In [1]:

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


np.random.seed(42)
```

In [2]:

```
Normal = ['train/Normal/'+name for name in os.listdir('train/Normal') if name.endswith('jpg') ]
Pneumonia = ['train/Pneumonia/'+name for name in os.listdir('train/Pneumonia') if name.endswith('jpg') ]
TB = ['train/TB/'+name for name in os.listdir('train/TB') if name.endswith('jpg') ]
test = ['test/'+name for name in os.listdir('test') if name.endswith('jpg') ]
#loading the images from all the files
```

In [3]:

```
from PIL import Image
def pre_process(path, size=128):
    img=Image.open(path).convert('LA') #2 color channels
    img=np.array(img.resize((size,size)))
    img = np.array(img)
    img = img.reshape(np.multiply(size,size)*2)
    return img
#processing the image to have a size of 128x128 and converting them to greyscale
```

In [4]:

```
%%time
Normal = [(pre_process(i), 'Normal') for i in Normal]
Pneumonia = [(pre_process(i),'Pneumonia') for i in Pneumonia]
TB = [(pre_process(i), 'TB') for i in TB]
X_testt = [pre_process(i) for i in test]
```

```
CPU times: user 15.6 s, sys: 1.02 s, total: 16.6 s
Wall time: 17.1 s
```

In [5]:

```
Normal = np.array(Normal)
Pneumonia = np.array(Pneumonia)
TB = np.array(TB)
X_testt = np.array(X_testt)
X_testt.shape
```

Out[5]:

```
(66, 32768)
```

In [6]:

```
%%time
X= [ j[0]    for i in [Normal,Pneumonia,TB]    for j in i   ]
y= [ j[1]    for i in [Normal,Pneumonia,TB]    for j in i   ]
X = np.array(X)
y = np.array(y)
```

```
CPU times: user 3.11 ms, sys: 2.77 ms, total: 5.88 ms
Wall time: 4.91 ms
```

In [7]:

```
from sklearn.preprocessing import OneHotEncoder
one = OneHotEncoder()
y = one.fit_transform(y.reshape(-1,1))
y.shape
#onehot encoding y
```

Out[7]:

```
(251, 3)
```

In [8]:

```
y_frame = pd.DataFrame(y.toarray().astype(int))
y_cnn = y_frame.iloc[:,:].to_numpy()
```

In [9]:

```
y_cnn
```

Out[9]:

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

```
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
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        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
        [1, 0, 0],
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        [1, 0, 0],
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        [0, 1, 0],
        [0, 1, 0],
        [0, 1, 0],
        [0, 1, 0],
        [0, 1, 0],
```

```
[0, 1, 0],
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[0, 0, 1],
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[0, 0, 1],
[0, 0, 1],
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[0, 0, 1],
```

```
       [0, 0, 1],
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       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
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       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1],
       [0, 0, 1]])
```

In [10]:

```
from sklearn.preprocessing import StandardScaler

sc= StandardScaler()

# Scale data to influence variance
X= sc.fit_transform(X)

#Transform the test data as that of the features. Same scale
X_testt = sc.transform(X_testt)
```

In [11]:

```
X = X.reshape(X.shape[0],128,128,2)
X_testt= X_testt.reshape(X_testt.shape[0],128,128,2)
#reshaping x and x_testt
```

In [12]:

```
#Splitting the values of X
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(X,y_cnn,test_size=0.20,random_state=42)
```

In [ ]:

In [13]:

```
import keras
from keras.optimizers import SGD
from keras.models import Sequential, Input, Model
from keras.layers import Dense, Activation, Dropout, Flatten, Conv2D, MaxPooling2D,BatchNormalization
from keras.layers.advanced_activations import LeakyReLU
import tensorflow as tf
```

In [14]:

```
epochs=32
activations='sigmoid'
```

In [15]:

```
num_class=3
```

In [16]:

```
model=Sequential()

model.add(Conv2D(128, kernel_size=3, activation='relu',input_shape=(128,128,2)))
model.add(MaxPooling2D((2,2)))

model.add(Conv2D(128, kernel_size=3, activation='relu'))
model.add(MaxPooling2D((2,2)))

# model.add(Conv2D(128, kernel_size=3, activation='relu'))
# model.add(MaxPooling2D((2,2)))

model.add(Flatten())
# model.add(BatchNormalization())
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.3))
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.2))
model.add(Dense(128,activation='relu'))
model.add(Dropout(0.2))
model.add(Dense(128,activation='relu'))
# model.add(Activation('sigmoid'))
model.add(Dropout(0.2))
model.add(Dense(num_class, activation='softmax'))
model.summary()
# CNN configuration
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 126, 126, 128)     2432
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 63, 63, 128)       0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 61, 61, 128)       147584
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 30, 30, 128)       0
_________________________________________________________________
flatten (Flatten)            (None, 115200)            0
_________________________________________________________________
dense (Dense)                (None, 256)               29491456
_________________________________________________________________
dropout (Dropout)            (None, 256)               0
_________________________________________________________________
dense_1 (Dense)              (None, 256)               65792
```

```
_________________________________________________________________
dropout_1 (Dropout)          (None, 256)               0
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
dropout_2 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_3 (Dense)              (None, 128)               16512
_________________________________________________________________
dropout_3 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_4 (Dense)              (None, 3)                 387
=================================================================
Total params: 29,757,059
Trainable params: 29,757,059
Non-trainable params: 0
_________________________________________________________________
```

In [17]:

```
%%time
opt = keras.optimizers.Adam(learning_rate=0.0001)
# opt = SGD(learning_rate=0.0001)

# es=EarlyStopping(monitor='val_accuracy',mode='min',verbose=1,patience=50)
model.compile(loss='categorical_crossentropy',optimizer=opt, metrics=['accuracy'])
history=model.fit(X_train,y_train,validation_data=(X_test,y_test), epochs=15, shuffle=True)
#Fitting the model to the data
```

```
Epoch 1/15
7/7 [==============================] - 5s 707ms/step - loss: 0.9888 - accuracy: 0.5100 - val_loss: 0.
6544 - val_accuracy: 0.8431
Epoch 2/15
7/7 [==============================] - 5s 684ms/step - loss: 0.6757 - accuracy: 0.7550 - val_loss: 0.
3876 - val_accuracy: 0.8824
Epoch 3/15
7/7 [==============================] - 5s 702ms/step - loss: 0.3909 - accuracy: 0.8650 - val_loss: 0.
2652 - val_accuracy: 0.9412
Epoch 4/15
7/7 [==============================] - 5s 703ms/step - loss: 0.3120 - accuracy: 0.8650 - val_loss: 0.
2861 - val_accuracy: 0.8824
Epoch 5/15
7/7 [==============================] - 5s 712ms/step - loss: 0.3530 - accuracy: 0.8450 - val_loss: 0.
2097 - val_accuracy: 0.9216
Epoch 6/15
7/7 [==============================] - 5s 712ms/step - loss: 0.2630 - accuracy: 0.9200 - val_loss: 0.
2069 - val_accuracy: 0.9412
Epoch 7/15
7/7 [==============================] - 5s 710ms/step - loss: 0.2231 - accuracy: 0.9050 - val_loss: 0.
2969 - val_accuracy: 0.8627
Epoch 8/15
7/7 [==============================] - 5s 717ms/step - loss: 0.1717 - accuracy: 0.9400 - val_loss: 0.
1935 - val_accuracy: 0.9412
Epoch 9/15
7/7 [==============================] - 5s 719ms/step - loss: 0.1114 - accuracy: 0.9500 - val_loss: 0.
1850 - val_accuracy: 0.9412
Epoch 10/15
7/7 [==============================] - 5s 738ms/step - loss: 0.0782 - accuracy: 0.9750 - val_loss: 0.
2293 - val_accuracy: 0.9216
Epoch 11/15
7/7 [==============================] - 5s 771ms/step - loss: 0.1529 - accuracy: 0.9400 - val_loss: 0.
2367 - val_accuracy: 0.9020
Epoch 12/15
7/7 [==============================] - 5s 715ms/step - loss: 0.0830 - accuracy: 0.9600 - val_loss: 0.
1515 - val_accuracy: 0.9412
Epoch 13/15
7/7 [==============================] - 5s 713ms/step - loss: 0.0596 - accuracy: 0.9850 - val_loss: 0.
1805 - val_accuracy: 0.9608
Epoch 14/15
7/7 [==============================] - 5s 723ms/step - loss: 0.0965 - accuracy: 0.9700 - val_loss: 0.
2040 - val_accuracy: 0.9216
Epoch 15/15
7/7 [==============================] - 5s 720ms/step - loss: 0.0598 - accuracy: 0.9750 - val_loss: 0.
1845 - val_accuracy: 0.9216
CPU times: user 7min 51s, sys: 1min 51s, total: 9min 43s
Wall time: 1min 29s
```

In [18]:

```
y_pred=model.predict(X_testt)
```

In [ ]:

In [19]:

```
%%time
classes= ['Normal', 'Pneumonia','TB']
tt=[]
for i in y_pred:
   xx=np.argmax(i)
   tt.append(classes[xx])
yy=[14,15,9,17,16,8,12,13,11,10,3,2,0,1,5,4,6,18,19,7,28,29,39,38,21,35,34,20,36,22,23,37,33,27,26,32,24,30,31,25,63,62,60,48,49,61,59,65,64,58,42,56,57,43,55,41,40,54,50,44,45,51,47,53,52,46]
for i in yy:
    print (tt[i])
#predicting the labels for the test set
```

```
TB
TB
Normal
TB
TB
Pneumonia
Pneumonia
Normal
Pneumonia
Normal
Pneumonia
Normal
Pneumonia
Normal
Pneumonia
Pneumonia
TB
Normal
TB
Pneumonia
TB
TB
Pneumonia
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Pneumonia
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TB
Normal
Normal
Pneumonia
Normal
Normal
Pneumonia
Pneumonia
TB
Pneumonia
Normal
Pneumonia
Pneumonia
Normal
Pneumonia
Pneumonia
Pneumonia
CPU times: user 1.28 ms, sys: 759 µs, total: 2.04 ms
Wall time: 1.47 ms
```

In [20]:

```
history.history
```

Out[20]:

```
{'loss': [0.9888035655021667,
  0.6756885051727295,
  0.3908952474594116,
  0.3120002746582031,
  0.352998584508959,
  0.2629569172859192,
  0.2230573147535324,
  0.17165055871009827,
  0.1113826185464859,
  0.07815152406692505,
  0.15290901064872742,
  0.0829678550362587,
  0.05955612286925316,
  0.09645931422710419,
  0.059843409806489944],
 'accuracy': [0.5099999904632568,
  0.7549999952316284,
  0.8650000095367432,
  0.8650000095367432,
  0.8450000286102295,
  0.9200000166893005,
  0.9049999713897705,
  0.9399999976158142,
  0.949999988079071,
  0.9750000238418579,
  0.9399999976158142,
  0.9599999785423279,
  0.9850000143051147,
  0.9700000286102295,
  0.9750000238418579],
 'val_loss': [0.6544054746627808,
  0.3876352608203888,
  0.265205979347229,
  0.2860654890537262,
  0.20974820852279663,
  0.20688176155090332,
  0.2969267666339874,
  0.1934560090303421,
  0.18496376276016235,
  0.22925595939159393,
  0.23672255873680115,
  0.15145492553710938,
  0.18051256239414215,
  0.20403285324573517,
  0.18446466326713562],
 'val_accuracy': [0.843137264251709,
  0.8823529481887817,
  0.9411764740943909,
  0.8823529481887817,
  0.9215686321258545,
  0.9411764740943909,
  0.8627451062202454,
  0.9411764740943909,
  0.9411764740943909,
  0.9215686321258545,
  0.9019607901573181,
  0.9411764740943909,
  0.9607843160629272,
  0.9215686321258545,
  0.9215686321258545]}
```

In [21]:

```
acc=history.history['accuracy']
val_acc=history.history['val_accuracy']
```

In [22]:

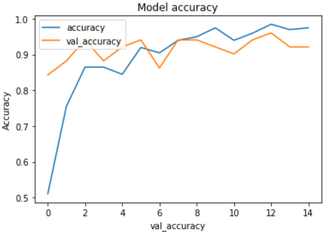
```
acc1=np.array(acc)
val_acc=np.array(val_acc)
```

In [26]:

```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('val_accuracy')
plt.legend(['accuracy', 'val_accuracy'], loc='upper left')
#plotting the graph of validation accuracy vs accuracy
```

Out[26]:

```
<matplotlib.legend.Legend at 0x1a604c2290>
```

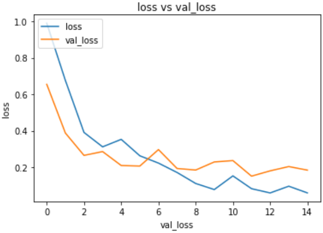


In [24]:

```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('loss vs val_loss')
plt.ylabel('loss')
plt.xlabel('val_loss')
plt.legend(['loss', 'val_loss'], loc='upper left')
#plotting graph of loss vs validation loss
```

Out[24]:

```
<matplotlib.legend.Legend at 0x123833bd0>
```



In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: