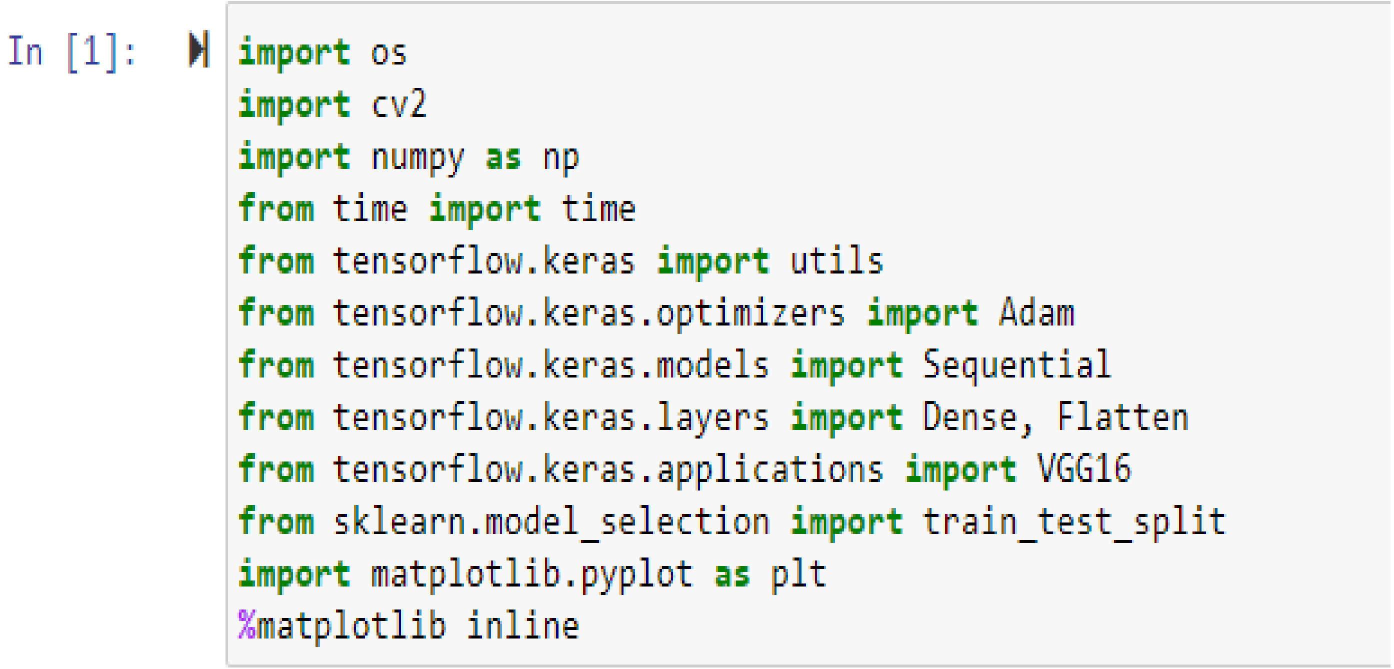
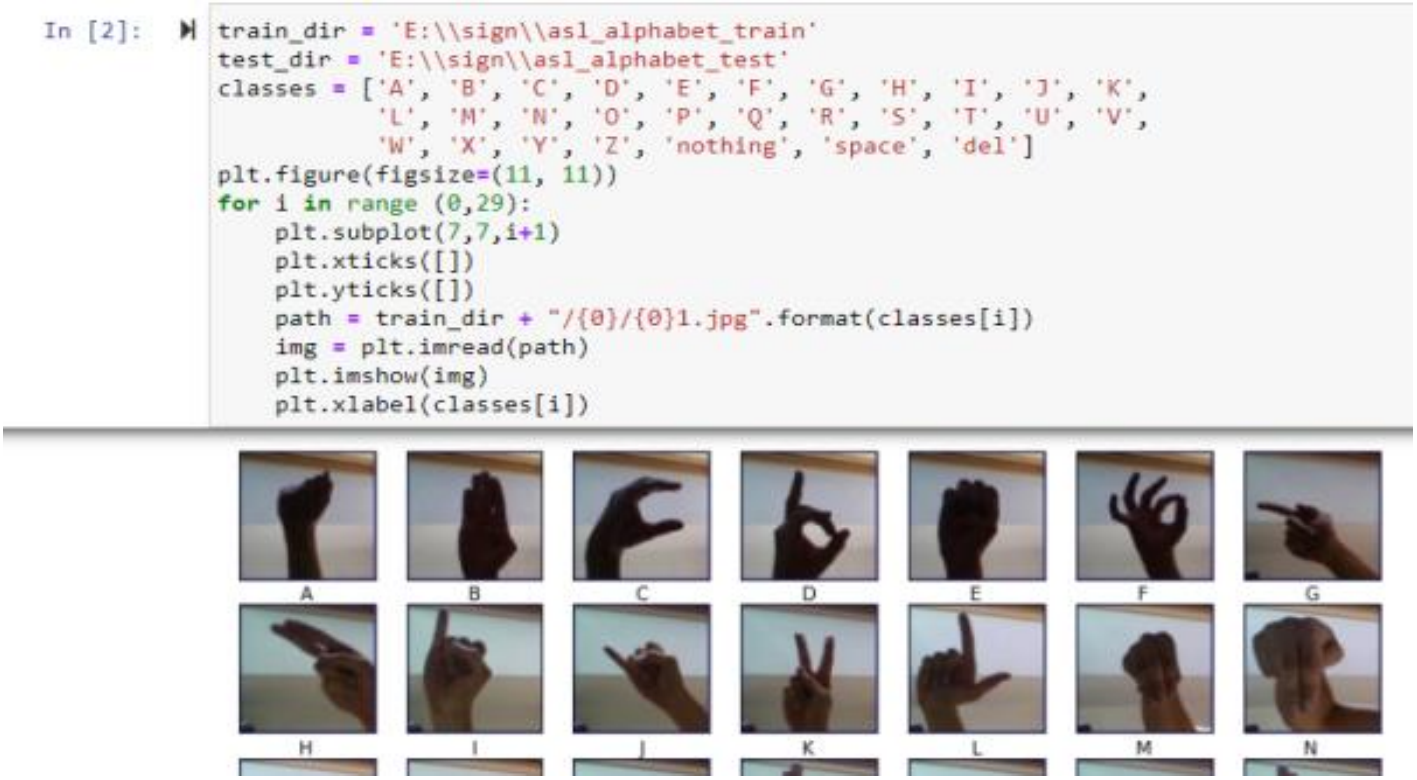


```
import os
import cv2
import numpy as np
from time import time
from tensorflow.keras import utils
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Flatten
from tensorflow.keras.applications import VGG16
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
%matplotlib inline
```



```
train_dir = 'E:\\sign\\asl_alphabet_train'
test_dir = 'E:\\sign\\asl_alphabet_test'
classes = ['A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K',
           'L', 'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T', 'U', 'V',
           'W', 'X', 'Y', 'Z', 'nothing', 'space', 'del']
plt.figure(figsize=(11, 11))
for i in range (0,29):
    plt.subplot(7,7,i+1)
    plt.xticks([])
    plt.yticks([])
    path = train_dir + "/{0}/{0}1.jpg".format(classes[i])
    img = plt.imread(path)
    plt.imshow(img)
    plt.xlabel(classes[i])
```

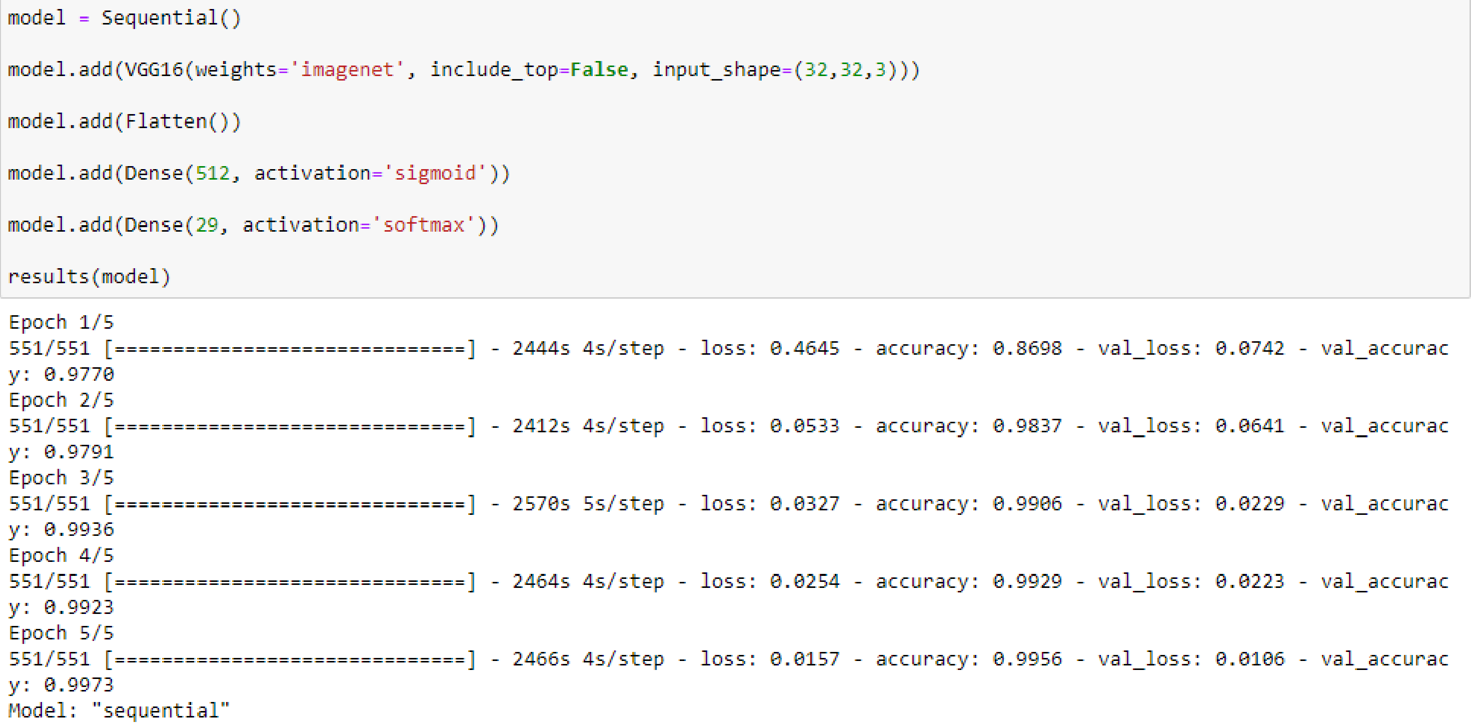
In [3]:

```
def load_data(train_dir):
    images = []
    labels = []
    size = 32,32
    index = -1
    for folder in os.listdir(train_dir):
        index +=1
        for image in os.listdir(train_dir + "/" + folder):
            temp_img = cv2.imread(train_dir + '/' + folder + '/' + image)
            temp_img = cv2.resize(temp_img, size)
            images.append(temp_img)
            labels.append(index)

    images = np.array(images)
    images = images.astype('float32')/255.0
    labels = utils.to_categorical(labels)
    x_train, x_test, y_train, y_test = train_test_split(images, labels, test_size = 0.1)

    print('Loaded', len(x_train),'images for training,','Train data shape =', x_train.shape)
    print('Loaded', len(x_test),'images for testing','Test data shape =', x_test.shape)

    return x_train, x_test, y_train, y_test

start = time()
x_train, x_test, y_train, y_test = load_data(train_dir)
print('Loading:', time() - start)
```

```
Loaded 78300 images for training, Train data shape = (78300, 32, 32, 3)
Loaded 8700 images for testing Test data shape = (8700, 32, 32, 3)
Loading: 57.585143089294434
```

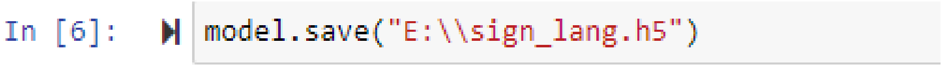
In [4]:

```
classes = 29
batch = 128
epochs = 5
learning_rate = 0.0001

def results(model):
  adam = Adam(lr=learning_rate)

  model.compile(optimizer=adam, loss='categorical_crossentropy', metrics=['accuracy'])

  start = time()
  history = model.fit(x_train, y_train, batch_size=batch, epochs=epochs, validation_split=0.1, shuffle = True, verbose=1)
  train_time = time() - start

  model.summary()

  plt.figure(figsize=(12, 12))
  plt.subplot(3, 2, 1)
  plt.plot(history.history['accuracy'], label = 'train_accuracy')
  plt.plot(history.history['val_accuracy'], label = 'val_accuracy')
  plt.xlabel('epoch')
  plt.ylabel('accuracy')
  plt.legend()
  plt.subplot(3, 2, 2)
  plt.plot(history.history['loss'], label = 'train_loss')
  plt.plot(history.history['val_loss'], label = 'val_loss')
  plt.xlabel('epoch')
  plt.ylabel('accuracy')
  plt.legend()
  plt.show()
```



```
model = Sequential()

model.add(VGG16(weights='imagenet', include_top=False, input_shape=(32,32,3)))

model.add(Flatten())

model.add(Dense(512, activation='sigmoid'))

model.add(Dense(29, activation='softmax'))

results(model)
```

```
Epoch 1/5
551/551 [==============================] - 2444s 4s/step - loss: 0.4645 - accuracy: 0.8698 - val_loss: 0.0742 - val_accurac
y: 0.9770
Epoch 2/5
551/551 [==============================] - 2412s 4s/step - loss: 0.0533 - accuracy: 0.9837 - val_loss: 0.0641 - val_accurac
y: 0.9791
Epoch 3/5
551/551 [==============================] - 2570s 5s/step - loss: 0.0327 - accuracy: 0.9906 - val_loss: 0.0229 - val_accurac
y: 0.9936
Epoch 4/5
551/551 [==============================] - 2464s 4s/step - loss: 0.0254 - accuracy: 0.9929 - val_loss: 0.0223 - val_accurac
y: 0.9923
Epoch 5/5
551/551 [==============================] - 2466s 4s/step - loss: 0.0157 - accuracy: 0.9956 - val_loss: 0.0106 - val_accurac
y: 0.9973
Model: "sequential"
```



```
In [6]:  model.save("E:\\sign_lang.h5")
```