```
pip install tensorflow==2.8.0
```

```
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 5.8/5.8 MB 50.3 MB/s eta 0:00:00
  Collecting tf-estimator-nightly==2.8.0.dev2021122109 (from tensorflow==2.8.0)
    Downloading tf_estimator_nightly-2.8.0.dev2021122109-py2.py3-none-any.whl (462 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 462.5/462.5 kB 29.5 MB/s eta 0:00:00
  Collecting keras<2.9,>=2.8.0rc0 (from tensorflow==2.8.0)
    Downloading keras-2.8.0-py2.py3-none-any.whl (1.4 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.4/1.4 MB 56.1 MB/s eta 0:00:00
  Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in /usr/local/lib/python3.10/dist-packages (from tensorflow==2.8
  Requirement already satisfied: grpcio<2.0,>=1.24.3 in /usr/local/lib/python3.10/dist-packages (from tensorflow==2.8.0) (1.60.1)
  Requirement already satisfied: wheel<1.0,>=0.23.0 in /usr/local/lib/python3.10/dist-packages (from astunparse>=1.6.0->tensorflow==2.8
  Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.10/dist-packages (from tensorboard<2.9,>=2.8->tensorfl
  Collecting google-auth-oauthlib<0.5,>=0.4.1 (from tensorboard<2.9,>=2.8->tensorflow==2.8.0)
    Downloading google_auth_oauthlib-0.4.6-py2.py3-none-any.whl (18 kB)
  Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.10/dist-packages (from tensorboard<2.9,>=2.8->tensorflow==2
  Requirement already satisfied: requests<3,>=2.21.0 in /usr/local/lib/python3.10/dist-packages (from tensorboard<2.9,>=2.8->tensorflow
  Collecting tensorboard-data-server<0.7.0,>=0.6.0 (from tensorboard<2.9,>=2.8->tensorflow==2.8.0)
    Downloading tensorboard_data_server-0.6.1-py3-none-manylinux2010_x86_64.whl (4.9 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.9/4.9 MB 36.9 MB/s eta 0:00:00
  Collecting tensorboard-plugin-wit>=1.6.0 (from tensorboard<2.9,>=2.8->tensorflow==2.8.0)
    Downloading tensorboard_plugin_wit-1.8.1-py3-none-any.whl (781 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 781.3/781.3 kB 25.6 MB/s eta 0:00:00
  Requirement already satisfied: werkzeug>=0.11.15 in /usr/local/lib/python3.10/dist-packages (from tensorboard<2.9,>=2.8->tensorflow==
  Requirement already satisfied: cachetools<6.0,>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3->tensorb
  Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3->tensorbo
  Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,
  Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.10/dist-packages (from google-auth-oauthlib<0.5,>=0
  Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0->tensorb
  Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2
  Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0->tensorboard<2
  Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests<3,>=2.21.0->tensorboard<2
  Requirement already satisfied: MarkupSafe>=2.1.1 in /usr/local/lib/python3.10/dist-packages (from werkzeug>=0.11.15->tensorboard<2.9,
  Requirement already satisfied: pyasn1<0.6.0,>=0.4.6 in /usr/local/lib/python3.10/dist-packages (from pyasn1-modules>=0.2.1->google-au
  Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.10/dist-packages (from requests-oauthlib>=0.7.0->google-auth
  Installing collected packages: tf-estimator-nightly, tensorboard-plugin-wit, keras, tensorboard-data-server, keras-preprocessing, goo
    Attempting uninstall: keras
      Found existing installation: keras 2.15.0
      Uninstalling keras-2.15.0:
        Successfully uninstalled keras-2.15.0
    Attempting uninstall: tensorboard-data-server
      Found existing installation: tensorboard-data-server 0.7.2
      Uninstalling tensorboard-data-server-0.7.2:
        Successfully uninstalled tensorboard-data-server-0.7.2
    Attempting uninstall: google-auth-oauthlib
      Found existing installation: google-auth-oauthlib 1.2.0
      Uninstalling google-auth-oauthlib-1.2.0:
        Successfully uninstalled google-auth-oauthlib-1.2.0
    Attempting uninstall: tensorboard
      Found existing installation: tensorboard 2.15.1
      Uninstalling tensorboard-2.15.1:
        Successfully uninstalled tensorboard-2.15.1
    Attempting uninstall: tensorflow
      Found existing installation: tensorflow 2.15.0
      Uninstalling tensorflow-2.15.0:
        Successfully uninstalled tensorflow-2.15.0
  ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the sour
  pandas-gbq 0.19.2 requires google-auth-oauthlib>=0.7.0, but you have google-auth-oauthlib 0.4.6 which is incompatible.
  Successfully installed google-auth-oauthlib-0.4.6 keras-2.8.0 keras-preprocessing-1.1.2 tensorboard-2.8.0 tensorboard-data-server-0.6
```

```
pip install scikit-learn
```

```
  Requirement already satisfied: scikit-learn in /usr/local/lib/python3.10/dist-packages (1.2.2)
  Requirement already satisfied: numpy>=1.17.3 in /usr/local/lib/python3.10/dist-packages (from scikit-learn) (1.23.5)
  Requirement already satisfied: scipy>=1.3.2 in /usr/local/lib/python3.10/dist-packages (from scikit-learn) (1.11.4)
  Requirement already satisfied: joblib>=1.1.1 in /usr/local/lib/python3.10/dist-packages (from scikit-learn) (1.3.2)
  Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn) (3.2.0)
```

```
import os
from glob import glob
from matplotlib import pyplot
import matplotlib.pyplot as plt
import tensorflow as tf
import random
import cv2
import pandas as pd
import numpy as np
import matplotlib.gridspec as gridspec
import seaborn as sns
import itertools
import sklearn
import itertools
import scipy
import skimage
from skimage.transform import resize
import csv
from tqdm import tqdm
from sklearn import model_selection
from sklearn.model_selection import train_test_split, learning_curve,KFold,cross_val_score,StratifiedKFold
from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report
import keras
from keras.utils import np_utils
from keras.utils.np_utils import to_categorical
from tensorflow.keras.utils import load_img,img_to_array
from keras.preprocessing.image import ImageDataGenerator
from keras import models, layers, optimizers
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, accuracy_score
from keras.layers import Activation,Dense, Dropout, Flatten

from keras.models import Model

%matplotlib inline

import warnings
warnings.filterwarnings("ignore")


from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

```
''' Data Path '''
train_path = '/content/drive/MyDrive/dataset'


File=[]
for f in os.listdir(train_path):
    File += [f]

'''  total number of classes '''
print(File)
```

```
['Closed', 'Open']
```

```
''' reading equal images for both GBM and LGG
    ie., 300 images for GBM and 300 images for LGG

 '''

train_data = []
n_of_images=136

''' label encoding '''
mapping={'Closed':0, 'Open':1}

count=0

for f in os.listdir(train_path):
    ''' joining path '''
    t=0
    path = os.path.join(train_path, f)
    for im in os.listdir(path):
        ''' loading an image '''
        img = load_img(os.path.join(path, im), grayscale=False, color_mode='rgb', target_size=(150,150))
        ''' converting an image to array '''
        img = img_to_array(img)
        ''' scaling  '''
        img = img / 255.0
        ''' appending image to train_data '''
        train_data.append([img, count])
        t+=1
        if t==n_of_images:
          break
    count=count+1


train_images, train_labels = zip(*train_data)


''' converting labels into to_categorical '''
train_labels = to_categorical(train_labels)

''' coverting train_images into numpy array '''
train_images = np.array(train_images)

''' converting train_labesl into numpy array '''
train_labels = np.array(train_labels)

''' shaep of train_images and train_labels '''
print(train_images.shape)
print(train_labels.shape)

     (272, 150, 150, 3)
     (272, 2)


''' reshaping images '''
train_images = train_images.reshape(-1,150,150,3)


''' train test split '''
X_train, X_test, y_train, y_test = train_test_split(train_images,train_labels, test_size=0.3,random_state=44)


''' shape of X_train, X_test, y_train, y_test '''
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)

     (190, 150, 150, 3)
     (82, 150, 150, 3)
     (190, 2)
     (82, 2)


''' data Augmentation '''
data_aug = ImageDataGenerator(horizontal_flip=True, vertical_flip=True, rotation_range=20, zoom_range=0.2,
                    width_shift_range=0.2, height_shift_range=0.2, shear_range=0.1, fill_mode="nearest")
```

####### Working with RESNET50 MODEL #######

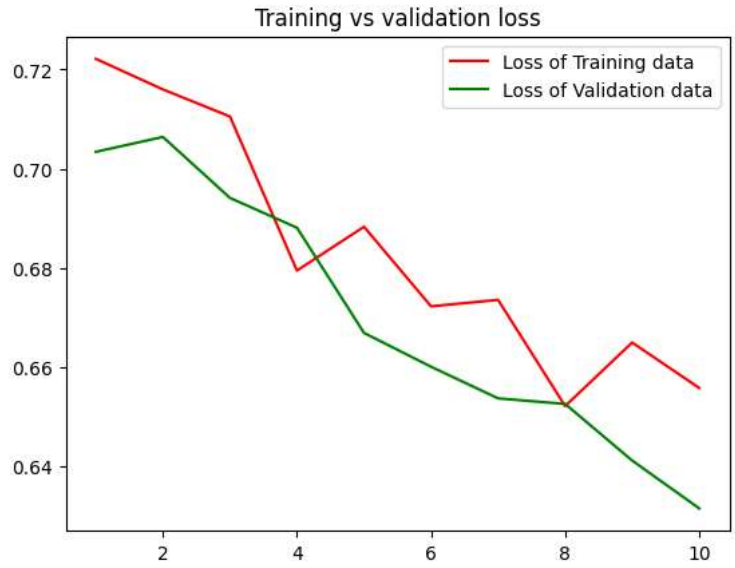
```
import tensorflow as tf
model1 =tf.keras.applications.resnet50.ResNet50(input_shape=(150,150,3),include_top=False,weights='imagenet',pooling='avg')
''' freezing layers '''
model1.trainable = False


inp = model1.input
''' Hidden Layer '''
x = tf.keras.layers.Dense(128, activation='relu')(model1.output)
''' Classification Layer '''
out = tf.keras.layers.Dense(2, activation='sigmoid')(x)

''' Model '''
model = tf.keras.Model(inputs=inp, outputs=out)

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


''' training '''
# Assuming you have data augmentation configured with `ImageDataGenerator` as `data_aug`
# Ensure that `data_aug` is correctly configured with the necessary augmentation parameters

# Use the flow method on `data_aug` to generate augmented data batches
augmented_data = data_aug.flow(X_train, y_train, batch_size=42)

# Train the model using the augmented data
history = model.fit(augmented_data, validation_data=(X_test, y_test), epochs=10)
```

```
Epoch 1/10
5/5 [==============================] - 26s 5s/step - loss: 0.7222 - accuracy: 0.5632 - val_loss: 0.7034 - val_accuracy: 0.5000
Epoch 2/10
5/5 [==============================] - 20s 4s/step - loss: 0.7160 - accuracy: 0.5211 - val_loss: 0.7064 - val_accuracy: 0.5000
Epoch 3/10
5/5 [==============================] - 22s 5s/step - loss: 0.7105 - accuracy: 0.5211 - val_loss: 0.6941 - val_accuracy: 0.5000
Epoch 4/10
5/5 [==============================] - 20s 5s/step - loss: 0.6795 - accuracy: 0.5842 - val_loss: 0.6881 - val_accuracy: 0.5000
Epoch 5/10
5/5 [==============================] - 22s 4s/step - loss: 0.6883 - accuracy: 0.5368 - val_loss: 0.6669 - val_accuracy: 0.6220
Epoch 6/10
5/5 [==============================] - 21s 4s/step - loss: 0.6723 - accuracy: 0.5579 - val_loss: 0.6601 - val_accuracy: 0.5000
Epoch 7/10
5/5 [==============================] - 22s 5s/step - loss: 0.6736 - accuracy: 0.5000 - val_loss: 0.6537 - val_accuracy: 0.5000
Epoch 8/10
5/5 [==============================] - 21s 4s/step - loss: 0.6522 - accuracy: 0.7316 - val_loss: 0.6526 - val_accuracy: 0.5732
Epoch 9/10
5/5 [==============================] - 22s 4s/step - loss: 0.6650 - accuracy: 0.5947 - val_loss: 0.6412 - val_accuracy: 0.5610
Epoch 10/10
5/5 [==============================] - 21s 5s/step - loss: 0.6558 - accuracy: 0.7158 - val_loss: 0.6316 - val_accuracy: 0.7073
```

```
''' prediction '''
y_pred=model.predict(X_test)

''' retreiving max val from predicted values '''
pred = np.argmax(y_pred,axis=1)

''' retreiving max val from actual values '''
ground = np.argmax(y_test,axis=1)

''' classificaion report '''
print(classification_report(ground,pred))
```

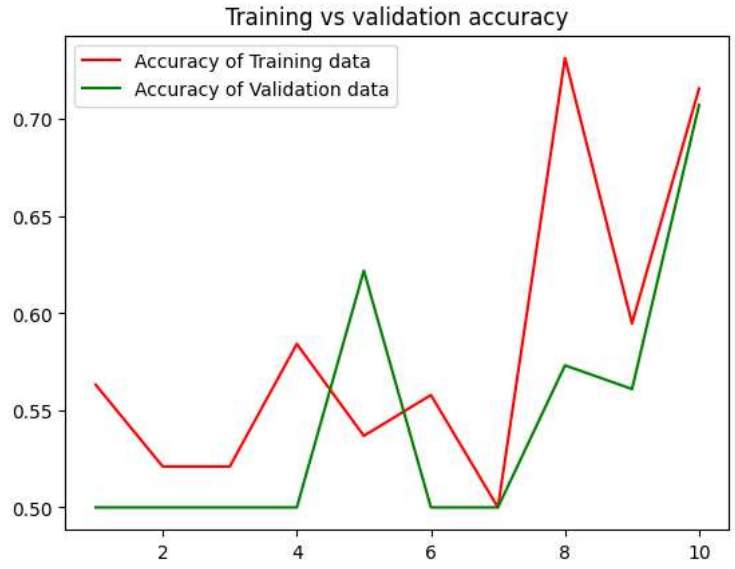
```
                  precision    recall  f1-score   support

               0       0.81      0.54      0.65        41
               1       0.65      0.88      0.75        41

        accuracy                           0.71        82
       macro avg       0.73      0.71      0.70        82
    weighted avg       0.73      0.71      0.70        82
```

```
''' training loss and validation loss graph '''
epochs = range(1,11)
plt.plot(epochs, history.history['loss'], 'r', label='Loss of Training data')
plt.plot(epochs, history.history['val_loss'], 'g', label='Loss of Validation data')
plt.title('Training vs validation loss')
plt.legend(loc=0)
plt.figure()
plt.show()
```




```
<Figure size 640x480 with 0 Axes>
```

```
''' training accuracy and validation accuracy graph '''
epochs = range(1,11)
plt.plot(epochs, history.history['accuracy'], 'r', label='Accuracy of Training data')
plt.plot(epochs, history.history['val_accuracy'], 'g', label='Accuracy of Validation data')
plt.title('Training vs validation accuracy')
plt.legend(loc=0)
plt.figure()
plt.show()
```

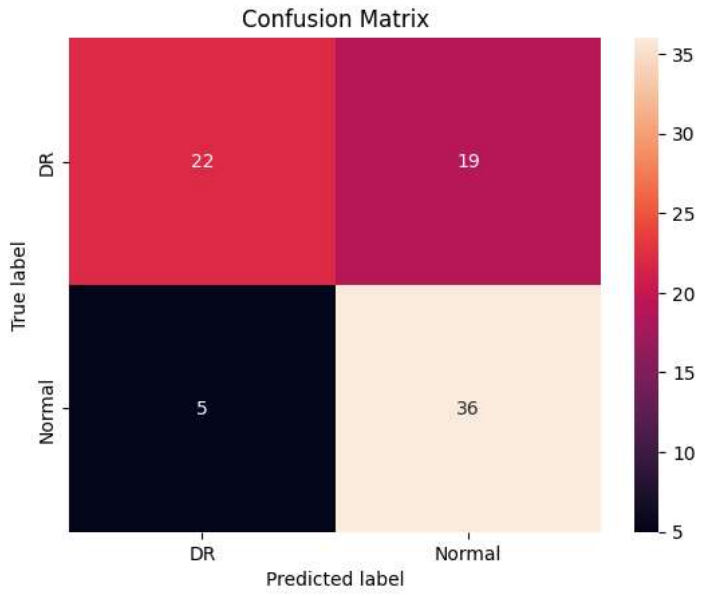



```
<Figure size 640x480 with 0 Axes>
```

```
''' checking accuracy score'''
y_test_arg=np.argmax(y_test,axis=1)
Y_pred = np.argmax(model.predict(X_test),axis=1)
accuracy = accuracy_score(y_test_arg, Y_pred)
print(accuracy)
```

```
0.7073170731707317
```

```
import seaborn as sns
from sklearn.metrics import confusion_matrix

cm = confusion_matrix(y_test_arg, Y_pred)
f = sns.heatmap(cm, annot=True, fmt='d')
# labels, title and ticks
f.set_xlabel('Predicted label');f.set_ylabel('True label');
f.set_title('Confusion Matrix');
f.xaxis.set_ticklabels(['DR', 'Normal']); f.yaxis.set_ticklabels(['DR', 'Normal']);
```




```
# Evaluating Metrices

TP = cm[1][1]
TN = cm[0][0]
FP = cm[0][1]
FN = cm[1][0]
print('True Positives:', TP)
print('True Negatives:', TN)
print('False Positives:', FP)
print('False Negatives:', FN)

# calculate accuracy
conf_accuracy = (float (TP+TN) / float(TP + TN + FP + FN))

# calculate mis-classification
conf_misclassification = 1- conf_accuracy

# calculate the sensitivity
conf_sensitivity = (TP / float(TP + FN))
# calculate the specificity
conf_specificity = (TN / float(TN + FP))

# calculate precision
conf_precision = (TN / float(TN + FP))
# calculate f_1 score
conf_f1 = 2 * ((conf_precision * conf_sensitivity) / (conf_precision + conf_sensitivity))
print('-'*50)
print(f'Accuracy: {round(conf_accuracy,2)}')
print(f'Mis-Classification: {round(conf_misclassification,2)}')
print(f'Sensitivity: {round(conf_sensitivity,2)}')
print(f'Specificity: {round(conf_specificity,2)}')
print(f'Precision: {round(conf_precision,2)}')
print(f'f_1 Score: {round(conf_f1,2)}')
```

```
True Positives: 36
True Negatives: 22
False Positives: 19
False Negatives: 5
--------------------------------------------------
Accuracy: 0.71
Mis-Classification: 0.29
Sensitivity: 0.88
```

```
Specificity: 0.54
Precision: 0.54
f_1 Score: 0.67
```

```
# calculate accuracy
conf_accuracy = (float (TP+TN) / float(TP + TN + FP + FN))

# calculate mis-classification
conf_misclassification = 1- conf_accuracy

# calculate the sensitivity
conf_sensitivity = (TP / float(TP + FN))
# calculate the specificity
conf_specificity = (TN / float(TN + FP))

# calculate precision
conf_precision = (TN / float(TN + FP))
# calculate NPV
conf_NPV = (TN / float(TN + FN))
# calculate f_1 score
conf_f1 = 4 * ((conf_precision * conf_sensitivity) / (conf_precision + conf_sensitivity))
print('-'*50)
print(f'Accuracy: {round(conf_accuracy,4)}')
print(f'Mis-Classification: {round(conf_misclassification,4)}')
print(f'Sensitivity: {round(conf_sensitivity,4)}')
print(f'Specificity: {round(conf_specificity,4)}')
print(f'Precision: {round(conf_precision,4)}')
print(f'NPV: {round(conf_NPV,4)}')
print(f'f_1 Score: {round(conf_f1,2)}')
```

```
--------------------------------------------------
Accuracy: 0.7073
Mis-Classification: 0.2927
Sensitivity: 0.878
Specificity: 0.5366
Precision: 0.5366
NPV: 0.8148
f_1 Score: 1.33
```

```
import matplotlib.pyplot as plt
from sklearn.metrics import roc_curve, roc_auc_score

# Calculate accuracy
conf_accuracy = (float(TP + TN) / float(TP + TN + FP + FN))

# Calculate mis-classification
conf_misclassification = 1 - conf_accuracy

# Calculate sensitivity
conf_sensitivity = (TP / float(TP + FN))

# Calculate specificity
conf_specificity = (TN / float(TN + FP))

# Calculate precision
conf_precision = (TN / float(TN + FP))

# Calculate NPV
conf_NPV = (TN / float(TN + FN))

# Calculate f_1 score
conf_f1 = 4 * ((conf_precision * conf_sensitivity) / (conf_precision + conf_sensitivity))

# Calculate predicted probabilities
y_scores = model.predict_on_batch(X_test)[:, 1]  # Assuming you have a model and input data (X) available

# Calculate false positive rate, true positive rate, and thresholds
fpr, tpr, thresholds = roc_curve(y_test_arg, y_scores)  # Replace y_true with your true labels

# Calculate AUC score
auc = roc_auc_score(y_test_arg, y_scores)  # Replace y_true with your true labels

# Plot ROC curve
plt.figure()
plt.plot(fpr, tpr, 'm', label='ROC curve (area = %0.2f)' % auc)
plt.plot([0, 1], [0, 1], 'b')
plt.xlim([0.0, 1.0])
```