Nguyhiem       1.00      1.00      1.00        29
         Phu       0.83      0.83      0.83        23

    accuracy                           0.90       149
   macro avg       0.90      0.90      0.90       149
weighted avg       0.90      0.90      0.90       149
```

```
heatmap_label_svm = confusion_matrix(test_labels_encoded, y_pred_svm)

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




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

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

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

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

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

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

10 Save grid search results

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

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

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

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

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

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

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

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

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

export_notebook_to_pdf(notebook_path, proj_dir)
```

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

```
Images\grid_search_results\notebook_export_2024-12-23_20_02_37.pdf

'e:\\Documents\\CS231\\project\\Traffic-Sign-Classification-through-
Images\\grid_search_results\\notebook_export_2024-12-23_20_02_37.pdf'
```

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

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

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

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