Importing of libraries

```
#Importing of the libraries

import tensorflow.keras
import tensorflow as tf
import os
import numpy as np
import pandas as pd
import random
import seaborn as sns

from tensorflow.keras.optimizers import *
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.layers import *
from tensorflow.keras.applications.resnet50 import ResNet50
from tensorflow.keras.models import *
from tensorflow.keras.losses import *
import matplotlib.pyplot as plt
from tensorflow.keras.preprocessing.image import load_img
from tensorflow.keras.applications.resnet50 import preprocess_input
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import multilabel_confusion_matrix,roc_auc_score,confusion_mat

import warnings
warnings.filterwarnings("ignore")


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

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
```

```
#!unzip "/content/drive/MyDrive/archive.zip" -d "/content/drive/MyDrive/Project/"
```

```
training_directory = '/content/drive/MyDrive/Project/Training/'
training_paths = []
for label in os.listdir(training_directory):
    for file in os.listdir(training_directory+label):
        training_paths.append(training_directory + label+'/'+file)

random.shuffle(training_paths)

#One of the image path fro the training directory is being displayed
print(training_paths[0])
```

```
    /content/drive/MyDrive/Project/Training/meningioma/Tr-me_1320.jpg
```

```
testing_directory = '/content/drive/MyDrive/Project/Testing/'
testing_paths = []
for label in os.listdir(testing_directory):
    for file in os.listdir(testing_directory+label):
        testing_paths.append(testing_directory+label+'/'+file)
random.shuffle(testing_paths)

#shows one of the training directory's picture routes
print(testing_paths[0])
```

```
    /content/drive/MyDrive/Project/Testing/meningioma/Te-me_0246.jpg
```

```
#how many photos are in the training directory.
len(training_paths)
```

```
    5712
```

```
#the training directory's picture count.
len(testing_paths)
```

```
    1311
```

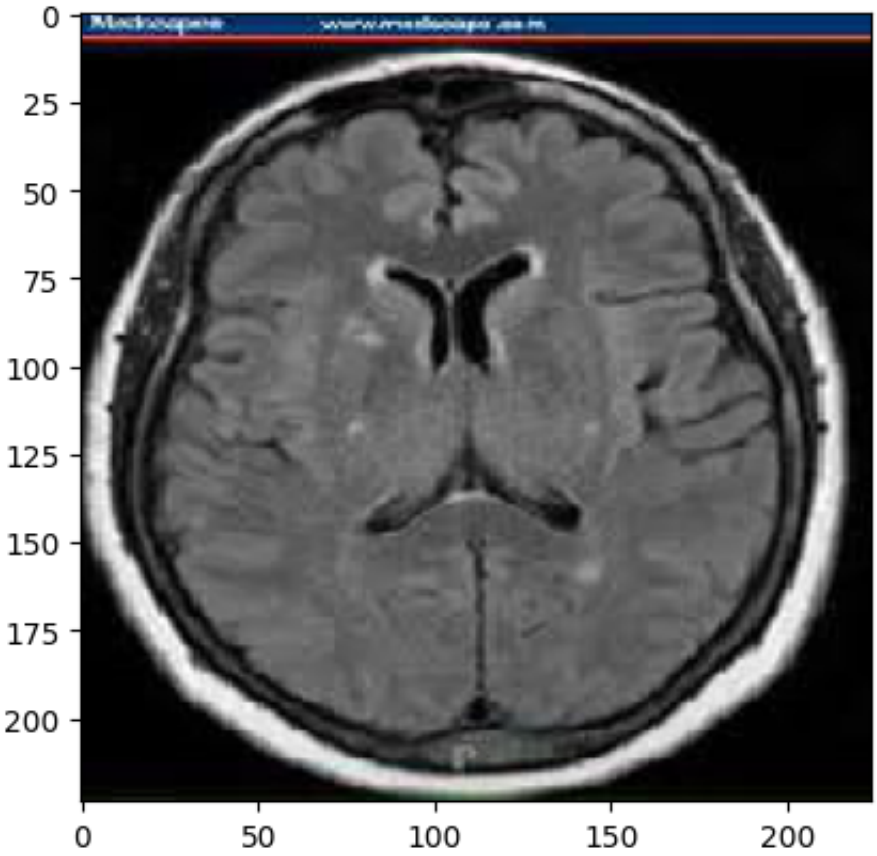
```
#arrays for storing the numbers used to label and train the images.
data_for_training = []
labels_for_training = []

#arrays for keeping the numbers needed to test the labels and images.
data_for_testing = []
labels_for_testing = []
```

```
#utilizing a loop to collect data from the training routes
for img_path in training_paths:
    #From the filenames, we are extracting the class labels.
    label = img_path.split(os.path.sep)[-2]

    #processed the (224*244) pictures that were loaded
    img = load_img(img_path, target_size=(224, 224))
    img = img_to_array(img)
    img = np.array(img)/255.0

    data_for_training.append(img)
    labels_for_training.append(label)


#utilizing a loop to collect data from the training routes
for img_path in testing_paths:
    #From the filenames, we are extracting the class labels.
    label = img_path.split(os.path.sep)[-2]

    #processed the (224*244) pictures that were loaded
    img = load_img(img_path, target_size=(224, 224))

    img = img_to_array(img)
    img = np.array(img)/255.0

    data_for_testing.append(img)
    labels_for_testing.append(label)
```

Sample Example from testing data

```
plt.imshow(data_for_testing[3])
```

```
<matplotlib.image.AxesImage at 0x7fec25189dc0>
```



Conversion of the labels and data to numpy arrays

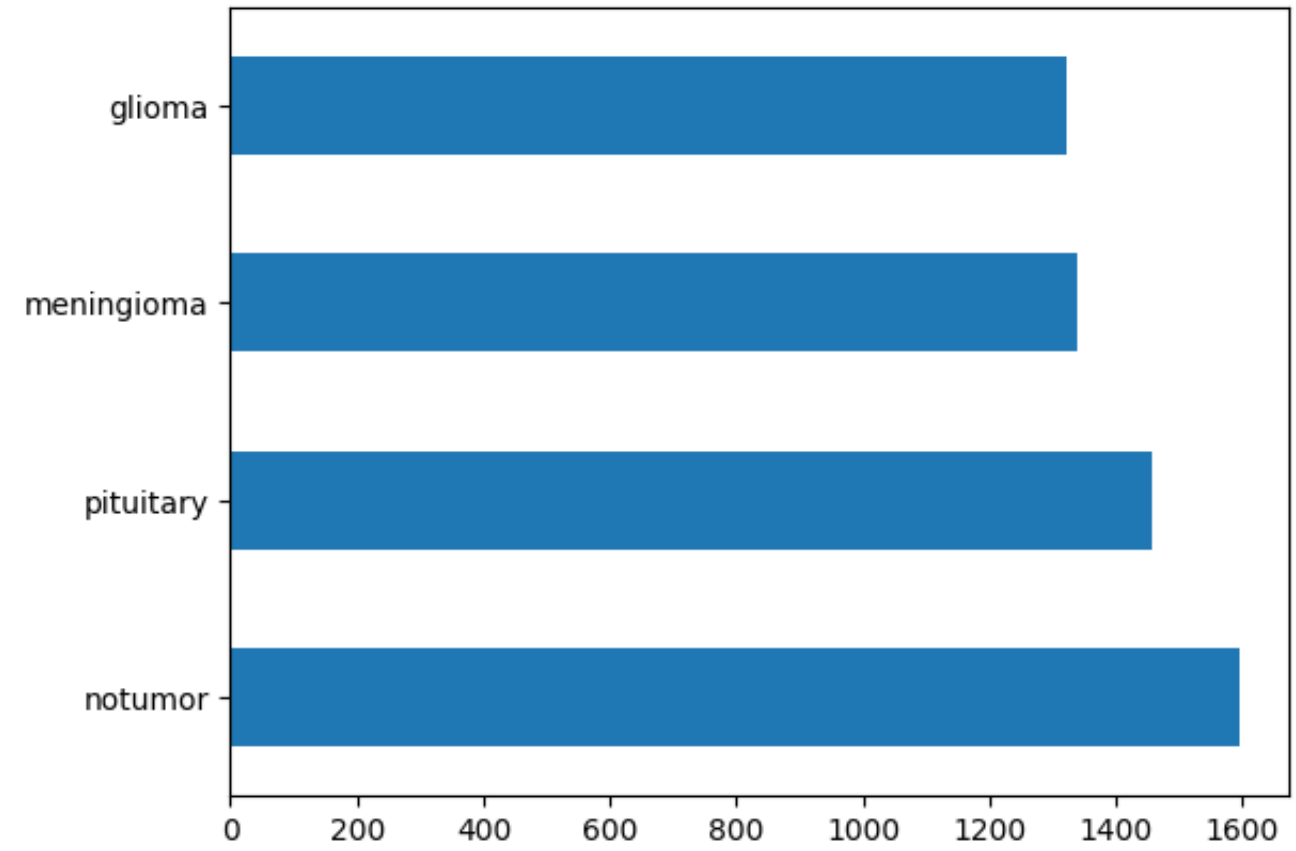
```
def data_label_conversion(data,labels):
  #data and label conversion to numpy arrays
  data = np.array(data, dtype="float32")
  labels = np.array(labels)
  #one hot label encoding
  lblenc = LabelEncoder()
  labels = lblenc.fit_transform(labels)
  labels_to_index=dict(zip(lblenc.classes_, lblenc.transform(lblenc.classes_)))
  labels = to_categorical(labels)
  return  data,labels,labels_to_index
```

Data insight for Training Data and Testing Data

Training Data

```
pd.Series(labels_for_training).value_counts().plot(kind='barh')
```

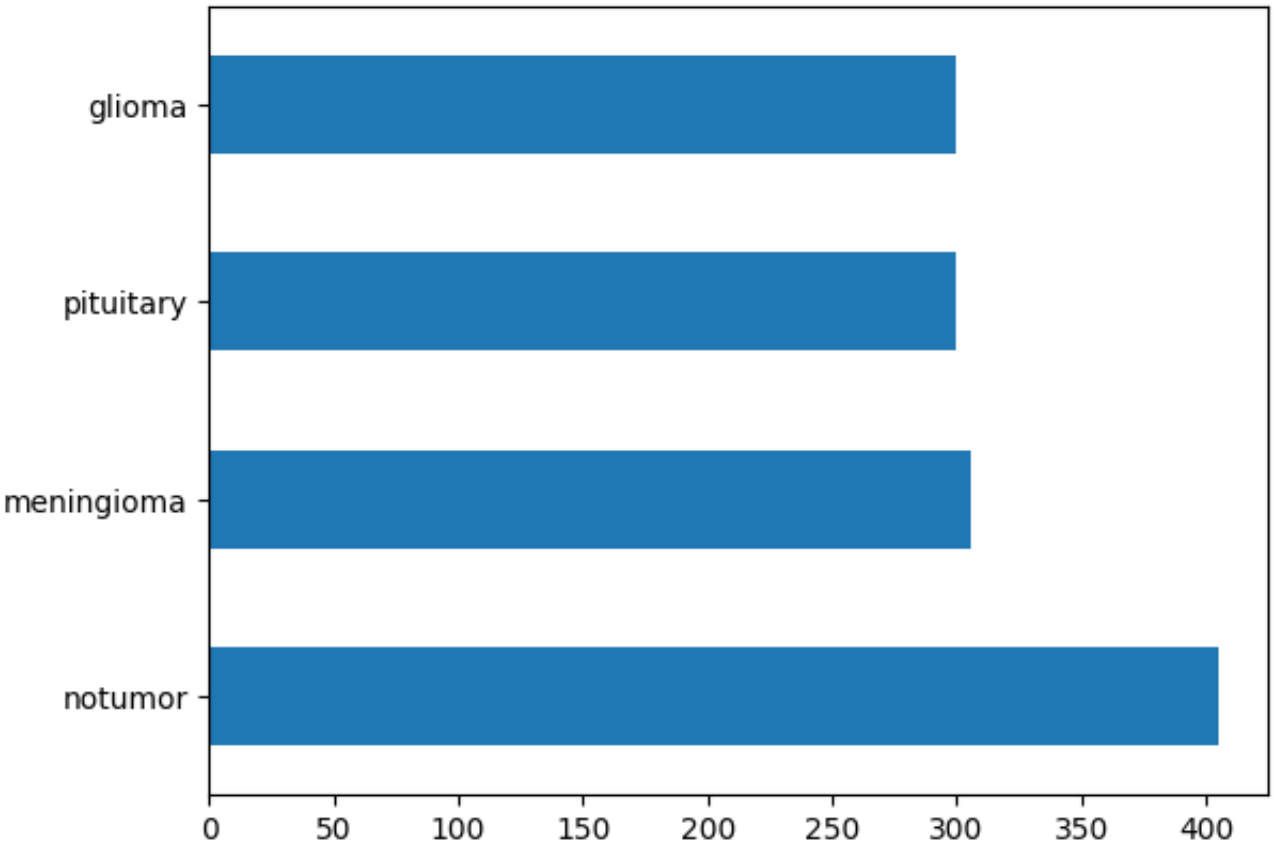
```
<Axes: >
```



Testing Data

```
pd.Series(labels_for_testing).value_counts().plot(kind='barh')
```

```
<Axes: >
```




```
data_for_training,labels_for_training,labels_to_index = data_label_conversion(data_
data_for_testing,labels_for_testing ,_= data_label_conversion(data_for_testing,labe
```

```
print("Train dataset size : ",data_for_training.shape)
print("---------------------------------------")
print("Test dataset size : ",data_for_testing.shape)
print("---------------------------------------")
```

```
Train dataset size :  (5712, 224, 224, 3)
---------------------------------------
Test dataset size :  (1311, 224, 224, 3)
---------------------------------------
```

```
#Labels have been converted to numerical values, as shown in the output below.
labels_to_index
```

```
{'glioma': 0, 'meningioma': 1, 'notumor': 2, 'pituitary': 3}
```

```
index_to_labels={}
for label,value in enumerate(labels_to_index):
    index_to_labels[label]=value
```

Rescaling and Data Generations

```
batch_size=32

#Generations of data and scaling
training_data_generation = ImageDataGenerator(validation_split=0.25)
testing_data_generation = ImageDataGenerator()

training_generation = training_data_generation.flow(data_for_training, labels_for_t
validation_generation = training_data_generation.flow(data_for_training, labels_for
testing_generation = testing_data_generation.flow(data_for_testing, labels_for_test


labels_for_training[3]
```

```
array([0., 1., 0., 0.], dtype=float32)
```

RESNet50 Initialization

```
model_resnet50 = ResNet50(weights='imagenet', input_shape=(224,224,3), include_top=
for layer in model_resnet50.layers[:171]:
    layer.trainable = False

for layer in model_resnet50.layers[171:]:
    layer.trainable = True
```

Execution of Resnet50 to our dataset

```
model = Sequential()
model.add(Input(shape=(224,224,3)))
model.add(model_resnet50)
model.add(Flatten())
model.add(Dropout(0.25))
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.2))
model.add(Dense(4, activation='softmax'))

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 resnet50 (Functional)       (None, 7, 7, 2048)        23587712

 flatten (Flatten)           (None, 100352)            0

 dropout (Dropout)           (None, 100352)            0

 dense (Dense)               (None, 128)               12845184

 dropout_1 (Dropout)         (None, 128)               0

 dense_1 (Dense)             (None, 4)                 516

=================================================================
Total params: 36,433,412
Trainable params: 13,900,420
Non-trainable params: 22,532,992
_________________________________________________________________
```

```
model.compile(optimizer=Adam(learning_rate=0.0001),
              loss='categorical_crossentropy',
              metrics=['accuracy','AUC'])
```

Execution of model for 15 epocs

```
history=model.fit(training_generation,
          epochs=15,
          validation_data=validation_generation
         )
```

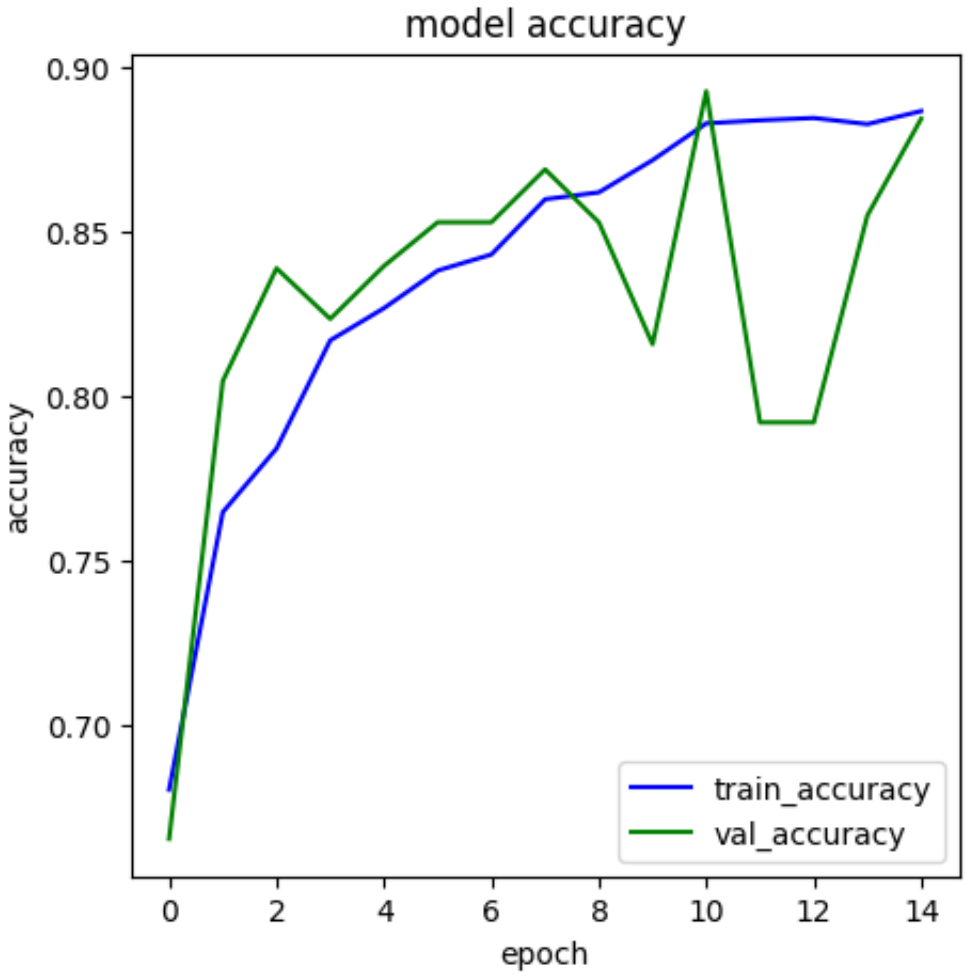
```
     Epoch 1/15
     134/134 [==============================] - 40s 167ms/step - loss: 0.8366 - acc
     Epoch 2/15
     134/134 [==============================] - 20s 146ms/step - loss: 0.5800 - acc
     Epoch 3/15
     134/134 [==============================] - 20s 148ms/step - loss: 0.5196 - acc
     Epoch 4/15
     134/134 [==============================] - 20s 150ms/step - loss: 0.4478 - acc
     Epoch 5/15
     134/134 [==============================] - 20s 152ms/step - loss: 0.4354 - acc
     Epoch 6/15
     134/134 [==============================] - 21s 156ms/step - loss: 0.4010 - acc
     Epoch 7/15
     134/134 [==============================] - 21s 159ms/step - loss: 0.3775 - acc
     Epoch 8/15
     134/134 [==============================] - 21s 157ms/step - loss: 0.3576 - acc
     Epoch 9/15
     134/134 [==============================] - 21s 158ms/step - loss: 0.3398 - acc
     Epoch 10/15
     134/134 [==============================] - 21s 159ms/step - loss: 0.3272 - acc
     Epoch 11/15
     134/134 [==============================] - 21s 155ms/step - loss: 0.3033 - acc
     Epoch 12/15
     134/134 [==============================] - 21s 159ms/step - loss: 0.2916 - acc
     Epoch 13/15
     134/134 [==============================] - 21s 157ms/step - loss: 0.2927 - acc
     Epoch 14/15
     134/134 [==============================] - 21s 155ms/step - loss: 0.2974 - acc
     Epoch 15/15
     134/134 [==============================] - 21s 154ms/step - loss: 0.2730 - acc
```

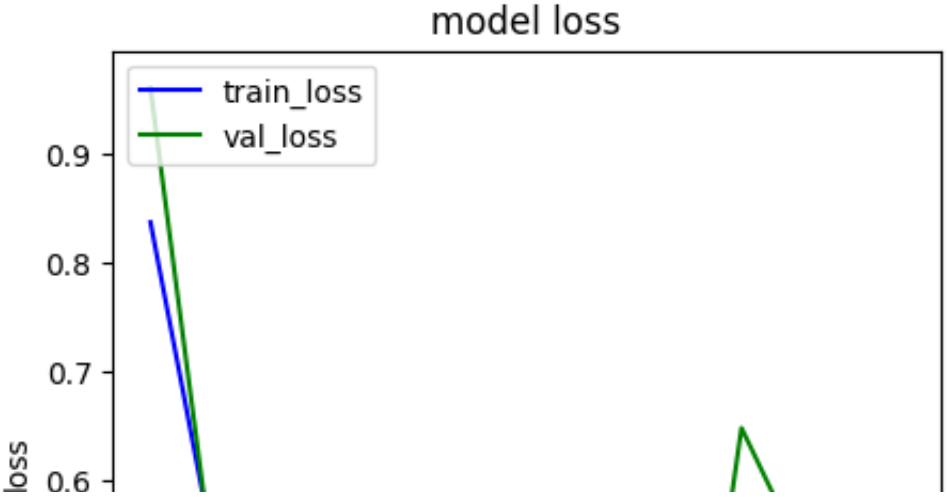
```
!mkdir -p saved_model
model.save('saved_model/ResNet50ForBrain')
```

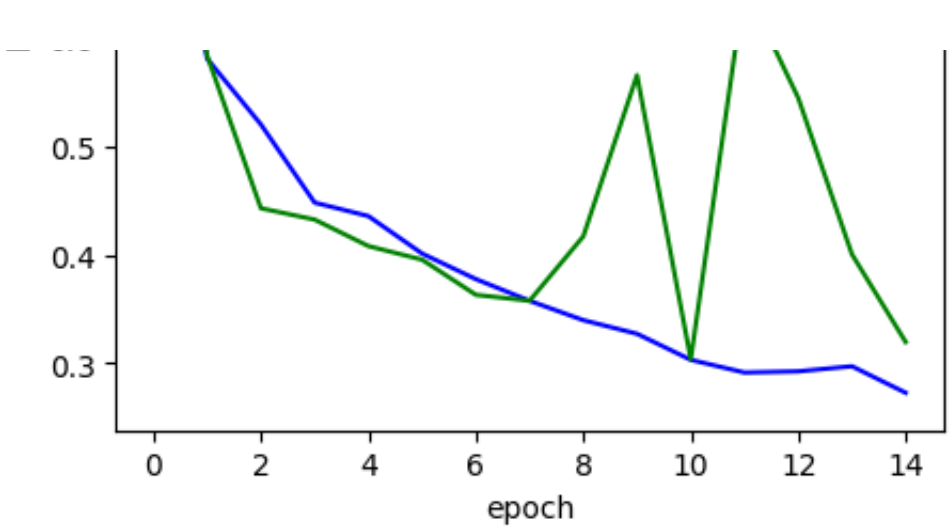
```
     WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _j
```

```
plt.figure(figsize=(5,5))
hist=history.history
plt.plot(hist["accuracy"],color="b",label="train_accuracy")
plt.plot(hist["val_accuracy"],color="g",label="val_accuracy")
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(loc="lower right")
```

```
plt.show()

plt.figure(figsize=(5,5))
plt.plot(hist['loss'],color="b",label="train_loss")
plt.plot(hist['val_loss'],color="g",label="val_loss")
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend( loc='upper left')
plt.show()
```







Evaluation of model

```
model.evaluate(training_generation)
```

```
134/134 [==============================] - 16s 114ms/step - loss: 0.2123 - acc
[0.2123422920703888, 0.920634925365448, 0.9920575022697449]
```

```
model.evaluate(validation_generation)
```

```
45/45 [==============================] - 5s 112ms/step - loss: 0.3197 - accura
[0.3196631669998169, 0.8844537734985352, 0.9817672371864319]
```

```
model.evaluate(testing_generation)
```

```
41/41 [==============================] - 6s 151ms/step - loss: 0.3405 - accura
[0.3404844105243683, 0.8634629845619202, 0.9781801700592041]
```

```
testing_prediction = model.predict(testing_generation)
```

```
41/41 [==============================] - 6s 112ms/step
```

```
testing_prediction
```

```
array([[2.6831549e-01, 7.2701001e-01, 1.9207840e-03, 2.7537309e-03],
       [9.6096926e-09, 1.3816761e-05, 9.9998617e-01, 5.5649108e-09],
       [4.4497759e-07, 7.6072522e-02, 7.4170186e-04, 9.2318529e-01],
       ...,
       [3.1496461e-02, 9.5081294e-01, 6.9550816e-03, 1.0735424e-02],
       [9.1720663e-05, 8.6746848e-05, 9.9982041e-01, 1.2485411e-06],
       [1.8357817e-07, 2.2906015e-02, 1.6144768e-04, 9.7693241e-01]],
      dtype=float32)
```

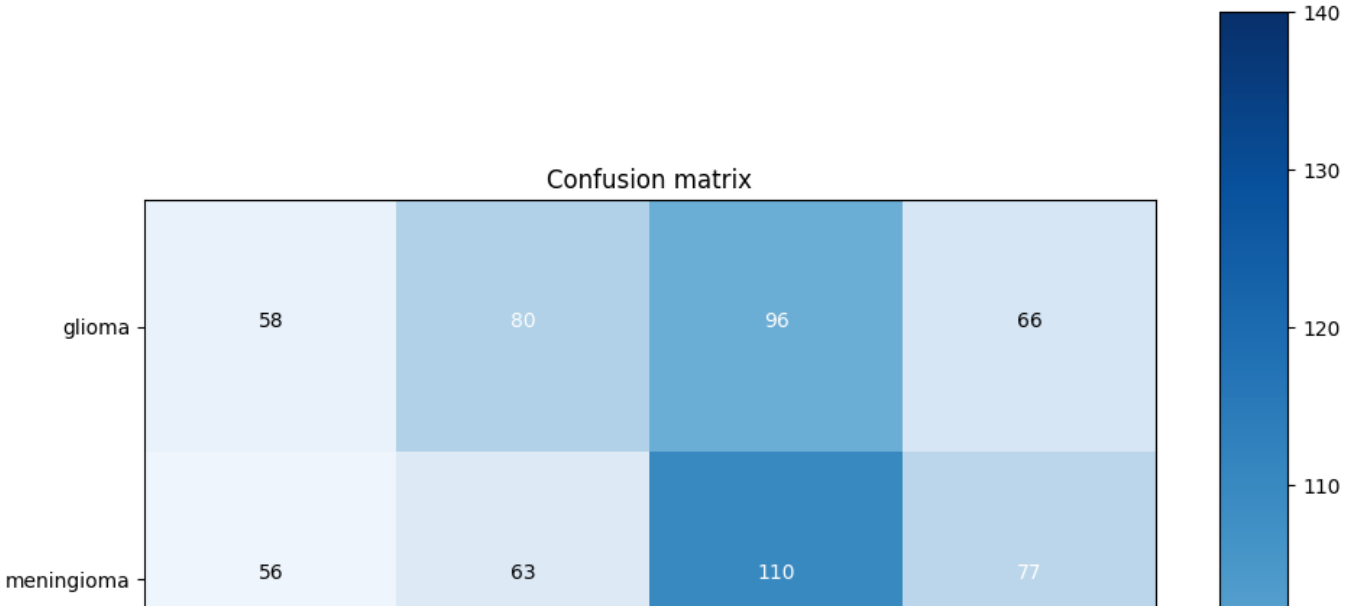
```
test_pred_class=[]
test_labels_class=[]
for i,pred in enumerate(testing_prediction):
    test_pred_class.append(np.int(np.argmax(pred)))

for i,pred in enumerate(labels_for_testing):
    test_labels_class.append(np.int(np.argmax(pred)))


labels=list(index_to_labels.values())
labels
```

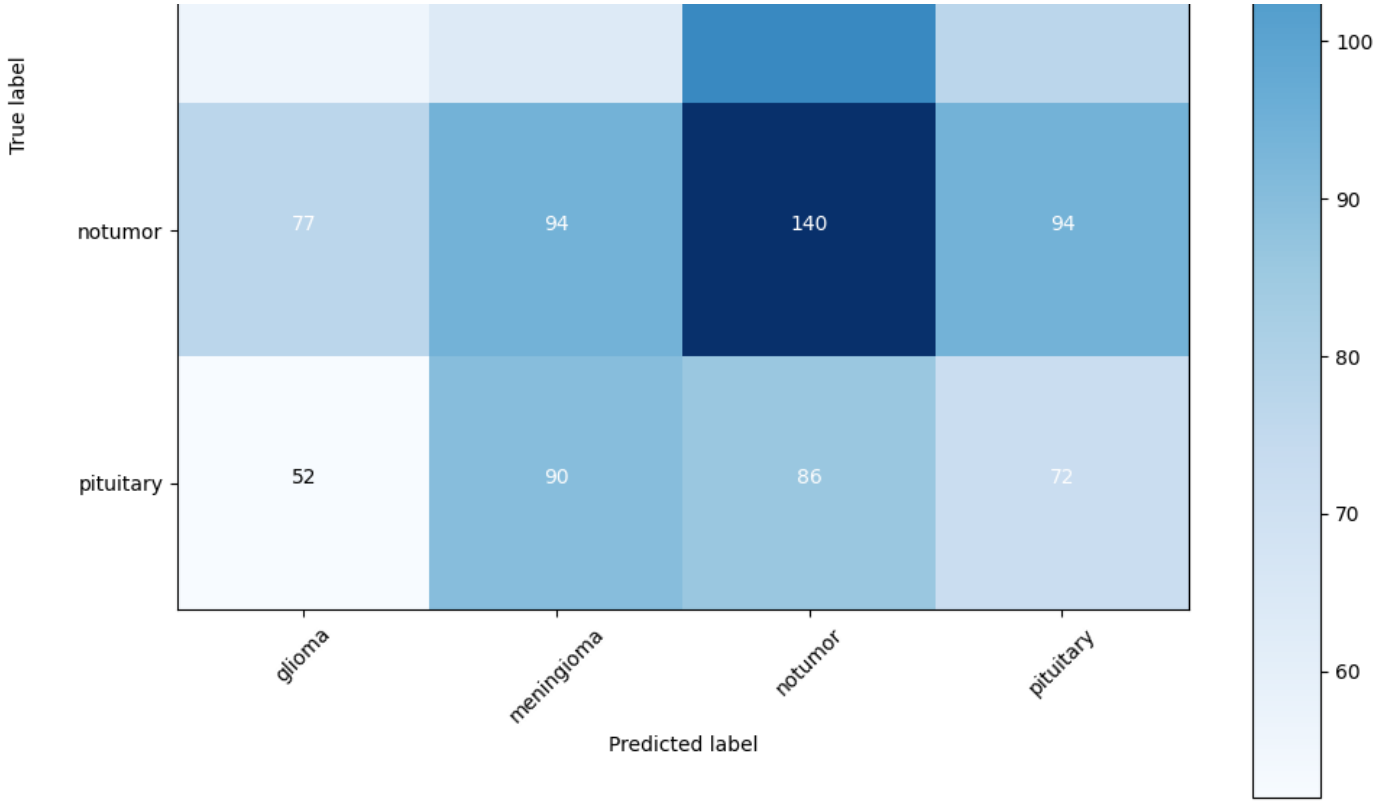
```
['glioma', 'meningioma', 'notumor', 'pituitary']
```

```
cm = confusion_matrix(test_labels_class, test_pred_class)
```

```
import itertools
from itertools import product
def plot_confusion_matrix(cm, classes,normalize=False,title='Confusion matrix',cmap

    plt.figure(figsize=(10,10))
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized")
    else:
        print('Without normalization')

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, cm[i, j],
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')


plot_confusion_matrix(cm,labels)
```

```
Confusion matrix, without normalization
```






```
AUC=roc_auc_score(labels_for_testing,testing_prediction)
AUC
```

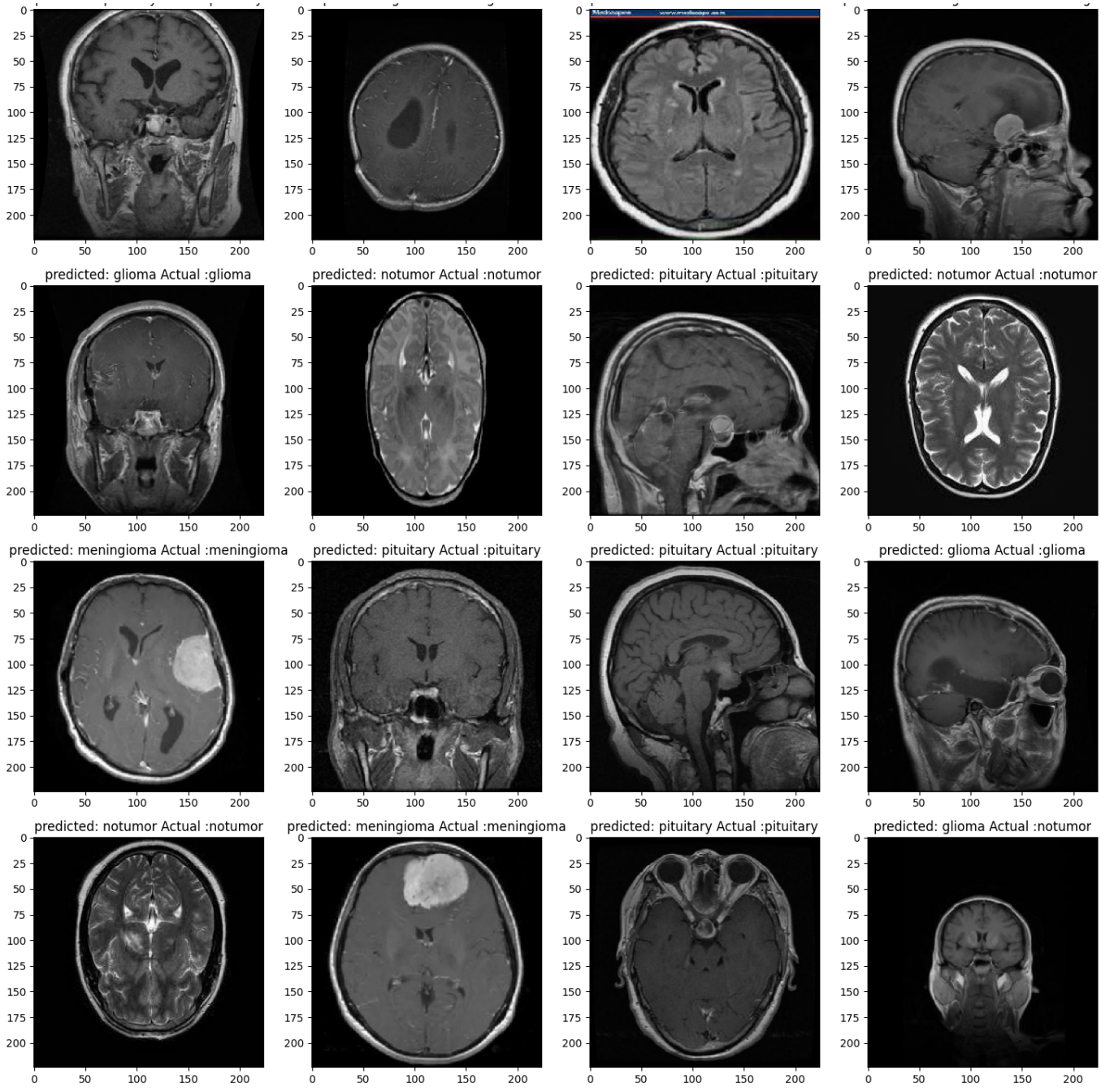
```
0.5091334367519806
```

```
path_to_label={}
for i,path in enumerate(testing_paths):
    label = path.split(os.path.sep)[-2]
    path_to_label[path]=label


predictions=model.predict(testing_generation)
```

```
     41/41 [==============================] - 4s 105ms/step
```

```
from PIL import Image



fig = plt.figure(figsize=(18, 18))
columns = 4
rows = 4
for i in range(1, columns*rows +1):
    img = load_img(testing_paths[i], target_size=(224, 224))
    img = img_to_array(img)
    img = np.array(img)/255.0
    img=np.reshape(img,(-1,224,224,3))
    pred=model.predict(img)
    index=np.argmax(pred)
    klass=index_to_labels[index]
    actual=path_to_label[testing_paths[i]]
    img=np.reshape(img,(224,224,3))
    fig.add_subplot(rows, columns, i)
    plt.imshow(img)
    plt.title(f'predicted: { klass} Actual :{actual}')
plt.show()
```

```
     1/1 [==============================] - 2s 2s/step
     1/1 [==============================] - 0s 45ms/step
     1/1 [==============================] - 0s 25ms/step
     1/1 [==============================] - 0s 27ms/step
     1/1 [==============================] - 0s 32ms/step
     1/1 [==============================] - 0s 25ms/step
     1/1 [==============================] - 0s 26ms/step
     1/1 [==============================] - 0s 24ms/step
     1/1 [==============================] - 0s 26ms/step
     1/1 [==============================] - 0s 26ms/step
     1/1 [==============================] - 0s 28ms/step
     1/1 [==============================] - 0s 26ms/step
     1/1 [==============================] - 0s 26ms/step
     1/1 [==============================] - 0s 24ms/step
     1/1 [==============================] - 0s 24ms/step
     1/1 [==============================] - 0s 30ms/step
```


predicted: glioma Actual :glioma
predicted: notumor Actual :notumor
predicted: pituitary Actual :pituitary
predicted: notumor Actual :notumor
predicted: meningioma Actual :meningioma
predicted: pituitary Actual :pituitary
predicted: pituitary Actual :pituitary
predicted: glioma Actual :glioma
predicted: notumor Actual :notumor
predicted: meningioma Actual :meningioma
predicted: pituitary Actual :pituitary
predicted: glioma Actual :notumor