In [1]:
```
# Import libraries
import os,cv2
import time
import numpy as np
import matplotlib.pyplot as plt

from sklearn.utils import shuffle
from sklearn.model_selection import train_test_split
from keras.preprocessing import image
from keras.utils import np_utils
from keras.models import Sequential
from keras.layers import Input
from keras.layers.core import Dense, Dropout, Activation, Flatten
from keras.layers.convolutional import Convolution2D, MaxPooling2D
from keras import callbacks
from keras import backend as K
K.set_image_data_format('channels_last')
from sklearn.metrics import classification_report,confusion_matrix
import itertools
from keras.models import Model
from tensorflow.keras.applications.resnet import ResNet50
```

Set path for application

In [2]:
```
data_path = 'D:/Harold/MyDNN/DataSet/Chest_xray_seperate'
data_dir_list = os.listdir(data_path)
print(data_path)
```

```
D:/Harold/MyDNN/DataSet/Chest_xray_seperate
```

Set Image Size and Epocs

In [3]:
```
img_rows=128
img_cols=128
num_channel=3
num_epoch=100
```

Define the number of classes

In [4]:
```
num_classes = 2

img_data_list=[]
```

In [5]:
```
def preprocess_input(x):
    x[:, :, :, 0] -= 103.939
    x[:, :, :, 1] -= 116.779
    x[:, :, :, 2] -= 123.68
    # 'RGB'->'BGR'
    x = x[:, :, :, ::-1]
    return x

def data_preperation():
    for dataset in data_dir_list:
        img_list=os.listdir(data_path+'/'+ dataset)
        print ('Loading the images of dataset-'+'{}\n'.format(dataset))
        for img in img_list:
            img_path = data_path + '/'+ dataset + '/'+ img
            img = image.load_img(img_path, target_size=(224, 224))
            x = image.img_to_array(img)
            x = np.expand_dims(x, axis=0)
            x = preprocess_input(x)
#             print('Input image shape:', x.shape)
            img_data_list.append(x)
        print('Loading Complete')

#     for dataset in data_dir_list:
#         img_list=os.listdir(data_path+'/'+ dataset)
#         print ('Loading the images of dataset-'+'{}\n'.format(dataset))
#         for img in img_list:
#             img_path = data_path + '/'+ dataset + '/'+ img
#             img = image.load_img(img_path, target_size=(224, 224))
#             x = image.img_to_array(img)
#             x = np.expand_dims(x, axis=0)
#             x = preprocess_input(x)
# #             print('Input image shape:', x.shape)
#             img_data_list.append(x)
#         print('Loading Complete')

def display_loss_accuracy(hist):
    train_loss=hist.history['loss']
    val_loss=hist.history['val_loss']
    train_acc=hist.history['accuracy']
    val_acc=hist.history['val_accuracy']
    xc=range(num_epoch)

    plt.figure(1,figsize=(7,5))
    plt.plot(xc,train_loss)
    plt.plot(xc,val_loss)
    plt.xlabel('num of Epochs')
    plt.ylabel('loss')
    plt.title('train_loss vs val_loss')
    plt.grid(True)
    plt.legend(['train','val'])
    #print plt.style.available # use bmh, classic,ggplot for big pictures
    plt.style.use(['classic'])

    plt.figure(2,figsize=(7,5))
    plt.plot(xc,train_acc)
    plt.plot(xc,val_acc)
    plt.xlabel('num of Epochs')
    plt.ylabel('accuracy')
    plt.title('train_acc vs val_acc')
    plt.grid(True)
    plt.legend(['train','val'],loc=4)
    #print plt.style.available # use bmh, classic,ggplot for big pictures
    plt.style.use(['classic'])
```

```
def get_featuremaps(model, layer_idx, X_batch):
    get_activations = K.function([model.layers[0].input, K.learning_phase()],[mode
l.layers[layer_idx].output,])
    activations = get_activations([X_batch,0])
    return activations

def plot_featuremap_activations(activations):
    print (np.shape(activations))
    feature_maps = activations[0][0]
    print (np.shape(feature_maps))
    print (feature_maps.shape)

    fig=plt.figure(figsize=(16,16))
    plt.imshow(feature_maps[:,:,filter_num],cmap='gray')
    plt.savefig("featuremaps-layer-{}".format(layer_num) + "-filternum-{}".format(f
ilter_num)+'.jpg')

    num_of_featuremaps=feature_maps.shape[2]
    fig=plt.figure(figsize=(16,16))
    plt.title("featuremaps-layer-{}".format(layer_num))
    subplot_num=int(np.ceil(np.sqrt(num_of_featuremaps)))
    for i in range(int(num_of_featuremaps)):
        ax = fig.add_subplot(subplot_num, subplot_num, i+1)
        #ax.imshow(output_image[0,:,:,i],interpolation='nearest' ) #to see the firs
t filter
        ax.imshow(feature_maps[:,:,i],cmap='gray')
        plt.xticks([])
        plt.yticks([])
        plt.tight_layout()
    plt.show()
    fig.savefig("featuremaps-layer-{}".format(layer_num) + '.jpg')

# Plotting the confusion matrix
def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):
    """
    This function prints and plots the confusion matrix.
    Normalization can be applied by setting `normalize=True`.
    """
    plt.figure()
    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 confusion matrix")
    else:
        print('Confusion matrix, without normalization')

    print(cm)

    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')
    plt.show()
```

Data Preperation

In [6]:
```
# Calling Data Preperation
data_preperation()
```

```
Loading the images of dataset-NORMAL

Loading Complete
Loading the images of dataset-PNEUMONIA

Loading Complete
```

In [7]:
```
print (len(img_data_list))
img_data = np.array(img_data_list)
#img_data = img_data.astype('float32')
print (img_data.shape)
img_data=np.rollaxis(img_data,1,0)
print (img_data.shape)
img_data=img_data[0]
print (img_data.shape)
```

```
5856
(5856, 1, 224, 224, 3)
(1, 5856, 224, 224, 3)
(5856, 224, 224, 3)
```

Assiging Labels

In [8]:
```
num_of_samples = img_data.shape[0]
labels = np.ones((num_of_samples,),dtype='int64')

labels[0:1582]=0
labels[1583:5856]=1

names = ['normal','pneumonia']
```

Creating clasas labels to one-hot encoding

In [9]:
```
# convert class labels to on-hot encoding
Y = np_utils.to_categorical(labels, num_classes)
```

Split Data set into training and validation set

In [10]:
```
#Shuffle the dataset
x,y = shuffle(img_data,Y, random_state=2)
# Split the dataset
X_train, X_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_sta
te=2)
```

Model Definition

Training the classifier alone

In [11]:
```
image_input = Input(shape=(224, 224, 3))
model = ResNet50(input_tensor=image_input, include_top=True,weights='imagenet')
model.summary()
last_layer = model.get_layer('avg_pool').output
x= Flatten(name='flatten')(last_layer)
out = Dense(num_classes, activation='softmax', name='output_layer')(x)
custom_resnet_model = Model(inputs=image_input,outputs= out)
custom_resnet_model.summary()
```

```
Model: "resnet50"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)            [(None, 224, 224, 3) 0
__________________________________________________________________________________________________
conv1_pad (ZeroPadding2D)       (None, 230, 230, 3)  0           input_1[0][0]
__________________________________________________________________________________________________
conv1_conv (Conv2D)             (None, 112, 112, 64) 9472        conv1_pad[0][0]
__________________________________________________________________________________________________
conv1_bn (BatchNormalization)   (None, 112, 112, 64) 256         conv1_conv
[0][0]
__________________________________________________________________________________________________
conv1_relu (Activation)         (None, 112, 112, 64) 0           conv1_bn[0][0]
__________________________________________________________________________________________________
pool1_pad (ZeroPadding2D)       (None, 114, 114, 64) 0           conv1_relu
[0][0]
__________________________________________________________________________________________________
pool1_pool (MaxPooling2D)       (None, 56, 56, 64)   0           pool1_pad[0][0]
__________________________________________________________________________________________________
conv2_block1_1_conv (Conv2D)    (None, 56, 56, 64)   4160        pool1_pool
[0][0]
__________________________________________________________________________________________________
conv2_block1_1_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block1_1_
conv[0][0]
__________________________________________________________________________________________________
conv2_block1_1_relu (Activation (None, 56, 56, 64)   0           conv2_block1_1_
bn[0][0]
__________________________________________________________________________________________________
conv2_block1_2_conv (Conv2D)    (None, 56, 56, 64)   36928       conv2_block1_1_
relu[0][0]
__________________________________________________________________________________________________
conv2_block1_2_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block1_2_
conv[0][0]
__________________________________________________________________________________________________
conv2_block1_2_relu (Activation (None, 56, 56, 64)   0           conv2_block1_2_
bn[0][0]
__________________________________________________________________________________________________
conv2_block1_0_conv (Conv2D)    (None, 56, 56, 256)  16640       pool1_pool
[0][0]
__________________________________________________________________________________________________
conv2_block1_3_conv (Conv2D)    (None, 56, 56, 256)  16640       conv2_block1_2_
relu[0][0]
__________________________________________________________________________________________________
conv2_block1_0_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block1_0_
conv[0][0]
```

```
________________________________________________________________________________
__________________
conv2_block1_3_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block1_3_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block1_add (Add)          (None, 56, 56, 256)  0           conv2_block1_0_
bn[0][0]
                                                                 conv2_block1_3_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block1_out (Activation)   (None, 56, 56, 256)  0           conv2_block1_ad
d[0][0]
________________________________________________________________________________
__________________
conv2_block2_1_conv (Conv2D)    (None, 56, 56, 64)   16448       conv2_block1_ou
t[0][0]
________________________________________________________________________________
__________________
conv2_block2_1_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block2_1_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block2_1_relu (Activation (None, 56, 56, 64)   0           conv2_block2_1_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block2_2_conv (Conv2D)    (None, 56, 56, 64)   36928       conv2_block2_1_
relu[0][0]
________________________________________________________________________________
__________________
conv2_block2_2_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block2_2_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block2_2_relu (Activation (None, 56, 56, 64)   0           conv2_block2_2_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block2_3_conv (Conv2D)    (None, 56, 56, 256)  16640       conv2_block2_2_
relu[0][0]
________________________________________________________________________________
__________________
conv2_block2_3_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block2_3_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block2_add (Add)          (None, 56, 56, 256)  0           conv2_block1_ou
t[0][0]
                                                                 conv2_block2_3_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block2_out (Activation)   (None, 56, 56, 256)  0           conv2_block2_ad
d[0][0]
________________________________________________________________________________
__________________
conv2_block3_1_conv (Conv2D)    (None, 56, 56, 64)   16448       conv2_block2_ou
t[0][0]
________________________________________________________________________________
__________________
conv2_block3_1_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block3_1_
conv[0][0]
```

```
__________________________________________________________________________________________________
conv2_block3_1_relu (Activation (None, 56, 56, 64)   0           conv2_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block3_2_conv (Conv2D)    (None, 56, 56, 64)   36928       conv2_block3_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block3_2_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block3_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block3_2_relu (Activation (None, 56, 56, 64)   0           conv2_block3_2_bn[0][0]
__________________________________________________________________________________________________
conv2_block3_3_conv (Conv2D)    (None, 56, 56, 256)  16640       conv2_block3_2_relu[0][0]
__________________________________________________________________________________________________
conv2_block3_3_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block3_3_conv[0][0]
__________________________________________________________________________________________________
conv2_block3_add (Add)          (None, 56, 56, 256)  0           conv2_block2_out[0][0]
                                                                 conv2_block3_3_bn[0][0]
__________________________________________________________________________________________________
conv2_block3_out (Activation)   (None, 56, 56, 256)  0           conv2_block3_add[0][0]
__________________________________________________________________________________________________
conv3_block1_1_conv (Conv2D)    (None, 28, 28, 128)  32896       conv2_block3_out[0][0]
__________________________________________________________________________________________________
conv3_block1_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block1_1_conv[0][0]
__________________________________________________________________________________________________
conv3_block1_1_relu (Activation (None, 28, 28, 128)  0           conv3_block1_1_bn[0][0]
__________________________________________________________________________________________________
conv3_block1_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block1_1_relu[0][0]
__________________________________________________________________________________________________
conv3_block1_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block1_2_conv[0][0]
__________________________________________________________________________________________________
conv3_block1_2_relu (Activation (None, 28, 28, 128)  0           conv3_block1_2_bn[0][0]
__________________________________________________________________________________________________
conv3_block1_0_conv (Conv2D)    (None, 28, 28, 512)  131584      conv2_block3_out[0][0]
__________________________________________________________________________________________________
```

```
conv3_block1_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block1_2_
relu[0][0]
__________________________________________________________________________________________________
conv3_block1_0_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block1_0_
conv[0][0]
__________________________________________________________________________________________________
conv3_block1_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block1_3_
conv[0][0]
__________________________________________________________________________________________________
conv3_block1_add (Add)          (None, 28, 28, 512)  0           conv3_block1_0_
bn[0][0]
                                                                 conv3_block1_3_
bn[0][0]
__________________________________________________________________________________________________
conv3_block1_out (Activation)   (None, 28, 28, 512)  0           conv3_block1_ad
d[0][0]
__________________________________________________________________________________________________
conv3_block2_1_conv (Conv2D)    (None, 28, 28, 128)  65664       conv3_block1_ou
t[0][0]
__________________________________________________________________________________________________
conv3_block2_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block2_1_
conv[0][0]
__________________________________________________________________________________________________
conv3_block2_1_relu (Activation (None, 28, 28, 128)  0           conv3_block2_1_
bn[0][0]
__________________________________________________________________________________________________
conv3_block2_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block2_1_
relu[0][0]
__________________________________________________________________________________________________
conv3_block2_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block2_2_
conv[0][0]
__________________________________________________________________________________________________
conv3_block2_2_relu (Activation (None, 28, 28, 128)  0           conv3_block2_2_
bn[0][0]
__________________________________________________________________________________________________
conv3_block2_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block2_2_
relu[0][0]
__________________________________________________________________________________________________
conv3_block2_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block2_3_
conv[0][0]
__________________________________________________________________________________________________
conv3_block2_add (Add)          (None, 28, 28, 512)  0           conv3_block1_ou
t[0][0]
                                                                 conv3_block2_3_
bn[0][0]
__________________________________________________________________________________________________
conv3_block2_out (Activation)   (None, 28, 28, 512)  0           conv3_block2_ad
d[0][0]
__________________________________________________________________________________________________
```

```
conv3_block3_1_conv (Conv2D)    (None, 28, 28, 128)  65664       conv3_block2_ou
t[0][0]
__________________________________________________________________________________
__________________
conv3_block3_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block3_1_
conv[0][0]
__________________________________________________________________________________
__________________
conv3_block3_1_relu (Activation (None, 28, 28, 128)  0           conv3_block3_1_
bn[0][0]
__________________________________________________________________________________
__________________
conv3_block3_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block3_1_
relu[0][0]
__________________________________________________________________________________
__________________
conv3_block3_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block3_2_
conv[0][0]
__________________________________________________________________________________
__________________
conv3_block3_2_relu (Activation (None, 28, 28, 128)  0           conv3_block3_2_
bn[0][0]
__________________________________________________________________________________
__________________
conv3_block3_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block3_2_
relu[0][0]
__________________________________________________________________________________
__________________
conv3_block3_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block3_3_
conv[0][0]
__________________________________________________________________________________
__________________
conv3_block3_add (Add)          (None, 28, 28, 512)  0           conv3_block2_ou
t[0][0]
                                                                 conv3_block3_3_
bn[0][0]
__________________________________________________________________________________
__________________
conv3_block3_out (Activation)   (None, 28, 28, 512)  0           conv3_block3_ad
d[0][0]
__________________________________________________________________________________
__________________
conv3_block4_1_conv (Conv2D)    (None, 28, 28, 128)  65664       conv3_block3_ou
t[0][0]
__________________________________________________________________________________
__________________
conv3_block4_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block4_1_
conv[0][0]
__________________________________________________________________________________
__________________
conv3_block4_1_relu (Activation (None, 28, 28, 128)  0           conv3_block4_1_
bn[0][0]
__________________________________________________________________________________
__________________
conv3_block4_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block4_1_
relu[0][0]
__________________________________________________________________________________
__________________
conv3_block4_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block4_2_
conv[0][0]
__________________________________________________________________________________
__________________
conv3_block4_2_relu (Activation (None, 28, 28, 128)  0           conv3_block4_2_
bn[0][0]
```

```
__________________________________________________________________________________________________
conv3_block4_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block4_2_relu[0][0]
__________________________________________________________________________________________________
conv3_block4_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block4_3_conv[0][0]
__________________________________________________________________________________________________
conv3_block4_add (Add)          (None, 28, 28, 512)  0           conv3_block3_out[0][0]
                                                                 conv3_block4_3_bn[0][0]
__________________________________________________________________________________________________
conv3_block4_out (Activation)   (None, 28, 28, 512)  0           conv3_block4_add[0][0]
__________________________________________________________________________________________________
conv4_block1_1_conv (Conv2D)    (None, 14, 14, 256)  131328      conv3_block4_out[0][0]
__________________________________________________________________________________________________
conv4_block1_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block1_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block1_1_relu (Activation (None, 14, 14, 256)  0           conv4_block1_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block1_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block1_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block1_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block1_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block1_2_relu (Activation (None, 14, 14, 256)  0           conv4_block1_2_bn[0][0]
__________________________________________________________________________________________________
conv4_block1_0_conv (Conv2D)    (None, 14, 14, 1024) 525312      conv3_block4_out[0][0]
__________________________________________________________________________________________________
conv4_block1_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block1_2_relu[0][0]
__________________________________________________________________________________________________
conv4_block1_0_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block1_0_conv[0][0]
__________________________________________________________________________________________________
conv4_block1_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block1_3_conv[0][0]
__________________________________________________________________________________________________
conv4_block1_add (Add)          (None, 14, 14, 1024) 0           conv4_block1_0_bn[0][0]
                                                                 conv4_block1_3_bn[0][0]
```

```
__________________________________________________________________________________________________
conv4_block1_out (Activation)   (None, 14, 14, 1024) 0           conv4_block1_add[0][0]
__________________________________________________________________________________________________
conv4_block2_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block1_out[0][0]
__________________________________________________________________________________________________
conv4_block2_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block2_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block2_1_relu (Activation (None, 14, 14, 256)  0           conv4_block2_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block2_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block2_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block2_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block2_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block2_2_relu (Activation (None, 14, 14, 256)  0           conv4_block2_2_bn[0][0]
__________________________________________________________________________________________________
conv4_block2_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block2_2_relu[0][0]
__________________________________________________________________________________________________
conv4_block2_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block2_3_conv[0][0]
__________________________________________________________________________________________________
conv4_block2_add (Add)          (None, 14, 14, 1024) 0           conv4_block1_out[0][0]
                                                                 conv4_block2_3_bn[0][0]
__________________________________________________________________________________________________
conv4_block2_out (Activation)   (None, 14, 14, 1024) 0           conv4_block2_add[0][0]
__________________________________________________________________________________________________
conv4_block3_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block2_out[0][0]
__________________________________________________________________________________________________
conv4_block3_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block3_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block3_1_relu (Activation (None, 14, 14, 256)  0           conv4_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block3_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block3_1_relu[0][0]
__________________________________________________________________________________________________
```

```
conv4_block3_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block3_2_
conv[0][0]
__________________________________________________________________________________________________
conv4_block3_2_relu (Activation (None, 14, 14, 256)  0           conv4_block3_2_
bn[0][0]
__________________________________________________________________________________________________
conv4_block3_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block3_2_
relu[0][0]
__________________________________________________________________________________________________
conv4_block3_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block3_3_
conv[0][0]
__________________________________________________________________________________________________
conv4_block3_add (Add)          (None, 14, 14, 1024) 0           conv4_block2_ou
t[0][0]
                                                                 conv4_block3_3_
bn[0][0]
__________________________________________________________________________________________________
conv4_block3_out (Activation)   (None, 14, 14, 1024) 0           conv4_block3_ad
d[0][0]
__________________________________________________________________________________________________
conv4_block4_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block3_ou
t[0][0]
__________________________________________________________________________________________________
conv4_block4_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block4_1_
conv[0][0]
__________________________________________________________________________________________________
conv4_block4_1_relu (Activation (None, 14, 14, 256)  0           conv4_block4_1_
bn[0][0]
__________________________________________________________________________________________________
conv4_block4_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block4_1_
relu[0][0]
__________________________________________________________________________________________________
conv4_block4_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block4_2_
conv[0][0]
__________________________________________________________________________________________________
conv4_block4_2_relu (Activation (None, 14, 14, 256)  0           conv4_block4_2_
bn[0][0]
__________________________________________________________________________________________________
conv4_block4_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block4_2_
relu[0][0]
__________________________________________________________________________________________________
conv4_block4_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block4_3_
conv[0][0]
__________________________________________________________________________________________________
conv4_block4_add (Add)          (None, 14, 14, 1024) 0           conv4_block3_ou
t[0][0]
                                                                 conv4_block4_3_
bn[0][0]
__________________________________________________________________________________________________
```

```
conv4_block4_out (Activation)   (None, 14, 14, 1024) 0           conv4_block4_ad
d[0][0]
________________________________________________________________________________
__________________
conv4_block5_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block4_ou
t[0][0]
________________________________________________________________________________
__________________
conv4_block5_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block5_1_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block5_1_relu (Activation (None, 14, 14, 256)  0           conv4_block5_1_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block5_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block5_1_
relu[0][0]
________________________________________________________________________________
__________________
conv4_block5_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block5_2_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block5_2_relu (Activation (None, 14, 14, 256)  0           conv4_block5_2_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block5_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block5_2_
relu[0][0]
________________________________________________________________________________
__________________
conv4_block5_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block5_3_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block5_add (Add)          (None, 14, 14, 1024) 0           conv4_block4_ou
t[0][0]
                                                                 conv4_block5_3_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block5_out (Activation)   (None, 14, 14, 1024) 0           conv4_block5_ad
d[0][0]
________________________________________________________________________________
__________________
conv4_block6_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block5_ou
t[0][0]
________________________________________________________________________________
__________________
conv4_block6_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block6_1_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block6_1_relu (Activation (None, 14, 14, 256)  0           conv4_block6_1_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block6_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block6_1_
relu[0][0]
________________________________________________________________________________
__________________
conv4_block6_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block6_2_
conv[0][0]
```

```
__________________________________________________________________________________________________
conv4_block6_2_relu (Activation (None, 14, 14, 256)  0           conv4_block6_2_bn[0][0]
__________________________________________________________________________________________________
conv4_block6_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block6_2_relu[0][0]
__________________________________________________________________________________________________
conv4_block6_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block6_3_conv[0][0]
__________________________________________________________________________________________________
conv4_block6_add (Add)          (None, 14, 14, 1024) 0           conv4_block5_out[0][0]
                                                                 conv4_block6_3_bn[0][0]
__________________________________________________________________________________________________
conv4_block6_out (Activation)   (None, 14, 14, 1024) 0           conv4_block6_add[0][0]
__________________________________________________________________________________________________
conv5_block1_1_conv (Conv2D)    (None, 7, 7, 512)    524800      conv4_block6_out[0][0]
__________________________________________________________________________________________________
conv5_block1_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block1_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block1_1_relu (Activation (None, 7, 7, 512)    0           conv5_block1_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block1_2_conv (Conv2D)    (None, 7, 7, 512)    2359808     conv5_block1_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block1_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block1_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block1_2_relu (Activation (None, 7, 7, 512)    0           conv5_block1_2_bn[0][0]
__________________________________________________________________________________________________
conv5_block1_0_conv (Conv2D)    (None, 7, 7, 2048)   2099200     conv4_block6_out[0][0]
__________________________________________________________________________________________________
conv5_block1_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block1_2_relu[0][0]
__________________________________________________________________________________________________
conv5_block1_0_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block1_0_conv[0][0]
__________________________________________________________________________________________________
conv5_block1_3_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block1_3_conv[0][0]
__________________________________________________________________________________________________
```

```
conv5_block1_add (Add)          (None, 7, 7, 2048)   0           conv5_block1_0_
bn[0][0]
                                                                 conv5_block1_3_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block1_out (Activation)   (None, 7, 7, 2048)   0           conv5_block1_ad
d[0][0]
________________________________________________________________________________
__________________
conv5_block2_1_conv (Conv2D)    (None, 7, 7, 512)    1049088     conv5_block1_ou
t[0][0]
________________________________________________________________________________
__________________
conv5_block2_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block2_1_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block2_1_relu (Activation (None, 7, 7, 512)    0           conv5_block2_1_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block2_2_conv (Conv2D)    (None, 7, 7, 512)    2359808     conv5_block2_1_
relu[0][0]
________________________________________________________________________________
__________________
conv5_block2_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block2_2_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block2_2_relu (Activation (None, 7, 7, 512)    0           conv5_block2_2_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block2_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block2_2_
relu[0][0]
________________________________________________________________________________
__________________
conv5_block2_3_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block2_3_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block2_add (Add)          (None, 7, 7, 2048)   0           conv5_block1_ou
t[0][0]
                                                                 conv5_block2_3_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block2_out (Activation)   (None, 7, 7, 2048)   0           conv5_block2_ad
d[0][0]
________________________________________________________________________________
__________________
conv5_block3_1_conv (Conv2D)    (None, 7, 7, 512)    1049088     conv5_block2_ou
t[0][0]
________________________________________________________________________________
__________________
conv5_block3_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block3_1_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block3_1_relu (Activation (None, 7, 7, 512)    0           conv5_block3_1_
bn[0][0]
________________________________________________________________________________
__________________
```

```
conv5_block3_2_conv (Conv2D)    (None, 7, 7, 512)    2359808     conv5_block3_1_
relu[0][0]
__________________________________________________________________________________
__________________
conv5_block3_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block3_2_
conv[0][0]
__________________________________________________________________________________
__________________
conv5_block3_2_relu (Activation (None, 7, 7, 512)    0           conv5_block3_2_
bn[0][0]
__________________________________________________________________________________
__________________
conv5_block3_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block3_2_
relu[0][0]
__________________________________________________________________________________
__________________
conv5_block3_3_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block3_3_
conv[0][0]
__________________________________________________________________________________
__________________
conv5_block3_add (Add)          (None, 7, 7, 2048)   0           conv5_block2_ou
t[0][0]
                                                                 conv5_block3_3_
bn[0][0]
__________________________________________________________________________________
__________________
conv5_block3_out (Activation)   (None, 7, 7, 2048)   0           conv5_block3_ad
d[0][0]
__________________________________________________________________________________
__________________
avg_pool (GlobalAveragePooling2 (None, 2048)         0           conv5_block3_ou
t[0][0]
__________________________________________________________________________________
__________________
predictions (Dense)             (None, 1000)         2049000     avg_pool[0][0]
==================================================================================
==================
Total params: 25,636,712
Trainable params: 25,583,592
Non-trainable params: 53,120
__________________________________________________________________________________
__________________
Model: "functional_1"
__________________________________________________________________________________
__________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================
==================
input_1 (InputLayer)            [(None, 224, 224, 3) 0
__________________________________________________________________________________
__________________
conv1_pad (ZeroPadding2D)       (None, 230, 230, 3)  0           input_1[0][0]
__________________________________________________________________________________
__________________
conv1_conv (Conv2D)             (None, 112, 112, 64) 9472        conv1_pad[0][0]
__________________________________________________________________________________
__________________
conv1_bn (BatchNormalization)   (None, 112, 112, 64) 256         conv1_conv
[0][0]
__________________________________________________________________________________
__________________
conv1_relu (Activation)         (None, 112, 112, 64) 0           conv1_bn[0][0]
__________________________________________________________________________________
__________________
```

```
pool1_pad (ZeroPadding2D)       (None, 114, 114, 64) 0           conv1_relu
[0][0]
__________________________________________________________________________________
__________________
pool1_pool (MaxPooling2D)       (None, 56, 56, 64)   0           pool1_pad[0][0]
__________________________________________________________________________________
__________________
conv2_block1_1_conv (Conv2D)    (None, 56, 56, 64)   4160        pool1_pool
[0][0]
__________________________________________________________________________________
__________________
conv2_block1_1_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block1_1_
conv[0][0]
__________________________________________________________________________________
__________________
conv2_block1_1_relu (Activation (None, 56, 56, 64)   0           conv2_block1_1_
bn[0][0]
__________________________________________________________________________________
__________________
conv2_block1_2_conv (Conv2D)    (None, 56, 56, 64)   36928       conv2_block1_1_
relu[0][0]
__________________________________________________________________________________
__________________
conv2_block1_2_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block1_2_
conv[0][0]
__________________________________________________________________________________
__________________
conv2_block1_2_relu (Activation (None, 56, 56, 64)   0           conv2_block1_2_
bn[0][0]
__________________________________________________________________________________
__________________
conv2_block1_0_conv (Conv2D)    (None, 56, 56, 256)  16640       pool1_pool
[0][0]
__________________________________________________________________________________
__________________
conv2_block1_3_conv (Conv2D)    (None, 56, 56, 256)  16640       conv2_block1_2_
relu[0][0]
__________________________________________________________________________________
__________________
conv2_block1_0_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block1_0_
conv[0][0]
__________________________________________________________________________________
__________________
conv2_block1_3_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block1_3_
conv[0][0]
__________________________________________________________________________________
__________________
conv2_block1_add (Add)          (None, 56, 56, 256)  0           conv2_block1_0_
bn[0][0]
                                                                 conv2_block1_3_
bn[0][0]
__________________________________________________________________________________
__________________
conv2_block1_out (Activation)   (None, 56, 56, 256)  0           conv2_block1_ad
d[0][0]
__________________________________________________________________________________
__________________
conv2_block2_1_conv (Conv2D)    (None, 56, 56, 64)   16448       conv2_block1_ou
t[0][0]
__________________________________________________________________________________
__________________
conv2_block2_1_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block2_1_
conv[0][0]
__________________________________________________________________________________
```

```
__________________
conv2_block2_1_relu (Activation (None, 56, 56, 64)   0           conv2_block2_1_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block2_2_conv (Conv2D)    (None, 56, 56, 64)   36928       conv2_block2_1_
relu[0][0]
________________________________________________________________________________
__________________
conv2_block2_2_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block2_2_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block2_2_relu (Activation (None, 56, 56, 64)   0           conv2_block2_2_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block2_3_conv (Conv2D)    (None, 56, 56, 256)  16640       conv2_block2_2_
relu[0][0]
________________________________________________________________________________
__________________
conv2_block2_3_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block2_3_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block2_add (Add)          (None, 56, 56, 256)  0           conv2_block1_ou
t[0][0]
                                                                 conv2_block2_3_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block2_out (Activation)   (None, 56, 56, 256)  0           conv2_block2_ad
d[0][0]
________________________________________________________________________________
__________________
conv2_block3_1_conv (Conv2D)    (None, 56, 56, 64)   16448       conv2_block2_ou
t[0][0]
________________________________________________________________________________
__________________
conv2_block3_1_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block3_1_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block3_1_relu (Activation (None, 56, 56, 64)   0           conv2_block3_1_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block3_2_conv (Conv2D)    (None, 56, 56, 64)   36928       conv2_block3_1_
relu[0][0]
________________________________________________________________________________
__________________
conv2_block3_2_bn (BatchNormali (None, 56, 56, 64)   256         conv2_block3_2_
conv[0][0]
________________________________________________________________________________
__________________
conv2_block3_2_relu (Activation (None, 56, 56, 64)   0           conv2_block3_2_
bn[0][0]
________________________________________________________________________________
__________________
conv2_block3_3_conv (Conv2D)    (None, 56, 56, 256)  16640       conv2_block3_2_
relu[0][0]
________________________________________________________________________________
__________________
conv2_block3_3_bn (BatchNormali (None, 56, 56, 256)  1024        conv2_block3_3_
```

```
conv[0][0]
__________________________________________________________________________________________________
conv2_block3_add (Add)          (None, 56, 56, 256)  0           conv2_block2_ou
t[0][0]
                                                                 conv2_block3_3_
bn[0][0]
__________________________________________________________________________________________________
conv2_block3_out (Activation)   (None, 56, 56, 256)  0           conv2_block3_ad
d[0][0]
__________________________________________________________________________________________________
conv3_block1_1_conv (Conv2D)    (None, 28, 28, 128)  32896       conv2_block3_ou
t[0][0]
__________________________________________________________________________________________________
conv3_block1_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block1_1_
conv[0][0]
__________________________________________________________________________________________________
conv3_block1_1_relu (Activation (None, 28, 28, 128)  0           conv3_block1_1_
bn[0][0]
__________________________________________________________________________________________________
conv3_block1_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block1_1_
relu[0][0]
__________________________________________________________________________________________________
conv3_block1_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block1_2_
conv[0][0]
__________________________________________________________________________________________________
conv3_block1_2_relu (Activation (None, 28, 28, 128)  0           conv3_block1_2_
bn[0][0]
__________________________________________________________________________________________________
conv3_block1_0_conv (Conv2D)    (None, 28, 28, 512)  131584      conv2_block3_ou
t[0][0]
__________________________________________________________________________________________________
conv3_block1_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block1_2_
relu[0][0]
__________________________________________________________________________________________________
conv3_block1_0_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block1_0_
conv[0][0]
__________________________________________________________________________________________________
conv3_block1_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block1_3_
conv[0][0]
__________________________________________________________________________________________________
conv3_block1_add (Add)          (None, 28, 28, 512)  0           conv3_block1_0_
bn[0][0]
                                                                 conv3_block1_3_
bn[0][0]
__________________________________________________________________________________________________
conv3_block1_out (Activation)   (None, 28, 28, 512)  0           conv3_block1_ad
d[0][0]
__________________________________________________________________________________________________
conv3_block2_1_conv (Conv2D)    (None, 28, 28, 128)  65664       conv3_block1_ou
```

```
t[0][0]
__________________________________________________________________________________________________
conv3_block2_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block2_1_conv[0][0]
__________________________________________________________________________________________________
conv3_block2_1_relu (Activation (None, 28, 28, 128)  0           conv3_block2_1_bn[0][0]
__________________________________________________________________________________________________
conv3_block2_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block2_1_relu[0][0]
__________________________________________________________________________________________________
conv3_block2_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block2_2_conv[0][0]
__________________________________________________________________________________________________
conv3_block2_2_relu (Activation (None, 28, 28, 128)  0           conv3_block2_2_bn[0][0]
__________________________________________________________________________________________________
conv3_block2_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block2_2_relu[0][0]
__________________________________________________________________________________________________
conv3_block2_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block2_3_conv[0][0]
__________________________________________________________________________________________________
conv3_block2_add (Add)          (None, 28, 28, 512)  0           conv3_block1_out[0][0]
                                                                 conv3_block2_3_bn[0][0]
__________________________________________________________________________________________________
conv3_block2_out (Activation)   (None, 28, 28, 512)  0           conv3_block2_add[0][0]
__________________________________________________________________________________________________
conv3_block3_1_conv (Conv2D)    (None, 28, 28, 128)  65664       conv3_block2_out[0][0]
__________________________________________________________________________________________________
conv3_block3_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block3_1_conv[0][0]
__________________________________________________________________________________________________
conv3_block3_1_relu (Activation (None, 28, 28, 128)  0           conv3_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv3_block3_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block3_1_relu[0][0]
__________________________________________________________________________________________________
conv3_block3_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block3_2_conv[0][0]
__________________________________________________________________________________________________
conv3_block3_2_relu (Activation (None, 28, 28, 128)  0           conv3_block3_2_bn[0][0]
__________________________________________________________________________________________________
```

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__________________
conv3_block3_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block3_2_
relu[0][0]
________________________________________________________________________________
__________________
conv3_block3_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block3_3_
conv[0][0]
________________________________________________________________________________
__________________
conv3_block3_add (Add)          (None, 28, 28, 512)  0           conv3_block2_ou
t[0][0]
                                                                 conv3_block3_3_
bn[0][0]
________________________________________________________________________________
__________________
conv3_block3_out (Activation)   (None, 28, 28, 512)  0           conv3_block3_ad
d[0][0]
________________________________________________________________________________
__________________
conv3_block4_1_conv (Conv2D)    (None, 28, 28, 128)  65664       conv3_block3_ou
t[0][0]
________________________________________________________________________________
__________________
conv3_block4_1_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block4_1_
conv[0][0]
________________________________________________________________________________
__________________
conv3_block4_1_relu (Activation (None, 28, 28, 128)  0           conv3_block4_1_
bn[0][0]
________________________________________________________________________________
__________________
conv3_block4_2_conv (Conv2D)    (None, 28, 28, 128)  147584      conv3_block4_1_
relu[0][0]
________________________________________________________________________________
__________________
conv3_block4_2_bn (BatchNormali (None, 28, 28, 128)  512         conv3_block4_2_
conv[0][0]
________________________________________________________________________________
__________________
conv3_block4_2_relu (Activation (None, 28, 28, 128)  0           conv3_block4_2_
bn[0][0]
________________________________________________________________________________
__________________
conv3_block4_3_conv (Conv2D)    (None, 28, 28, 512)  66048       conv3_block4_2_
relu[0][0]
________________________________________________________________________________
__________________
conv3_block4_3_bn (BatchNormali (None, 28, 28, 512)  2048        conv3_block4_3_
conv[0][0]
________________________________________________________________________________
__________________
conv3_block4_add (Add)          (None, 28, 28, 512)  0           conv3_block3_ou
t[0][0]
                                                                 conv3_block4_3_
bn[0][0]
________________________________________________________________________________
__________________
conv3_block4_out (Activation)   (None, 28, 28, 512)  0           conv3_block4_ad
d[0][0]
________________________________________________________________________________
__________________
conv4_block1_1_conv (Conv2D)    (None, 14, 14, 256)  131328      conv3_block4_ou
t[0][0]
________________________________________________________________________________
```

```
__________________
conv4_block1_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block1_1_
conv[0][0]
__________________________________________________________________________________
__________________
conv4_block1_1_relu (Activation (None, 14, 14, 256)  0           conv4_block1_1_
bn[0][0]
__________________________________________________________________________________
__________________
conv4_block1_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block1_1_
relu[0][0]
__________________________________________________________________________________
__________________
conv4_block1_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block1_2_
conv[0][0]
__________________________________________________________________________________
__________________
conv4_block1_2_relu (Activation (None, 14, 14, 256)  0           conv4_block1_2_
bn[0][0]
__________________________________________________________________________________
__________________
conv4_block1_0_conv (Conv2D)    (None, 14, 14, 1024) 525312      conv3_block4_ou
t[0][0]
__________________________________________________________________________________
__________________
conv4_block1_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block1_2_
relu[0][0]
__________________________________________________________________________________
__________________
conv4_block1_0_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block1_0_
conv[0][0]
__________________________________________________________________________________
__________________
conv4_block1_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block1_3_
conv[0][0]
__________________________________________________________________________________
__________________
conv4_block1_add (Add)          (None, 14, 14, 1024) 0           conv4_block1_0_
bn[0][0]
                                                                 conv4_block1_3_
bn[0][0]
__________________________________________________________________________________
__________________
conv4_block1_out (Activation)   (None, 14, 14, 1024) 0           conv4_block1_ad
d[0][0]
__________________________________________________________________________________
__________________
conv4_block2_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block1_ou
t[0][0]
__________________________________________________________________________________
__________________
conv4_block2_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block2_1_
conv[0][0]
__________________________________________________________________________________
__________________
conv4_block2_1_relu (Activation (None, 14, 14, 256)  0           conv4_block2_1_
bn[0][0]
__________________________________________________________________________________
__________________
conv4_block2_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block2_1_
relu[0][0]
__________________________________________________________________________________
__________________
conv4_block2_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block2_2_
```

```
conv[0][0]
__________________________________________________________________________________________________
conv4_block2_2_relu (Activation (None, 14, 14, 256)  0           conv4_block2_2_bn[0][0]
__________________________________________________________________________________________________
conv4_block2_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block2_2_relu[0][0]
__________________________________________________________________________________________________
conv4_block2_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block2_3_conv[0][0]
__________________________________________________________________________________________________
conv4_block2_add (Add)          (None, 14, 14, 1024) 0           conv4_block1_out[0][0]
                                                                 conv4_block2_3_bn[0][0]
__________________________________________________________________________________________________
conv4_block2_out (Activation)   (None, 14, 14, 1024) 0           conv4_block2_add[0][0]
__________________________________________________________________________________________________
conv4_block3_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block2_out[0][0]
__________________________________________________________________________________________________
conv4_block3_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block3_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block3_1_relu (Activation (None, 14, 14, 256)  0           conv4_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block3_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block3_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block3_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block3_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block3_2_relu (Activation (None, 14, 14, 256)  0           conv4_block3_2_bn[0][0]
__________________________________________________________________________________________________
conv4_block3_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block3_2_relu[0][0]
__________________________________________________________________________________________________
conv4_block3_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block3_3_conv[0][0]
__________________________________________________________________________________________________
conv4_block3_add (Add)          (None, 14, 14, 1024) 0           conv4_block2_out[0][0]
                                                                 conv4_block3_3_bn[0][0]
__________________________________________________________________________________________________
conv4_block3_out (Activation)   (None, 14, 14, 1024) 0           conv4_block3_ad
```

```
d[0][0]
__________________________________________________________________________________________________
conv4_block4_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block3_ou
t[0][0]
__________________________________________________________________________________________________
conv4_block4_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block4_1_
conv[0][0]
__________________________________________________________________________________________________
conv4_block4_1_relu (Activation (None, 14, 14, 256)  0           conv4_block4_1_
bn[0][0]
__________________________________________________________________________________________________
conv4_block4_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block4_1_
relu[0][0]
__________________________________________________________________________________________________
conv4_block4_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block4_2_
conv[0][0]
__________________________________________________________________________________________________
conv4_block4_2_relu (Activation (None, 14, 14, 256)  0           conv4_block4_2_
bn[0][0]
__________________________________________________________________________________________________
conv4_block4_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block4_2_
relu[0][0]
__________________________________________________________________________________________________
conv4_block4_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block4_3_
conv[0][0]
__________________________________________________________________________________________________
conv4_block4_add (Add)          (None, 14, 14, 1024) 0           conv4_block3_ou
t[0][0]
                                                                 conv4_block4_3_
bn[0][0]
__________________________________________________________________________________________________
conv4_block4_out (Activation)   (None, 14, 14, 1024) 0           conv4_block4_ad
d[0][0]
__________________________________________________________________________________________________
conv4_block5_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block4_ou
t[0][0]
__________________________________________________________________________________________________
conv4_block5_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block5_1_
conv[0][0]
__________________________________________________________________________________________________
conv4_block5_1_relu (Activation (None, 14, 14, 256)  0           conv4_block5_1_
bn[0][0]
__________________________________________________________________________________________________
conv4_block5_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block5_1_
relu[0][0]
__________________________________________________________________________________________________
conv4_block5_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block5_2_
conv[0][0]
__________________________________________________________________________________________________
```

```
__________________
conv4_block5_2_relu (Activation (None, 14, 14, 256)  0           conv4_block5_2_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block5_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block5_2_
relu[0][0]
________________________________________________________________________________
__________________
conv4_block5_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block5_3_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block5_add (Add)          (None, 14, 14, 1024) 0           conv4_block4_ou
t[0][0]
                                                                 conv4_block5_3_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block5_out (Activation)   (None, 14, 14, 1024) 0           conv4_block5_ad
d[0][0]
________________________________________________________________________________
__________________
conv4_block6_1_conv (Conv2D)    (None, 14, 14, 256)  262400      conv4_block5_ou
t[0][0]
________________________________________________________________________________
__________________
conv4_block6_1_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block6_1_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block6_1_relu (Activation (None, 14, 14, 256)  0           conv4_block6_1_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block6_2_conv (Conv2D)    (None, 14, 14, 256)  590080      conv4_block6_1_
relu[0][0]
________________________________________________________________________________
__________________
conv4_block6_2_bn (BatchNormali (None, 14, 14, 256)  1024        conv4_block6_2_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block6_2_relu (Activation (None, 14, 14, 256)  0           conv4_block6_2_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block6_3_conv (Conv2D)    (None, 14, 14, 1024) 263168      conv4_block6_2_
relu[0][0]
________________________________________________________________________________
__________________
conv4_block6_3_bn (BatchNormali (None, 14, 14, 1024) 4096        conv4_block6_3_
conv[0][0]
________________________________________________________________________________
__________________
conv4_block6_add (Add)          (None, 14, 14, 1024) 0           conv4_block5_ou
t[0][0]
                                                                 conv4_block6_3_
bn[0][0]
________________________________________________________________________________
__________________
conv4_block6_out (Activation)   (None, 14, 14, 1024) 0           conv4_block6_ad
d[0][0]
________________________________________________________________________________
```

```
__________________
conv5_block1_1_conv (Conv2D)    (None, 7, 7, 512)    524800      conv4_block6_ou
t[0][0]
________________________________________________________________________________
__________________
conv5_block1_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block1_1_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block1_1_relu (Activation (None, 7, 7, 512)    0           conv5_block1_1_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block1_2_conv (Conv2D)    (None, 7, 7, 512)    2359808     conv5_block1_1_
relu[0][0]
________________________________________________________________________________
__________________
conv5_block1_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block1_2_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block1_2_relu (Activation (None, 7, 7, 512)    0           conv5_block1_2_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block1_0_conv (Conv2D)    (None, 7, 7, 2048)   2099200     conv4_block6_ou
t[0][0]
________________________________________________________________________________
__________________
conv5_block1_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block1_2_
relu[0][0]
________________________________________________________________________________
__________________
conv5_block1_0_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block1_0_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block1_3_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block1_3_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block1_add (Add)          (None, 7, 7, 2048)   0           conv5_block1_0_
bn[0][0]
                                                                 conv5_block1_3_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block1_out (Activation)   (None, 7, 7, 2048)   0           conv5_block1_ad
d[0][0]
________________________________________________________________________________
__________________
conv5_block2_1_conv (Conv2D)    (None, 7, 7, 512)    1049088     conv5_block1_ou
t[0][0]
________________________________________________________________________________
__________________
conv5_block2_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block2_1_
conv[0][0]
________________________________________________________________________________
__________________
conv5_block2_1_relu (Activation (None, 7, 7, 512)    0           conv5_block2_1_
bn[0][0]
________________________________________________________________________________
__________________
conv5_block2_2_conv (Conv2D)    (None, 7, 7, 512)    2359808     conv5_block2_1_
```

```
relu[0][0]
__________________________________________________________________________________________________
conv5_block2_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block2_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block2_2_relu (Activation (None, 7, 7, 512)    0           conv5_block2_2_bn[0][0]
__________________________________________________________________________________________________
conv5_block2_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block2_2_relu[0][0]
__________________________________________________________________________________________________
conv5_block2_3_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block2_3_conv[0][0]
__________________________________________________________________________________________________
conv5_block2_add (Add)          (None, 7, 7, 2048)   0           conv5_block1_out[0][0]
                                                                 conv5_block2_3_bn[0][0]
__________________________________________________________________________________________________
conv5_block2_out (Activation)   (None, 7, 7, 2048)   0           conv5_block2_add[0][0]
__________________________________________________________________________________________________
conv5_block3_1_conv (Conv2D)    (None, 7, 7, 512)    1049088     conv5_block2_out[0][0]
__________________________________________________________________________________________________
conv5_block3_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block3_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block3_1_relu (Activation (None, 7, 7, 512)    0           conv5_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block3_2_conv (Conv2D)    (None, 7, 7, 512)    2359808     conv5_block3_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block3_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block3_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block3_2_relu (Activation (None, 7, 7, 512)    0           conv5_block3_2_bn[0][0]
__________________________________________________________________________________________________
conv5_block3_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block3_2_relu[0][0]
__________________________________________________________________________________________________
conv5_block3_3_bn (BatchNormali (None, 7, 7, 2048)   8192        conv5_block3_3_conv[0][0]
__________________________________________________________________________________________________
conv5_block3_add (Add)          (None, 7, 7, 2048)   0           conv5_block2_out[0][0]
                                                                 conv5_block3_3_
```

```
bn[0][0]
________________________________________________________________________________
__________________
conv5_block3_out (Activation)    (None, 7, 7, 2048)    0            conv5_block3_ad
d[0][0]
________________________________________________________________________________
__________________
avg_pool (GlobalAveragePooling2 (None, 2048)           0            conv5_block3_ou
t[0][0]
________________________________________________________________________________
__________________
flatten (Flatten)                (None, 2048)           0            avg_pool[0][0]
________________________________________________________________________________
```

In [12]:

```
for layer in custom_resnet_model.layers[:-1]:
    layer.trainable = False

custom_resnet_model.layers[-1].trainable
```

Out[12]:

```
True
```

In [13]:

```
custom_resnet_model.compile(loss='categorical_crossentropy',optimizer='adam',metric
s=['accuracy'])
```

In [14]:
```
t=time.time()
hist = custom_resnet_model.fit(X_train, y_train, batch_size=32, epochs=num_epoch, v
erbose=1, validation_data=(X_test, y_test))
print('Training time: %s' % (t - time.time()))
(loss, accuracy) = custom_resnet_model.evaluate(X_test, y_test, batch_size=10, verb
ose=1)
print("[INFO] loss={:.4f}, accuracy: {:.4f}%".format(loss,accuracy * 100))
```

```
Epoch 1/100
147/147 [==============================] - 11s 73ms/step - loss: 0.2067 - accura
cy: 0.9142 - val_loss: 0.1091 - val_accuracy: 0.9616
Epoch 2/100
147/147 [==============================] - 10s 65ms/step - loss: 0.1197 - accura
cy: 0.9554 - val_loss: 0.0955 - val_accuracy: 0.9676
Epoch 3/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0949 - accura
cy: 0.9661 - val_loss: 0.1064 - val_accuracy: 0.9582
Epoch 4/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0924 - accura
cy: 0.9654 - val_loss: 0.0828 - val_accuracy: 0.9718
Epoch 5/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0836 - accura
cy: 0.9686 - val_loss: 0.0833 - val_accuracy: 0.9753
Epoch 6/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0743 - accura
cy: 0.9733 - val_loss: 0.0775 - val_accuracy: 0.9761
Epoch 7/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0727 - accura
cy: 0.9757 - val_loss: 0.0867 - val_accuracy: 0.9744
Epoch 8/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0664 - accura
cy: 0.9765 - val_loss: 0.0931 - val_accuracy: 0.9701
Epoch 9/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0622 - accura
cy: 0.9782 - val_loss: 0.0788 - val_accuracy: 0.9727
Epoch 10/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0598 - accura
cy: 0.9793 - val_loss: 0.0762 - val_accuracy: 0.9770
Epoch 11/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0532 - accura
cy: 0.9827 - val_loss: 0.0738 - val_accuracy: 0.9753
Epoch 12/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0503 - accura
cy: 0.9821 - val_loss: 0.0948 - val_accuracy: 0.9710
Epoch 13/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0492 - accura
cy: 0.9819 - val_loss: 0.0755 - val_accuracy: 0.9753
Epoch 14/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0486 - accura
cy: 0.9836 - val_loss: 0.0798 - val_accuracy: 0.9770
Epoch 15/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0464 - accura
cy: 0.9842 - val_loss: 0.0955 - val_accuracy: 0.9625
Epoch 16/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0418 - accura
cy: 0.9861 - val_loss: 0.0794 - val_accuracy: 0.9744
Epoch 17/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0412 - accura
cy: 0.9878 - val_loss: 0.0813 - val_accuracy: 0.9744
Epoch 18/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0438 - accura
cy: 0.9855 - val_loss: 0.0734 - val_accuracy: 0.9787
Epoch 19/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0393 - accura
cy: 0.9872 - val_loss: 0.0721 - val_accuracy: 0.9787
Epoch 20/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0358 - accura
cy: 0.9883 - val_loss: 0.0855 - val_accuracy: 0.9684
Epoch 21/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0341 - accura
cy: 0.9908 - val_loss: 0.0864 - val_accuracy: 0.9735
```

```
Epoch 22/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0340 - accura
cy: 0.9898 - val_loss: 0.0735 - val_accuracy: 0.9778
Epoch 23/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0353 - accura
cy: 0.9887 - val_loss: 0.0731 - val_accuracy: 0.9761
Epoch 24/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0286 - accura
cy: 0.9921 - val_loss: 0.0750 - val_accuracy: 0.9770
Epoch 25/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0283 - accura
cy: 0.9912 - val_loss: 0.0749 - val_accuracy: 0.9787
Epoch 26/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0277 - accura
cy: 0.9923 - val_loss: 0.0863 - val_accuracy: 0.9727
Epoch 27/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0267 - accura
cy: 0.9927 - val_loss: 0.0818 - val_accuracy: 0.9727
Epoch 28/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0250 - accura
cy: 0.9940 - val_loss: 0.0814 - val_accuracy: 0.9735
Epoch 29/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0243 - accura
cy: 0.9936 - val_loss: 0.0795 - val_accuracy: 0.9753
Epoch 30/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0240 - accura
cy: 0.9936 - val_loss: 0.0763 - val_accuracy: 0.9778
Epoch 31/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0265 - accura
cy: 0.9925 - val_loss: 0.0915 - val_accuracy: 0.9727
Epoch 32/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0206 - accura
cy: 0.9951 - val_loss: 0.0808 - val_accuracy: 0.9735
Epoch 33/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0198 - accura
cy: 0.9951 - val_loss: 0.0782 - val_accuracy: 0.9761
Epoch 34/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0194 - accura
cy: 0.9964 - val_loss: 0.0955 - val_accuracy: 0.9693
Epoch 35/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0182 - accura
cy: 0.9959 - val_loss: 0.0821 - val_accuracy: 0.9753
Epoch 36/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0179 - accura
cy: 0.9966 - val_loss: 0.0887 - val_accuracy: 0.9735
Epoch 37/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0186 - accura
cy: 0.9964 - val_loss: 0.0857 - val_accuracy: 0.9761
Epoch 38/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0165 - accura
cy: 0.9968 - val_loss: 0.0872 - val_accuracy: 0.9735
Epoch 39/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0150 - accura
cy: 0.9981 - val_loss: 0.0834 - val_accuracy: 0.9753
Epoch 40/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0180 - accura
cy: 0.9944 - val_loss: 0.0843 - val_accuracy: 0.9761
Epoch 41/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0170 - accura
cy: 0.9962 - val_loss: 0.0986 - val_accuracy: 0.9735
Epoch 42/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0151 - accura
cy: 0.9972 - val_loss: 0.0936 - val_accuracy: 0.9735
Epoch 43/100
```

```
147/147 [==============================] - 10s 65ms/step - loss: 0.0168 - accura
cy: 0.9962 - val_loss: 0.0853 - val_accuracy: 0.9761
Epoch 44/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0127 - accura
cy: 0.9983 - val_loss: 0.1224 - val_accuracy: 0.9684
Epoch 45/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0167 - accura
cy: 0.9957 - val_loss: 0.1033 - val_accuracy: 0.9710
Epoch 46/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0117 - accura
cy: 0.9987 - val_loss: 0.0952 - val_accuracy: 0.9727
Epoch 47/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0111 - accura
cy: 0.9983 - val_loss: 0.0926 - val_accuracy: 0.9744
Epoch 48/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0141 - accura
cy: 0.9981 - val_loss: 0.0909 - val_accuracy: 0.9753
Epoch 49/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0113 - accura
cy: 0.9983 - val_loss: 0.0916 - val_accuracy: 0.9744
Epoch 50/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0101 - accura
cy: 0.9991 - val_loss: 0.0862 - val_accuracy: 0.9778
Epoch 51/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0101 - accura
cy: 0.9989 - val_loss: 0.0902 - val_accuracy: 0.9753
Epoch 52/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0094 - accura
cy: 0.9994 - val_loss: 0.0990 - val_accuracy: 0.9753
Epoch 53/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0090 - accura
cy: 0.9996 - val_loss: 0.1023 - val_accuracy: 0.9718
Epoch 54/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0096 - accura
cy: 0.9991 - val_loss: 0.0929 - val_accuracy: 0.9761
Epoch 55/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0090 - accura
cy: 0.9991 - val_loss: 0.0948 - val_accuracy: 0.9727
Epoch 56/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0100 - accura
cy: 0.9991 - val_loss: 0.1009 - val_accuracy: 0.9710
Epoch 57/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0083 - accura
cy: 0.9996 - val_loss: 0.0982 - val_accuracy: 0.9727
Epoch 58/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0081 - accura
cy: 0.9996 - val_loss: 0.0913 - val_accuracy: 0.9770
Epoch 59/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0100 - accura
cy: 0.9985 - val_loss: 0.1036 - val_accuracy: 0.9744
Epoch 60/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0077 - accura
cy: 0.9998 - val_loss: 0.1002 - val_accuracy: 0.9735
Epoch 61/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0068 - accura
cy: 0.9998 - val_loss: 0.0951 - val_accuracy: 0.9770
Epoch 62/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0062 - accura
cy: 1.0000 - val_loss: 0.1036 - val_accuracy: 0.9701
Epoch 63/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0062 - accura
cy: 0.9998 - val_loss: 0.1074 - val_accuracy: 0.9727
Epoch 64/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0060 - accura
```

```
cy: 0.9998 - val_loss: 0.0957 - val_accuracy: 0.9770
Epoch 65/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0057 - accura
cy: 0.9998 - val_loss: 0.1313 - val_accuracy: 0.9659
Epoch 66/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0072 - accura
cy: 0.9998 - val_loss: 0.1006 - val_accuracy: 0.9761
Epoch 67/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0058 - accura
cy: 0.9998 - val_loss: 0.1022 - val_accuracy: 0.9753
Epoch 68/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0056 - accura
cy: 1.0000 - val_loss: 0.1004 - val_accuracy: 0.9753
Epoch 69/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0047 - accura
cy: 1.0000 - val_loss: 0.1055 - val_accuracy: 0.9710
Epoch 70/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0047 - accura
cy: 1.0000 - val_loss: 0.1090 - val_accuracy: 0.9718
Epoch 71/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0047 - accura
cy: 1.0000 - val_loss: 0.1058 - val_accuracy: 0.9744
Epoch 72/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0054 - accura
cy: 1.0000 - val_loss: 0.1174 - val_accuracy: 0.9710
Epoch 73/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0053 - accura
cy: 0.9998 - val_loss: 0.1061 - val_accuracy: 0.9761
Epoch 74/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0043 - accura
cy: 1.0000 - val_loss: 0.1115 - val_accuracy: 0.9718
Epoch 75/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0045 - accura
cy: 1.0000 - val_loss: 0.1042 - val_accuracy: 0.9753
Epoch 76/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0065 - accura
cy: 0.9994 - val_loss: 0.1071 - val_accuracy: 0.9744
Epoch 77/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0043 - accura
cy: 1.0000 - val_loss: 0.1119 - val_accuracy: 0.9718
Epoch 78/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0037 - accura
cy: 1.0000 - val_loss: 0.1121 - val_accuracy: 0.9735
Epoch 79/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0065 - accura
cy: 0.9989 - val_loss: 0.1177 - val_accuracy: 0.9735
Epoch 80/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0038 - accura
cy: 0.9998 - val_loss: 0.1113 - val_accuracy: 0.9761
Epoch 81/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0043 - accura
cy: 1.0000 - val_loss: 0.1083 - val_accuracy: 0.9770
Epoch 82/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0032 - accura
cy: 1.0000 - val_loss: 0.1102 - val_accuracy: 0.9761
Epoch 83/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0036 - accura
cy: 1.0000 - val_loss: 0.1150 - val_accuracy: 0.9744
Epoch 84/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0030 - accura
cy: 1.0000 - val_loss: 0.1154 - val_accuracy: 0.9753
Epoch 85/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0026 - accura
cy: 1.0000 - val_loss: 0.1183 - val_accuracy: 0.9735
```

```
Epoch 86/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0028 - accura
cy: 1.0000 - val_loss: 0.1158 - val_accuracy: 0.9727
Epoch 87/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0027 - accura
cy: 1.0000 - val_loss: 0.1133 - val_accuracy: 0.9753
Epoch 88/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0025 - accura
cy: 1.0000 - val_loss: 0.1141 - val_accuracy: 0.9761
Epoch 89/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0024 - accura
cy: 1.0000 - val_loss: 0.1178 - val_accuracy: 0.9744
Epoch 90/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0023 - accura
cy: 1.0000 - val_loss: 0.1189 - val_accuracy: 0.9735
Epoch 91/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0026 - accura
cy: 1.0000 - val_loss: 0.1188 - val_accuracy: 0.9735
Epoch 92/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0029 - accura
cy: 1.0000 - val_loss: 0.1139 - val_accuracy: 0.9744
Epoch 93/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0026 - accura
cy: 1.0000 - val_loss: 0.1202 - val_accuracy: 0.9735
Epoch 94/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0022 - accura
cy: 1.0000 - val_loss: 0.1155 - val_accuracy: 0.9761
Epoch 95/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0022 - accura
cy: 1.0000 - val_loss: 0.1174 - val_accuracy: 0.9761
Epoch 96/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0028 - accura
cy: 1.0000 - val_loss: 0.1203 - val_accuracy: 0.9761
Epoch 97/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0021 - accura
cy: 1.0000 - val_loss: 0.1201 - val_accuracy: 0.9753
Epoch 98/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0034 - accura
cy: 0.9996 - val_loss: 0.2196 - val_accuracy: 0.9488
Epoch 99/100
147/147 [==============================] - 10s 66ms/step - loss: 0.0162 - accura
cy: 0.9934 - val_loss: 0.1327 - val_accuracy: 0.9735
Epoch 100/100
147/147 [==============================] - 10s 65ms/step - loss: 0.0020 - accura
cy: 1.0000 - val_loss: 0.1323 - val_accuracy: 0.9744
Training time: -975.6852314472198
118/118 [==============================] - 3s 25ms/step - loss: 0.1323 - accurac
y: 0.9744
```

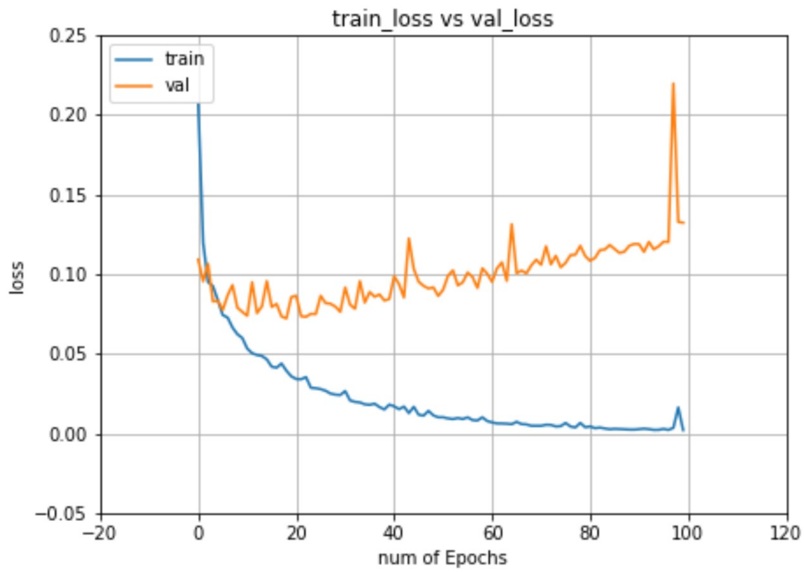
In [15]:

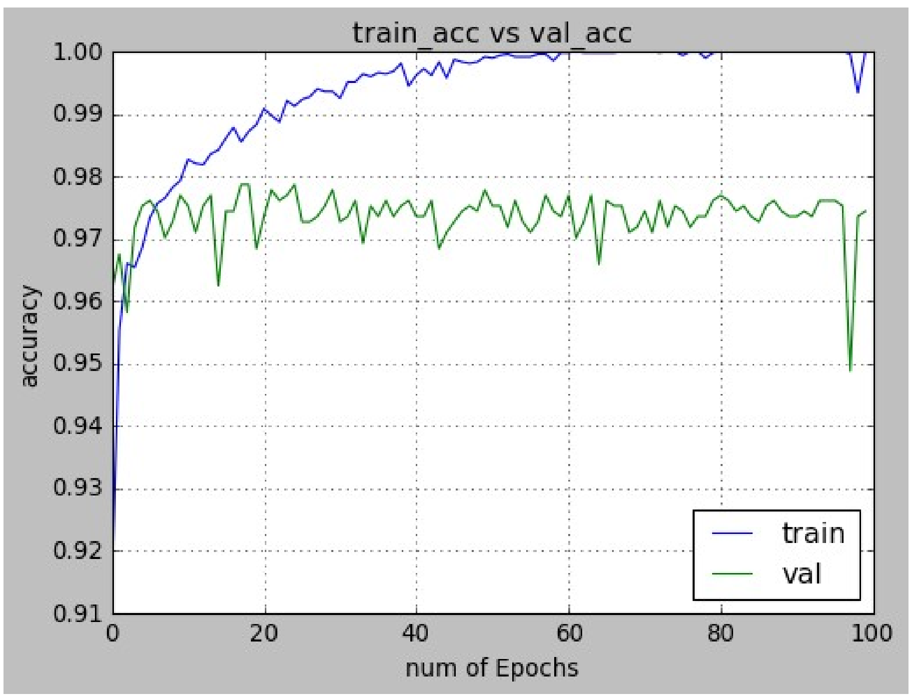
```python
(loss, accuracy) = custom_resnet_model.evaluate(X_test, y_test, batch_size=10, verb
ose=1)

print("[INFO] loss={:.4f}, accuracy: {:.4f}%".format(loss,accuracy * 100))
```

```
118/118 [==============================] - 3s 23ms/step - loss: 0.1323 - accurac
y: 0.9744
[INFO] loss=0.1323, accuracy: 97.4403%
```

visualizing losses and accuracy

In [16]:
```
display_loss_accuracy(hist)
```





Evaluating the model

In [17]:
```
score = custom_resnet_model.evaluate(X_test, y_test, verbose=0)
print('Test Loss:', score[0])
print('Test accuracy:', score[1])

test_image = X_test[0:1]
print (test_image.shape)

print(model.predict(test_image))
print(model.predict_classes(test_image))
print(y_test[0:1])
```

```
Test Loss: 0.13225294649600983
Test accuracy: 0.9744027256965637
(1, 224, 224, 3)
[[4.82067890e-07 2.68882036e-06 2.46438071e-06 1.46347942e-04
  1.14383847e-05 4.81724349e-08 2.50176436e-06 1.93318300e-07
  1.12078631e-07 1.33230387e-07 1.55274762e-07 4.57866662e-07
  8.66559446e-07 2.24399500e-07 6.64423965e-08 1.10845995e-07
  1.35442542e-06 5.03833007e-07 1.79790817e-07 6.47744287e-07
  3.05023384e-08 9.56223190e-08 1.10445868e-07 1.10137853e-06
  7.54676677e-08 4.63201928e-07 2.87497016e-07 7.07335062e-08
  5.35643494e-07 1.51549584e-05 2.59477027e-08 2.91564879e-06
  7.73133081e-07 4.95935637e-07 1.98538643e-07 2.52716568e-08
  1.83687155e-06 7.88459204e-07 3.27636599e-07 1.85687998e-06
  1.74747020e-05 5.42289399e-07 8.17253891e-08 6.31402060e-08
  3.37520163e-07 1.02205229e-06 7.63697062e-06 5.59314408e-08
  7.33921922e-07 4.65218932e-07 4.84302063e-06 6.55129497e-08
  2.73576143e-06 3.79595463e-06 7.06228604e-07 5.70710426e-06
  9.65091203e-07 2.63103260e-07 4.50051573e-07 6.29083502e-07
  2.09377595e-06 1.72502826e-06 1.25136467e-06 6.38593519e-07
  7.39525774e-07 3.34286518e-08 9.70000769e-07 1.03747618e-06
  3.67367988e-07 1.14979400e-06 3.29745234e-07 2.08577912e-05
  1.47276842e-05 4.14989336e-06 7.56582722e-06 6.36893992e-06
  8.98751387e-06 9.69357734e-06 2.66852585e-05 2.10938379e-05
  9.31147923e-08 4.12824157e-08 4.71741544e-08 1.20277676e-07
  2.82732515e-07 7.39384305e-08 4.42064376e-08 4.16540644e-07
  7.95168603e-07 5.63529099e-08 8.61598224e-08 3.73003417e-07
  3.13063069e-08 1.43328606e-07 2.56055932e-06 1.59463571e-08
  2.61807202e-07 2.08426371e-07 2.79966450e-09 2.37027564e-07
  8.26529174e-07 9.52778294e-07 8.84871895e-07 6.70584797e-08
  4.19899031e-08 3.42380346e-08 7.15500903e-08 1.04467529e-06
  1.84370560e-06 1.10508445e-07 1.32549957e-07 1.20732386e-06
  4.30385662e-05 2.32143202e-06 1.15385831e-06 2.89288717e-08
  7.44268647e-08 1.84088658e-05 1.56171754e-05 3.71134149e-07
  2.79030104e-07 1.25042470e-06 1.56302053e-06 1.15310036e-06
  2.40664394e-06 1.65841428e-07 4.56227317e-05 2.70883021e-07
  7.59855823e-09 1.88321238e-07 1.26450095e-06 6.97321809e-08
  8.32176397e-07 2.10207972e-07 2.25861598e-07 9.37061273e-08
  1.62370782e-07 8.13763492e-08 4.42455530e-07 9.24499304e-08
  5.98086899e-06 3.80057621e-08 3.88246093e-08 8.12120277e-07
  1.10410170e-07 3.98443092e-07 2.99336165e-07 5.37295023e-07
  1.38613882e-06 2.95345467e-06 7.86266270e-08 2.17395083e-07
  7.75959563e-08 1.36170161e-06 7.63363289e-07 3.60099807e-06
  1.50860660e-06 4.62941415e-07 4.47918381e-07 1.67911749e-05
  5.81790516e-07 6.88692182e-07 1.80056261e-07 5.41830104e-06
  1.66806376e-06 1.10999708e-05 2.09217092e-06 5.40804081e-07
  2.85339570e-06 7.10956510e-06 7.90489878e-07 5.44291697e-06
  2.60349816e-06 4.81833240e-06 5.70534951e-07 5.57362114e-07
  1.02933473e-06 1.04458866e-06 4.40884469e-05 1.90422298e-07
  1.48606148e-07 4.46824458e-07 1.89701916e-06 3.72328145e-07
  2.70331907e-06 1.42775207e-06 2.15032173e-06 1.50941526e-06
  4.57386960e-07 2.96538616e-07 9.06139022e-08 1.39788681e-05
  1.63965376e-06 2.08460364e-07 8.88446650e-08 1.14750846e-05
  6.00025544e-07 1.29099749e-06 1.63062253e-07 1.93221626e-06
  3.26226086e-07 2.26011565e-07 1.00890395e-06 3.64552739e-06
  2.38593344e-07 3.57042865e-07 1.42592728e-06 1.51925451e-06
  1.76033518e-06 1.65332074e-06 1.73654357e-07 6.30601699e-06
  1.29027364e-06 2.55493205e-06 1.25809265e-07 6.50791947e-07
  2.88133009e-07 3.74395086e-07 1.28145970e-07 7.58302292e-07
  2.54769958e-07 5.29478257e-07 9.42013060e-07 1.10448559e-06
  1.35511527e-06 2.74070345e-07 4.58742932e-07 1.18524120e-07
  1.96650092e-07 8.79864217e-07 6.76232673e-07 1.05864603e-06
  7.84085387e-07 1.61685605e-07 1.75777370e-06 3.27096785e-07
  2.50208632e-06 2.27774103e-06 1.32969490e-06 2.00462722e-07
```

```
1.95692806e-07 3.73978310e-07 1.26169480e-05 9.73640454e-07
7.51481721e-09 3.16245831e-07 1.91538516e-06 1.11579197e-07
5.43942451e-06 3.55741150e-07 2.83933048e-07 5.07502136e-06
2.17246588e-06 2.19098570e-06 3.57639419e-06 2.53928022e-07
2.06906194e-07 3.27570973e-07 1.17160323e-06 3.96143605e-07
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2.81511035e-07 4.72189640e-07 4.67730388e-08 1.60121218e-07
9.27563732e-08 2.03835686e-08 8.10001666e-09 6.71593412e-08
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4.02625938e-06 2.03273908e-06 5.60944713e-08 3.95658226e-08
1.71023977e-08 2.75019083e-08 3.71704267e-08 3.75872098e-08
3.24326976e-07 1.62003513e-08 2.47091805e-08 5.32830882e-08
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3.06480871e-07 4.37967174e-06 3.83125638e-07 2.59487564e-07
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7.38245376e-07 1.07934525e-07 8.58397584e-07 6.98828399e-06
3.47092168e-06 1.10831215e-05 1.25559709e-05 2.39583405e-05
1.33940068e-06 1.43173759e-06 4.31827516e-07 5.54513917e-07
1.33714991e-07 2.53679673e-07 5.93662328e-08 6.51950813e-08
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1.58720539e-07 2.18869877e-06 1.01007416e-07 9.33262001e-08
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7.03610851e-07 5.05889552e-08 1.70242330e-07 3.62089213e-06
1.10505658e-08 1.03553134e-07 6.95341598e-08 7.76962622e-07
1.41140958e-07 2.01013586e-06 1.21628759e-07 1.97350872e-07
8.37480698e-08 1.60278351e-08 2.88566788e-08 1.44770496e-07
3.86343402e-07 2.70098553e-07 5.88721143e-08 1.20218971e-07
1.64466272e-07 1.54137524e-07 2.27946529e-07 6.77903458e-08
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9.30536407e-06 8.10772235e-07 1.49337247e-05 1.51340806e-04
4.47854944e-08 5.67501527e-04 1.10032076e-07 2.25565200e-05
6.77242133e-05 6.33004038e-06 4.39342193e-06 8.99438674e-05
7.28008381e-05 2.19390568e-05 1.23546979e-05 1.25297393e-05
4.20370634e-06 3.13102093e-04 3.20764656e-07 5.62300329e-06
1.37011142e-04 1.94485983e-06 4.81351935e-06 9.91487832e-05
1.63843524e-05 8.57108080e-06 1.35260478e-07 1.85790210e-04
4.36487335e-06 2.35706648e-05 3.92094895e-04 1.27935903e-02
2.70703390e-06 1.01705751e-04 4.49157596e-05 6.13191901e-07
1.15572448e-05 1.44345540e-04 2.29499601e-05 1.85781857e-06
2.22390395e-06 9.81719568e-05 9.97880561e-05 7.91112107e-05
3.96518726e-06 3.96266415e-07 8.61680601e-04 6.50838228e-06
2.06842174e-06 7.68140399e-06 1.07899541e-05 2.91467586e-06
2.84931957e-06 1.47860090e-04 4.30169575e-06 1.07488831e-05
4.59787589e-05 5.46703232e-05 7.03009573e-06 1.99430560e-05
3.42860039e-06 4.22399671e-06 6.29881397e-05 5.03593292e-05
1.70047624e-05 2.34267577e-06 6.42493023e-06 1.19209335e-06
2.15346809e-04 3.78162440e-06 8.40231860e-06 5.85121888e-05
1.26830651e-06 3.94399819e-07 9.75983203e-05 3.36703924e-05
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1.90323753e-05 1.14208233e-05 3.64518337e-06 2.74725782e-04
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1.99341756e-07 4.80747442e-09 1.07438849e-08 4.42679458e-08
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-17-83421ec204f5> in <module>
      7
      8 print(model.predict(test_image))
----> 9 print(model.predict_classes(test_image))
```

Testing a new image

In [18]:
```
test_image_path = 'D:/Harold/MyDNN/DataSet/Chest_xray_seperate/PNEUMONIA/person11_b
acteria_45.jpeg'
test_image = image.load_img(test_image_path, target_size=(224, 224))
x = image.img_to_array(test_image)
x = np.expand_dims(x, axis=0)
x = preprocess_input(x)
print (x.shape)


# if num_channel==1:
#     if (K.image_data_format() == 'channels_first'):
#         test_image= np.expand_dims(test_image, axis=0)
#         test_image= np.expand_dims(test_image, axis=0)
#         print (test_image.shape)
#     else:
#         test_image= np.expand_dims(test_image, axis=3)
#         test_image= np.expand_dims(test_image, axis=0)
#         print (test_image.shape)
# else:
#     if (K.image_data_format() == 'channels_first'):
#         test_image=np.rollaxis(test_image,2,0)
#         test_image= np.expand_dims(test_image, axis=0)
#         print (test_image.shape)
#     else:
#         test_image= np.expand_dims(test_image, axis=0)
#         print (test_image.shape)


# Predicting the test image
print((custom_resnet_model.predict(x)))
# print(custom_resnet_model.predict_classes(x))
```

```
(1, 224, 224, 3)
[[7.928144e-08 9.999999e-01]]
```

Visualizing the intermediate layer

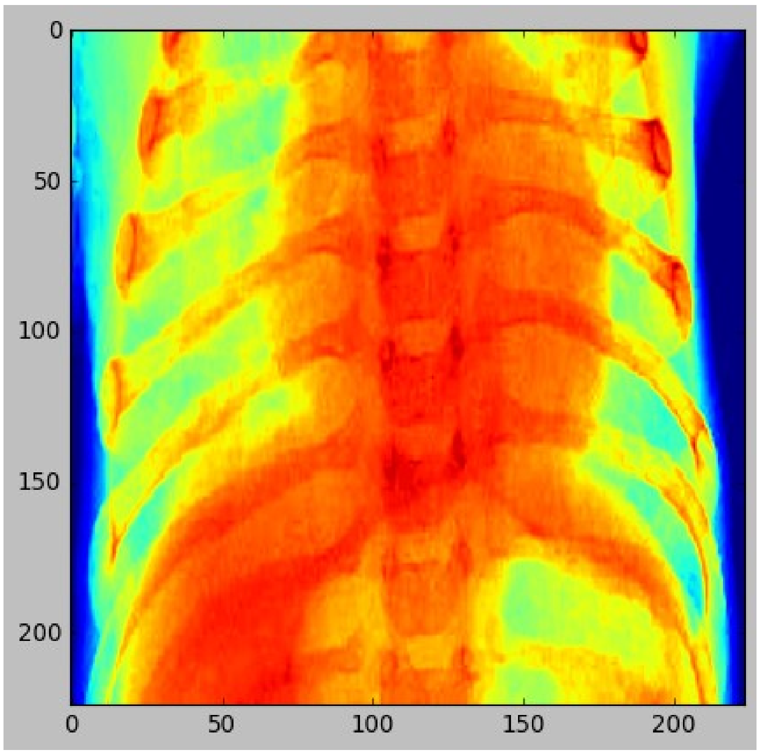
In [19]:
```
from keras.models import Model
layer_outputs = [layer.output for layer in model.layers]
activation_model = Model(inputs=custom_resnet_model.input, outputs=layer_outputs)
activations = custom_resnet_model.predict(X_train[10].reshape(1,224,224,3))
print(activations.shape)
def display_activation(activations, col_size, row_size, act_index):
    activation = activations[0, act_index]
    activation_index=1
    fig, ax = plt.subplots(row_size, col_size, figsize=(row_size*2.5,col_size*1))
    for row in range(0,row_size):
        for col in range(0,col_size):
            ax[row][col].imshow(activation[0, :, :, activation_index], cmap='gray')
            activation_index += 1
plt.imshow(test_image)
plt.imshow(X_train[10][:,:,0]);
display_activation(activations, 8, 4, 1)
```

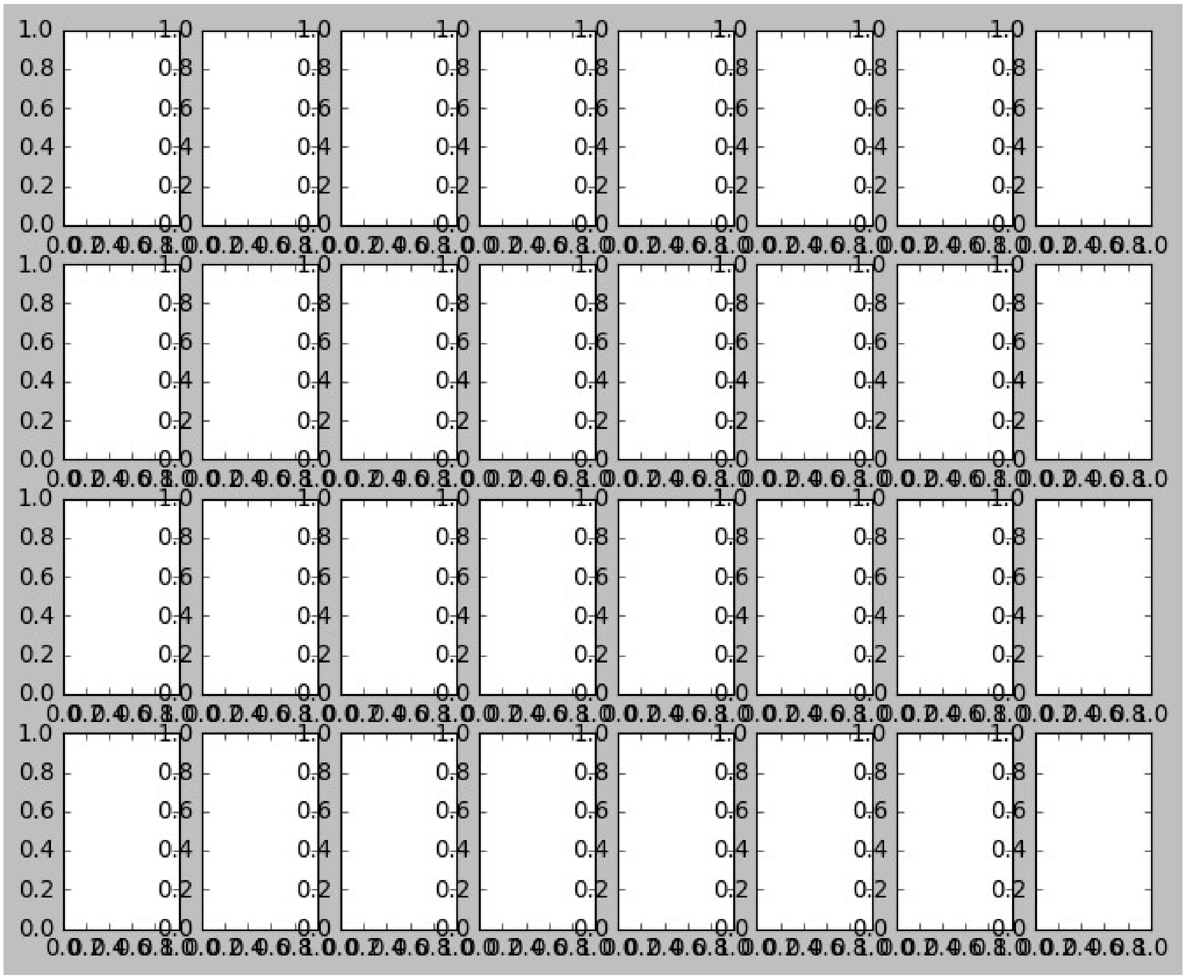
```
(1, 2)

---------------------------------------------------------------------------
IndexError                                Traceback (most recent call last)
<ipython-input-19-32e8200fb41b> in <module>
     14 plt.imshow(test_image)
     15 plt.imshow(X_train[10][:,:,0]);
---> 16 display_activation(activations, 8, 4, 1)

<ipython-input-19-32e8200fb41b> in display_activation(activations, col_size, row
_size, act_index)
     10     for row in range(0,row_size):
     11         for col in range(0,col_size):
---> 12             ax[row][col].imshow(activation[0, :, :, activation_index], c
map='gray')
     13             activation_index += 1
     14 plt.imshow(test_image)

IndexError: invalid index to scalar variable.
```





Confusion matrix

In [21]:
```
Y_pred = custom_resnet_model.predict(X_test)
print(Y_pred)
y_pred = np.argmax(Y_pred, axis=1)
print(y_pred)
#y_pred = model.predict_classes(X_test)
#print(y_pred)
target_names = ['class 0(Normal)', 'class 1(Pneumonia)']
print(classification_report(np.argmax(y_test,axis=1), y_pred,target_names=target_na
mes))
print(confusion_matrix(np.argmax(y_test,axis=1), y_pred))
```

```
[[9.9328565e-07 9.9999905e-01]
 [1.0000000e+00 6.4503549e-16]
 [1.3406505e-04 9.9986589e-01]
 ...
 [1.9769919e-10 1.0000000e+00]
 [7.7234494e-09 1.0000000e+00]
 [9.9999988e-01 9.0127173e-08]]
[1 0 1 ... 1 1 0]
                    precision    recall  f1-score   support

   class 0(Normal)       0.94      0.96      0.95       312
class 1(Pneumonia)       0.99      0.98      0.98       860

          accuracy                           0.97      1172
         macro avg       0.96      0.97      0.97      1172
      weighted avg       0.97      0.97      0.97      1172

[[301  11]
 [ 19 841]]
```

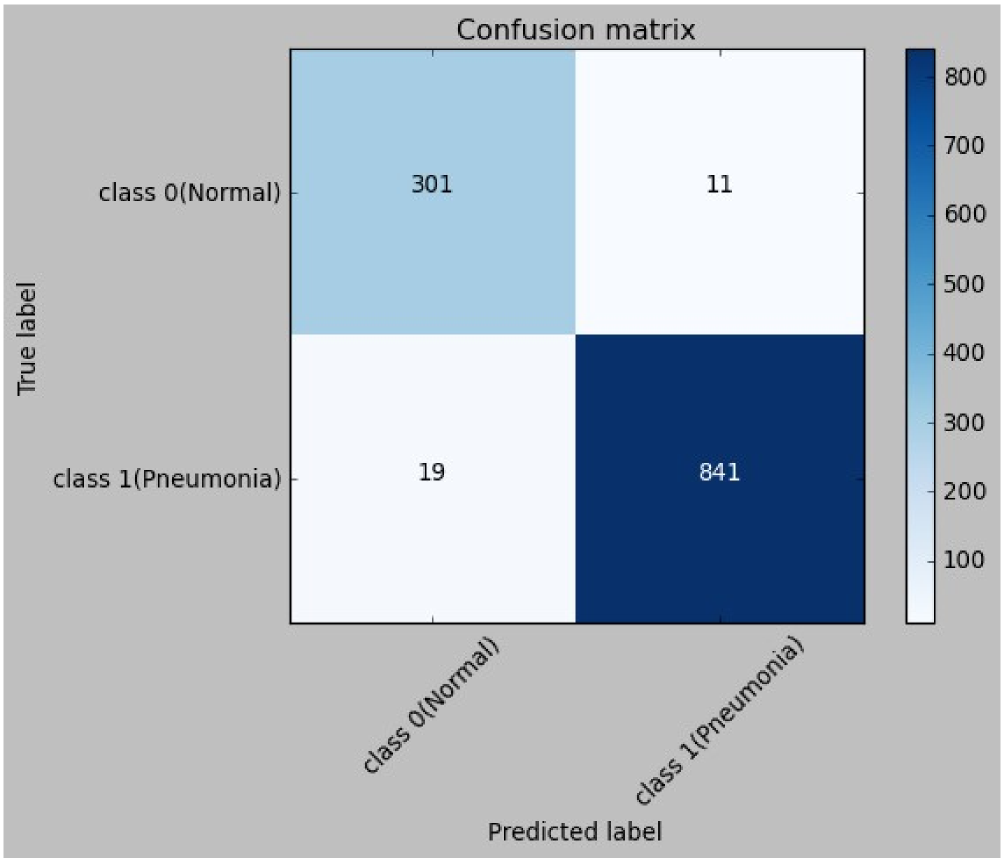
Compute confusion matrix

In [22]:
```
# Compute confusion matrix
cnf_matrix = (confusion_matrix(np.argmax(y_test,axis=1), y_pred))

np.set_printoptions(precision=2)

# Plot non-normalized confusion matrix
plot_confusion_matrix(cnf_matrix, classes=target_names,
                      title='Confusion matrix')
```

```
Confusion matrix, without normalization
[[301  11]
 [ 19 841]]
```



In [ ]: