VGG16 Architecture Implementation

```
!nvidia-smi
```

```
Sat Aug 24 05:36:54 2024
+---------------------------------------------------------------------------------------+
| NVIDIA-SMI 535.104.05             Driver Version: 535.104.05   CUDA Version: 12.2     |
|-----------------------------------------+----------------------+----------------------+
| GPU  Name                 Persistence-M | Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp   Perf          Pwr:Usage/Cap |         Memory-Usage | GPU-Util  Compute M. |
|                                         |                      |               MIG M. |
|=========================================+======================+======================|
|   0  Tesla T4                       Off | 00000000:00:04.0 Off |                    0 |
| N/A   48C    P0              27W /  70W |  14091MiB / 15360MiB |      0%      Default |
|                                         |                      |                  N/A |
+-----------------------------------------+----------------------+----------------------+

+---------------------------------------------------------------------------------------+
| Processes:                                                                            |
|  GPU   GI   CI        PID   Type   Process name                            GPU Memory |
|        ID   ID                                                             Usage      |
|=======================================================================================|
+---------------------------------------------------------------------------------------+
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import os

import cv2
from sklearn.preprocessing import LabelEncoder, OneHotEncoder

from keras.models import Sequential
from keras.layers import Flatten, Dense, Input, Conv2D, MaxPool2D, Dropout
from keras.preprocessing import image
from keras.applications.imagenet_utils import preprocess_input
from keras.optimizers import SGD
```



```
def VGG16(input_tensor=None, classes=2):

    model = Sequential()

    # Block1
    model.add(Conv2D(64, (3,3), activation='relu', padding='same', name='block1_conv1', input_shape=(300,300,3)))
    model.add(Conv2D(64, (3,3), activation='relu', padding='same', name='block1_conv2'))
    model.add(MaxPool2D((2,2), strides=(2,2), name='block1_maxpool'))

    # Block2
    model.add(Conv2D(128, (3,3), activation='relu', padding='same', name='block2_conv1'))
    model.add(Conv2D(128, (3,3), activation='relu', padding='same', name='block2_conv2'))
    model.add(MaxPool2D((2,2), strides=(2,2), name='block2_maxpool'))

    # Block3
    model.add(Conv2D(256, (3,3), activation='relu', padding='same', name='block3_conv1'))
    model.add(Conv2D(256, (3,3), activation='relu', padding='same', name='block3_conv2'))
    model.add(Conv2D(256, (3,3), activation='relu', padding='same', name='block3_conv3'))
    model.add(MaxPool2D((2,2), strides=(2,2), name='block3_maxpool'))


    # Block4
    model.add(Conv2D(512, (3,3), activation='relu', padding='same', name='block4_conv1'))
    model.add(Conv2D(512, (3,3), activation='relu', padding='same', name='block4_conv2'))
    model.add(Conv2D(512, (3,3), activation='relu', padding='same', name='block4_conv3'))
    model.add(MaxPool2D((2,2), strides=(2,2), name='block4_maxpool'))


    # Block5
    model.add(Conv2D(512, (3,3), activation='relu', padding='same', name='block5_conv1'))
    model.add(Conv2D(512, (3,3), activation='relu', padding='same', name='block5_conv2'))
    model.add(Conv2D(512, (3,3), activation='relu', padding='same', name='block5_conv3'))
    model.add(MaxPool2D((2,2), strides=(2,2), name='block5_maxpool'))
```

```
    # Block6
    model.add(Flatten(name="flatten"))
    model.add(Dense(4096, activation='relu', name='fc1'))
    model.add(Dropout(0.5))
    model.add(Dense(4096, activation='relu', name='fc2'))
    model.add(Dropout(0.5))
    model.add(Dense(classes, activation='softmax', name='prediction'))

    return model
```

```
model = VGG16(classes=2)
```

```
model.summary()
```

Model: "sequential_3"

Layer (type)	Output Shape	Param #
block1_conv1 (Conv2D)	(None, 300, 300, 64)	1,792
block1_conv2 (Conv2D)	(None, 300, 300, 64)	36,928
block1_maxpool (MaxPooling2D)	(None, 150, 150, 64)	0
block2_conv1 (Conv2D)	(None, 150, 150, 128)	73,856
block2_conv2 (Conv2D)	(None, 150, 150, 128)	147,584
block2_maxpool (MaxPooling2D)	(None, 75, 75, 128)	0
block3_conv1 (Conv2D)	(None, 75, 75, 256)	295,168
block3_conv2 (Conv2D)	(None, 75, 75, 256)	590,080
block3_conv3 (Conv2D)	(None, 75, 75, 256)	590,080
block3_maxpool (MaxPooling2D)	(None, 37, 37, 256)	0
block4_conv1 (Conv2D)	(None, 37, 37, 512)	1,180,160
block4_conv2 (Conv2D)	(None, 37, 37, 512)	2,359,808
block4_conv3 (Conv2D)	(None, 37, 37, 512)	2,359,808
block4_maxpool (MaxPooling2D)	(None, 18, 18, 512)	0
block5_conv1 (Conv2D)	(None, 18, 18, 512)	2,359,808
block5_conv2 (Conv2D)	(None, 18, 18, 512)	2,359,808
block5_conv3 (Conv2D)	(None, 18, 18, 512)	2,359,808
block5_maxpool (MaxPooling2D)	(None, 9, 9, 512)	0
flatten (Flatten)	(None, 41472)	0
fc1 (Dense)	(None, 4096)	169,873,408
dropout_8 (Dropout)	(None, 4096)	0
fc2 (Dense)	(None, 4096)	16,781,312
dropout_9 (Dropout)	(None, 4096)	0
prediction (Dense)	(None, 2)	8,194

Total params: 201,377,602 (768.19 MB)
Trainable params: 201,377,602 (768.19 MB)

```
opt = SGD(learning_rate=0.01)
model.compile(optimizer=opt, loss='categorical_crossentropy', metrics = ['accuracy'])
```

```
training_ds_path = '/content/drive/MyDrive/datasets/img-clsf/dataset/train'
testing_ds_path = '/content/drive/MyDrive/datasets/img-clsf/dataset/test'
```

```
cats_n_dogs = os.listdir(training_ds_path)
print(cats_n_dogs)
```

```
['dogs', 'cats']
```

```
arr_cats_dogs = []

for item in cats_n_dogs:
    #print(item)
    all_c_d = os.listdir(training_ds_path + "/" + item)
    #print(training_ds_path + "/" + item)

    for cat_dog in all_c_d:
        arr_cats_dogs.append((item, str(training_ds_path+ "/" + item) + '/' + cat_dog))

print(arr_cats_dogs)
```

```
[('dogs', '/content/drive/MyDrive/datasets/img-clsf/dataset/train/dogs/dog_293.jpg'), ('dogs', '/content/drive/MyDrive/datasets/img-clsf
```

```
cats_n_dogs_df = pd.DataFrame(data=arr_cats_dogs, columns=['cats_dogs','image'])
print(cats_n_dogs_df)
```

```
     cats_dogs                                              image
0         dogs  /content/drive/MyDrive/datasets/img-clsf/datas...
1         dogs  /content/drive/MyDrive/datasets/img-clsf/datas...
2         dogs  /content/drive/MyDrive/datasets/img-clsf/datas...
3         dogs  /content/drive/MyDrive/datasets/img-clsf/datas...
4         dogs  /content/drive/MyDrive/datasets/img-clsf/datas...
..         ...                                                ...
552       cats  /content/drive/MyDrive/datasets/img-clsf/datas...
553       cats  /content/drive/MyDrive/datasets/img-clsf/datas...
554       cats  /content/drive/MyDrive/datasets/img-clsf/datas...
555       cats  /content/drive/MyDrive/datasets/img-clsf/datas...
556       cats  /content/drive/MyDrive/datasets/img-clsf/datas...

[557 rows x 2 columns]
```

```
print("Total number of images: ", len(arr_cats_dogs))
cats_n_dogs_df['cats_dogs'].value_counts()
```

```
Total number of images:  557
```

cats_dogs	count
cats	279
dogs	278

dtype: int64

```
#path = './dataset/train/'

im_size = 300

images = []
labels = []

for indx in cats_n_dogs:
    data_path = training_ds_path + "/" + str(indx)

    image_files = [image for image in os.listdir(data_path)]

    for img_file in image_files:
        img = cv2.imread(data_path + '/' + img_file)
        img = cv2.resize(img, (im_size, im_size))
        images.append(img)
        labels.append(indx)
```

```
images = np.array(images)
images = images.astype('float32') / 255.0
images.shape
```

```
(557, 300, 300, 3)
```

```
y = cats_n_dogs_df['cats_dogs'].values

le = LabelEncoder()
y = le.fit_transform(y)
print(y)
le.classes_
```

```
[1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0]
array(['cats', 'dogs'], dtype=object)
```

```
y = y.reshape(-1,1)

ohe = OneHotEncoder(sparse_output=False)
y = ohe.fit_transform(y)
y.shape
```

```
(557, 2)
```

```
y
```

```
array([[0., 1.],
       [0., 1.],
       [0., 1.],
       ...,
       [1., 0.],
       [1., 0.],
       [1., 0.]])
```

```
model.fit(images, y, epochs=15, batch_size=32)
```

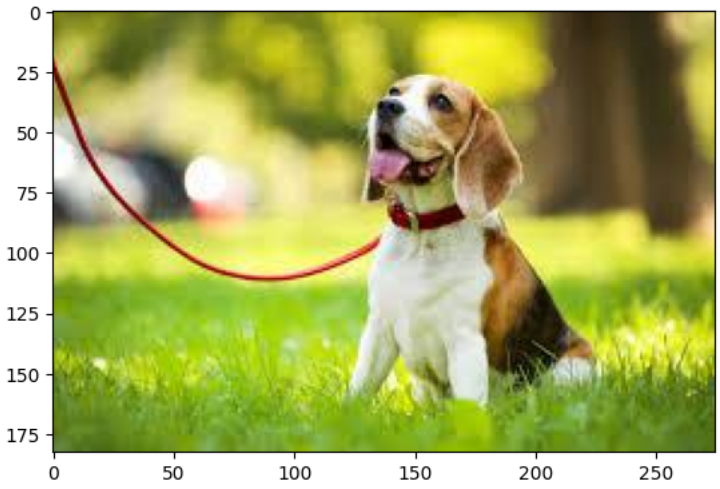
```
Epoch 1/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 22s 1s/step - accuracy: 0.5123 - loss: 0.6932
Epoch 2/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 35s 832ms/step - accuracy: 0.5080 - loss: 0.6931
Epoch 3/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 21s 841ms/step - accuracy: 0.4550 - loss: 0.6933
Epoch 4/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 21s 847ms/step - accuracy: 0.4962 - loss: 0.6933
Epoch 5/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 20s 850ms/step - accuracy: 0.5297 - loss: 0.6929
Epoch 6/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 16s 858ms/step - accuracy: 0.5335 - loss: 0.6927
Epoch 7/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 21s 862ms/step - accuracy: 0.5351 - loss: 0.6929
Epoch 8/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 20s 864ms/step - accuracy: 0.5359 - loss: 0.6929
Epoch 9/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 21s 869ms/step - accuracy: 0.5088 - loss: 0.6930
Epoch 10/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 21s 871ms/step - accuracy: 0.4953 - loss: 0.6932
Epoch 11/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 16s 880ms/step - accuracy: 0.5200 - loss: 0.6930
Epoch 12/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 21s 882ms/step - accuracy: 0.5019 - loss: 0.6931
Epoch 13/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 20s 881ms/step - accuracy: 0.5360 - loss: 0.6930
Epoch 14/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 16s 885ms/step - accuracy: 0.5158 - loss: 0.6929
Epoch 15/15
18/18 ━━━━━━━━━━━━━━━━━━━━ 20s 885ms/step - accuracy: 0.5149 - loss: 0.6930
<keras.src.callbacks.history.History at 0x7e35e1a31000>
```

```
from matplotlib.pyplot import imread
from matplotlib.pyplot import imshow
```

```
def PredictImage(image_path):
  img = image.load_img(image_path, target_size=(300, 300))

  x = image.img_to_array(img)
  x = np.expand_dims(x, axis=0)
  x = preprocess_input(x)
  my_image = imread(image_path)
  imshow(my_image)

  values =  model.predict(x)
  print( np.argmax(values))

  return le.classes_[np.argmax(values)]
```

```
PredictImage('/content/drive/MyDrive/datasets/img-clsf/dataset/test/dogs/dog_354.jpg')
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 27ms/step
1
'dogs'
```




```
PredictImage('/content/drive/MyDrive/datasets/img-clsf/dataset/test/cats/cat_162.jpg')
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 17ms/step
0
'cats'
```