```
import tensorflow
import tensorflow as tf
from tensorflow import keras
from keras.layers import Input,Lambda,Dense,Flatten
from keras.models import Model
from keras.applications.vgg16 import VGG16,preprocess_input
from keras.preprocessing import image
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Sequential
from tensorflow.keras.optimizers.legacy import Adam
import numpy
from glob import glob
import matplotlib.pyplot as pyplot
from keras.models import load_model
from sklearn.metrics import confusion_matrix,classification_report
import seaborn
import os
%matplotlib inline
# changed from qt to inline
```

```
classes_list=['closed', 'no_yawn', 'open', 'yawn']
def printClassList():
    for class_name in classes_list:
        print(f"{classes_list.index(class_name)} -->  {class_name}")
printClassList()
def getClassvalue(index):
    print(classes_list[index])
```

```
0 -->  closed
1 -->  no_yawn
2 -->  open
3 -->  yawn
```

```
IMAGE_SIZE=[180,180]
training_path=r'C:/Users/kmman/Documents/Dissertation/driver-detection/driver-detection/train'
testing_path=r'C:/Users/kmman/Documents/Dissertation/driver-detection/driver-detection/test'
```

```
VGG16_Architecture=VGG16(input_shape=IMAGE_SIZE+[3],weights='imagenet',include_top=False)
```

```
VGG16_Architecture.summary()
```

```
Model: "vgg16"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 180, 180, 3)]     0

 block1_conv1 (Conv2D)       (None, 180, 180, 64)      1792
 block1_conv2 (Conv2D)       (None, 180, 180, 64)     36928

 block1_pool (MaxPooling2D)  (None, 90, 90, 64)       0

 block2_conv1 (Conv2D)       (None, 90, 90, 128)      73856

 block2_conv2 (Conv2D)       (None, 90, 90, 128)      147584

 block2_pool (MaxPooling2D)  (None, 45, 45, 128)      0

 block3_conv1 (Conv2D)       (None, 45, 45, 256)      295168

 block3_conv2 (Conv2D)       (None, 45, 45, 256)      590080

 block3_conv3 (Conv2D)       (None, 45, 45, 256)      590080

 block3_pool (MaxPooling2D)  (None, 22, 22, 256)      0

 block4_conv1 (Conv2D)       (None, 22, 22, 512)      1180160

 block4_conv2 (Conv2D)       (None, 22, 22, 512)      2359808

 block4_conv3 (Conv2D)       (None, 22, 22, 512)      2359808

 block4_pool (MaxPooling2D)  (None, 11, 11, 512)      0

 block5_conv1 (Conv2D)       (None, 11, 11, 512)      2359808

 block5_conv2 (Conv2D)       (None, 11, 11, 512)      2359808

 block5_conv3 (Conv2D)       (None, 11, 11, 512)      2359808

 block5_pool (MaxPooling2D)  (None, 5, 5, 512)        0

=================================================================
Total params: 14,714,688
Trainable params: 14,714,688
Non-trainable params: 0
_________________________________________________________________
```

```
for layer in VGG16_Architecture.layers:
    print(layer)
    layer.trainable=False
```

```
<keras.engine.input_layer.InputLayer object at 0x000001A30349B6D0>
<keras.layers.convolutional.conv2d.Conv2D object at 
0x000001A31B1BEF20>
<keras.layers.convolutional.conv2d.Conv2D object at 
0x000001A31B1BF880>
<keras.layers.pooling.max_pooling2d.MaxPooling2D object at 
```

```
0x000001A31B32C730>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B1BFD90>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B32E2C0>
<keras.layers.pooling.max_pooling2d.MaxPooling2D object at
0x000001A31B32F370>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B32FB50>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B32FDF0>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B32D0F0>
<keras.layers.pooling.max_pooling2d.MaxPooling2D object at
0x000001A31B381180>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B3820E0>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B3831F0>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B383FD0>
<keras.layers.pooling.max_pooling2d.MaxPooling2D object at
0x000001A31B39C610>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B382AA0>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B3829E0>
<keras.layers.convolutional.conv2d.Conv2D object at
0x000001A31B39CA30>
<keras.layers.pooling.max_pooling2d.MaxPooling2D object at
0x000001A31B39F1F0>
```

```
folders =
'C:/Users/kmman/Documents/Dissertation/driver-detection/driver-
detection/train'
num_dirs = len([d for d in os.listdir(folders) if
os.path.isdir(os.path.join(folders, d))])
```

```
x=Flatten()(VGG16_Architecture.output)
```

```
x
```

```
<KerasTensor: shape=(None, 12800) dtype=float32 (created by layer
'flatten')>
```

```
prediction=Dense(num_dirs,activation='softmax')(x)
```

```
prediction
```

```
<KerasTensor: shape=(None, 4) dtype=float32 (created by layer
'dense')>
```

```python
model=Model(inputs=VGG16_Architecture.input,outputs=prediction)

model.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 180, 180, 3)]     0

 block1_conv1 (Conv2D)       (None, 180, 180, 64)      1792

 block1_conv2 (Conv2D)       (None, 180, 180, 64)      36928

 block1_pool (MaxPooling2D)  (None, 90, 90, 64)        0

 block2_conv1 (Conv2D)       (None, 90, 90, 128)       73856

 block2_conv2 (Conv2D)       (None, 90, 90, 128)       147584

 block2_pool (MaxPooling2D)  (None, 45, 45, 128)       0

 block3_conv1 (Conv2D)       (None, 45, 45, 256)       295168

 block3_conv2 (Conv2D)       (None, 45, 45, 256)       590080

 block3_conv3 (Conv2D)       (None, 45, 45, 256)       590080

 block3_pool (MaxPooling2D)  (None, 22, 22, 256)       0

 block4_conv1 (Conv2D)       (None, 22, 22, 512)       1180160

 block4_conv2 (Conv2D)       (None, 22, 22, 512)       2359808

 block4_conv3 (Conv2D)       (None, 22, 22, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 11, 11, 512)       0

 block5_conv1 (Conv2D)       (None, 11, 11, 512)       2359808

 block5_conv2 (Conv2D)       (None, 11, 11, 512)       2359808

 block5_conv3 (Conv2D)       (None, 11, 11, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 5, 5, 512)         0

 flatten (Flatten)           (None, 12800)             0

 dense (Dense)               (None, 4)                 51204

=================================================================
Total params: 14,765,892
Trainable params: 51,204
Non-trainable params: 14,714,688
_________________________________________________________________
```

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

```
train_data_generator=ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2, preprocessing_function=lambda img: tf.image.resize(img, IMAGE_SIZE))
test_data_generator=ImageDataGenerator(rescale=1./255, preprocessing_function=lambda img: tf.image.resize(img, IMAGE_SIZE))
```

```
train_data_generator
```

```
<keras.preprocessing.image.ImageDataGenerator at 0x1a3034856c0>
```

```
test_data_generator=ImageDataGenerator(rescale=1./255)
```

```
training_set=train_data_generator.flow_from_directory(training_path,target_size=IMAGE_SIZE,batch_size=32,class_mode='categorical')
```

```
Found 2900 images belonging to 4 classes.
```

```
testing_set=test_data_generator.flow_from_directory(testing_path,target_size=IMAGE_SIZE,batch_size=32,class_mode='categorical')
```

```
Found 311 images belonging to 4 classes.
```

```
training_set.labels
```

```
array([0, 0, 0, ..., 3, 3, 3])
```

```
len(training_set)
```

```
91
```

```
len(testing_set)
```

```
10
```

```
model.fit(
    training_set,
    validation_data=testing_set,
    epochs=3,
    steps_per_epoch=len(training_set),
    validation_steps=len(testing_set)
)
```

```
Epoch 1/3
91/91 [==============================] - 871s 10s/step - loss: 0.4946
- accuracy: 0.7928 - val_loss: 0.1400 - val_accuracy: 0.9325
Epoch 2/3
91/91 [==============================] - 894s 10s/step - loss: 0.2003
- accuracy: 0.9228 - val_loss: 0.0665 - val_accuracy: 0.9871
Epoch 3/3
91/91 [==============================] - 773s 8s/step - loss: 0.1440 -
accuracy: 0.9531 - val_loss: 0.1082 - val_accuracy: 0.9518
```

```
<keras.callbacks.History at 0x1a31c5fab30>
```

```
model.save("./Models/Predefine_Architecture_VGG16_Model.h5")
```

```
VGG16_model=load_model("./Models/
Predefine_Architecture_VGG16_Model.h5")
```

```
test_prediction=model.predict(testing_set)
```

```
10/10 [==============================] - 72s 7s/step
```

```
test_prediction
```

```
array([[6.7802743e-05, 3.1868341e-05, 4.8112324e-01, 5.1877707e-01],
       [4.7799849e-09, 2.3212215e-06, 3.9498922e-05, 9.9995828e-01],
       [4.6462003e-05, 6.8450696e-05, 5.7905680e-01, 4.2082834e-01],
       ...,
       [9.9992919e-01, 6.6918255e-05, 2.2329816e-06, 1.6207852e-06],
       [9.7402062e-07, 3.8020353e-06, 4.5793716e-04, 9.9953735e-01],
       [6.1534192e-06, 9.9996948e-01, 7.6545120e-06, 1.6685844e-05]],
      dtype=float32)
```

```
predicted_values=[numpy.argmax(result) for result in test_prediction]
```

```
for i in range(len(predicted_values)):
    print(predicted_values[i]," - > ",testing_set.labels[i])
```

```
3  - >  0
3  - >  0
2  - >  0
1  - >  0
0  - >  0
0  - >  0
1  - >  0
1  - >  0
1  - >  0
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1  - >  0
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```

```
3  - >  3
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2  - >  3
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1  - >  3
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1  - >  3
3  - >  3
1  - >  3
0  - >  3
3  - >  3
1  - >  3
```

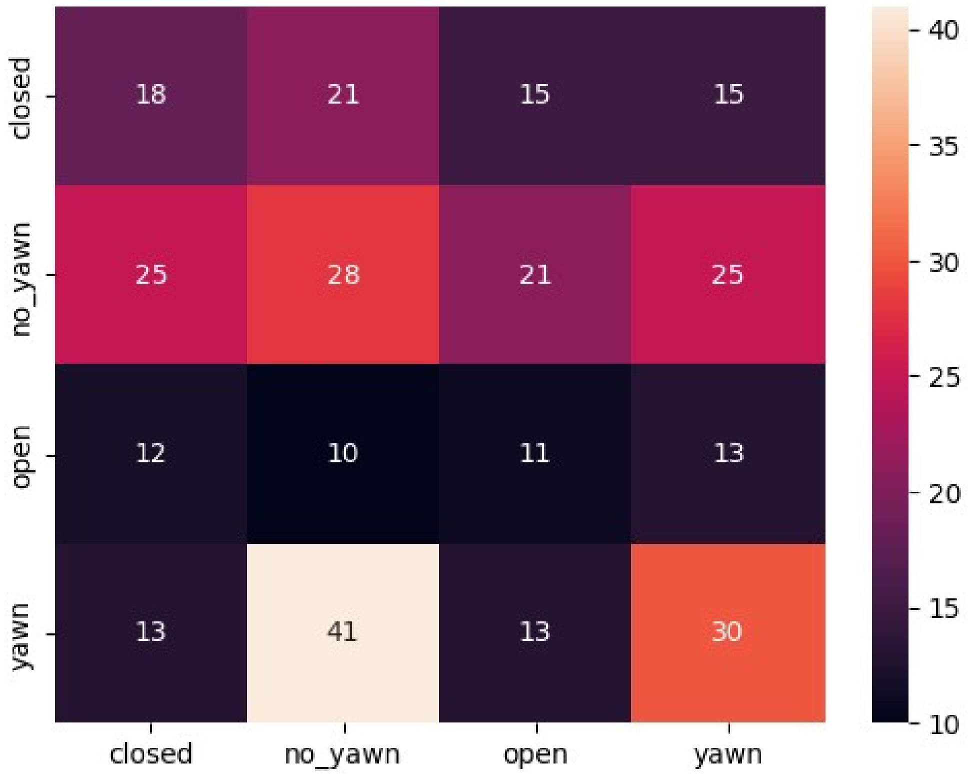
```
confusion_matrix_data=confusion_matrix(predicted_values,testing_set.la
bels)

confusion_matrix_data
```

```
array([[18, 21, 15, 15],
       [25, 28, 21, 25],
       [12, 10, 11, 13],
       [13, 41, 13, 30]], dtype=int64)
```

```
pyplot.figure('Confusion Matrix')
seaborn.heatmap(confusion_matrix_data,annot=True,xticklabels=classes_l
ist,yticklabels=classes_list)
# seaborn.heatmap(confusion_matrix_data,annot=True)
```

```
<Axes: >
```



```
classification_report_data=classification_report(predicted_values,test
ing_set.labels,target_names=classes_list)
```

```
print(classification_report_data)
```

```
              precision    recall  f1-score   support

      closed       0.26      0.26      0.26        69
     no_yawn       0.28      0.28      0.28        99
        open       0.18      0.24      0.21        46
        yawn       0.36      0.31      0.33        97

    accuracy                           0.28       311
   macro avg       0.27      0.27      0.27       311
```

```
weighted avg       0.29      0.28      0.28       311
```