Segmentation Notebook

In [1]:

```
# Load the Drive helper and mount
from google.colab import drive
drive.mount('/content/drive')
```

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

In [3]:

```
!wget --header="Host: storage.googleapis.com" --header="User-Agent: Mozilla/5.0 (Windows NT 10.0;
Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/86.0.4240.198 Safari/537.36" --header="A
ccept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,ap
ation/signed-exchange;v=b3;q=0.9" --header="Accept-Language: en-US,en;q=0.9" --header="Referer: ht
tps://www.kaggle.com/" "https://storage.googleapis.com/kaggle-data-
sets/246422/519715/bundle/archive.zip?X-Goog-Algorithm=GOOG4-RSA-SHA256&X-Goog-Credential=gcp-kagg
le-com%40kaggle-161607.iam.gserviceaccount.com%2F20201118%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-
Date=20201118T192853Z&X-Goog-Expires=259199&X-Goog-SignedHeaders=host&X-Goog-
Signature=90faf3de550e9c38639e65bf6eab3cac1d8f47790cdc09fc3c2e97aa35e3a4e4485da8aa2deee19bee691762
833f5a8d123cd459ea098f1653d73dc25beb4497db397bb321338c813e785f89d799e5ee1933c233c8078ef8f725375398
48f82406f54eedb6c7f0a1b10a603c6afc07f76c15f63f7ed0508877f08d94fe25b503541fed7fbe57927f08243833818a
6cdd689066cf7083b6db16f6df55639a8da847aacd33a2b7c65b3e63abe36b541920b1bac40f01d9d5da29823a07eababa
4a00793b48bb3b28b74da8405434003936a8f66847820ca1408f446fd8ef0d9d646af87176726e72524d83bed2efb75394
07235a2" -c -O 'archive.zip'
```

```
--2020-11-18 19:29:15--  https://storage.googleapis.com/kaggle-data-
sets/246422/519715/bundle/archive.zip?X-Goog-Algorithm=GOOG4-RSA-SHA256&X-Goog-Credential=gcp-kagg
le-com%40kaggle-161607.iam.gserviceaccount.com%2F20201118%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-
Date=20201118T192853Z&X-Goog-Expires=259199&X-Goog-SignedHeaders=host&X-Goog-
Signature=90faf3de550e9c38639e65bf6eab3cac1d8f47790cdc09fc3c2e97aa35e3a4e4485da8aa2deee19bee691762
833f5a8d123cd459ea098f1653d73dc25beb4497db397bb321338c813e785f89d799e5ee1933c233c8078ef8f725375398
48f82406f54eedb6c7f0a1b10a603c6afc07f76c15f63f7ed0508877f08d94fe25b503541fed7fbe57927f08243833818a
6cdd689066cf7083b6db16f6df55639a8da847aacd33a2b7c65b3e63abe36b541920b1bac40f01d9d5da29823a07eababa
4a00793b48bb3b28b74da8405434003936a8f66847820ca1408f446fd8ef0d9d646af87176726e72524d83bed2efb75394
07235a2
Resolving storage.googleapis.com (storage.googleapis.com)... 108.177.119.128, 108.177.126.128, 108
.177.127.128, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|108.177.119.128|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 3256848012 (3.0G) [application/zip]
Saving to: 'archive.zip'

archive.zip         100%[===================>]   3.03G  43.9MB/s    in 95s

2020-11-18 19:30:50 (32.7 MB/s) - 'archive.zip' saved [3256848012/3256848012]
```

In [4]:

```
from zipfile import ZipFile
zip_file = ZipFile('archive.zip','r')
zip_file.extractall()
```

In [2]:

```
!pip install -q tensorflow-io
!pip install pydicom
```

```
     |████████████████████████████████| 22.4MB 1.4MB/s
Collecting pydicom
  Downloading
https://files.pythonhosted.org/packages/72/7b/6ed88f82dd33a32cdb43432dab7f84fcd40c49d63251442b3cfe0
3d4/pydicom-2.1.1-py3-none-any.whl (1.9MB)
     |████████████████████████████████| 1.9MB 13.1MB/s
Installing collected packages: pydicom
```

```
Successfully installed pydicom-2.1.1
```

In [5]:

```
import warnings
warnings.filterwarnings("ignore")
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
import re
import os
import datetime as dt
from datetime import datetime
#!pip install pydicom
import pydicom as dicom
from tqdm.notebook import tqdm
from glob import glob
import pandas as pd
import tensorflow as tf
import tensorflow_io as tfio
import mask_functions
import keras.backend as K
#reading all dcm files into train and text
train = sorted(glob("pneumothorax/dicom-images-train/*/*/*.dcm")) #There is an image after 2
subfolders . Rather than manually typing the entire path we are using glob to access the image wit
h ease
test = sorted(glob("pneumothorax/dicom-images-test/*/*/*.dcm"))

#reading the csv

dataset = pd.read_csv("pneumothorax/train-rle.csv", delimiter=",")
```

In [6]:

```
missing_images=0
train_df=[]
remove=[]
for i in tqdm(train):
  sample=dicom.dcmread(i) #reading each image
  train={}
  train["UID"]=sample.SOPInstanceUID
  try: #try and except to avoid throwing an error in case any file is missing
    encoded_pixels = dataset[dataset["ImageId"] == train["UID"]].values[0][1] #We are checking whea
ther each image(from the train) present has been mapped to the csv file given .
    train["EncodedPixels"]=encoded_pixels
  except:
    missing_images=missing_images+1
    remove.append("pneumothorax/dicom-images-train/" + sample.StudyInstanceUID + "/" + sample.Serie
sInstanceUID + "/" + sample.SOPInstanceUID + ".dcm")
     #if the image details are not present in the csv that means that the file is missing
  train["path"] = "pneumothorax/dicom-images-train/" + sample.StudyInstanceUID + "/" + sample.Serie
sInstanceUID + "/" + sample.SOPInstanceUID + ".dcm" #saving the path in csv for further reference
  train_df.append(train)

patients_train = pd.DataFrame(train_df,columns=["UID", "EncodedPixels","path"])

patients_train=patients_train.loc[~patients_train['path'].isin(remove)] #remove rows which do not h
ave images
patients_train = patients_train[patients_train["EncodedPixels"] != ' -1']
patients_train.drop('UID',axis=1,inplace=True)
patients_train.head()
```

Out[6]:

	EncodedPixels	path
6	209126 1 1019 6 1015 10 1012 13 1010 14 1008 ...	pneumothorax/dicom-images-train/1.2.276.0.7230...
13	891504 5 1018 8 1015 10 1013 12 1011 14 1009 ...	pneumothorax/dicom-images-train/1.2.276.0.7230...
14	261328 6 1015 11 1011 15 1007 18 1004 21 1002...	pneumothorax/dicom-images-train/1.2.276.0.7230...
18	592184 33 976 58 956 73 941 88 926 102 917 10...	pneumothorax/dicom-images-train/1.2.276.0.7230...

28	530522 1 1022 3 1019 6 1017 7 1016 9 1014 10...	EncodedPixels	pneumothorax/dicom-images-train/1.2.276.0.7230...	path

In [7]:

```
def decode_img(img):
# convert the compressed string to a 3D uint8 tensor
#image_bytes = tf.io.read_file(img)
  image = tfio.image.decode_dicom_image(img, dtype=tf.uint8,color_dim=True,scale='preserve')
  image = tf.image.convert_image_dtype(image, tf.float32)#converting the image to tf.float32
  image=tf.squeeze(image,[0]) #squeezing the image because the file is of the shape(1,1024,1024,1)
and we want (1024,1024,3)
  b = tf.constant([1,1,3], tf.int32)
  image=tf.tile(image,b)#the image is of the shape (1024,1024,1) to make it (1024,1024,3) I am
using tf.tile
  image=tf.image.resize(image,size=[256,256]) # resize the image to the desired size
  return image
```

In [8]:

```
def process_path(file_path,label):
  img = tf.io.read_file(file_path) #reading the image from the file path
  img = decode_img(img) #passing the image to the function
  return img,label
```

In [9]:

```
def dice_coef(y_true, y_pred, smooth=1):
    y_true_f = K.flatten(y_true)
    y_pred_f = K.flatten(y_pred)
    intersection = K.sum(y_true_f * y_pred_f)
    return (2. * intersection + smooth) / (K.sum(y_true_f) + K.sum(y_pred_f) + smooth)
```

In [10]:

```
file_paths=patients_train['path'].values
labels=patients_train['EncodedPixels'].values
```

In [11]:

```
import mask_functions
from PIL import Image
mask=np.zeros((len(patients_train),256,256,1),dtype=np.bool)
for j,i in tqdm(enumerate(patients_train['EncodedPixels'].values)):
  a=(Image.fromarray(mask_functions.rle2mask(i,1024,1024).T).resize((256,256), resample=Image.BILIN
EAR)) #obtaining the masks and then resizing them
  a=np.array(a)
  a=np.expand_dims(a,axis=-1)
  mask[j]=a
```

In [12]:

```
train_path=[]
train_mask=[]
test_path=[]
test_mask=[]
train_len=len(patients_train)-int(len(patients_train)*0.2)                    #We are dividin
the data into train and test
test_len=int(len(patients_train)*0.2)
count=0

for i in tqdm(range(0,len(patients_train))):
  if count<=train_len:
    train_path.append(file_paths[i])
    train_mask.append(mask[i])
    count=count+1
  else:
    test_path.append(file_paths[i])
    test_mask.append(mask[i])
```

```
train_path=np.array(train_path)
test_path=np.array(test_path)
```

In [13]:

```
train_ds = tf.data.Dataset.from_tensor_slices((train_path,train_mask))
train_ds = train_ds.shuffle(len(train_path),seed=42)

test_ds = tf.data.Dataset.from_tensor_slices((test_path,test_mask))
test_ds = test_ds.shuffle(len(test_path),seed=42)
```

In [14]:

```
def augment(image,label):
  a=tf.random.uniform((),minval=0,maxval=1)
  if a<0.2:
    image=tf.image.flip_left_right(image)
    label=tf.image.flip_left_right(label)
  if a<0.4 and a>0.2:
    image = tf.image.random_brightness(image, max_delta=0.15) # Random brightness
  if a<0.6 and a>0.4:
    image=tf.image.adjust_gamma(image, gamma=tf.random.uniform((),minval=0,maxval=1), gain=1)
  if a<0.8 and a>0.6:
    image=tf.image.random_contrast(image,lower=0.2,upper=0.3)
  if a<1.0 and a>0.8:
    image=tf.image.random_saturation(image, lower=2, upper=5)
  return image, label
```

In [15]:

```
import keras.backend as K
AUTOTUNE = tf.data.experimental.AUTOTUNE
train_ds = train_ds.map(process_path,num_parallel_calls=AUTOTUNE) #mapping the file paths to the
above function
val_ds = test_ds.map(process_path,num_parallel_calls=AUTOTUNE)
```

In [16]:

```
train_ds=train_ds.map(augment,num_parallel_calls=AUTOTUNE) #augmenting train data
```

In [17]:

```
def set_shapes(img, label, img_shape=(256,256,3)):
    img.set_shape(img_shape)
    label.set_shape((256,256,1))
    return img, label
```

In [18]:

```
train_ds = train_ds.map(set_shapes, num_parallel_calls=AUTOTUNE)
val_ds = val_ds.map(set_shapes, num_parallel_calls=AUTOTUNE)
```

In [19]:

```
train_dataset = train_ds.batch(64).cache().prefetch(1920)
test_dataset=val_ds.batch(64).cache().prefetch(1920)
```

Simple Unet model

In [20]:

```
#https://github.com/bnsreenu/python_for_microscopists/blob/master/074-Defining%20U-
net%20in%20Python%20using%20Keras.py
import tensorflow as tf
```

```
IMG_WIDTH = 256
IMG_HEIGHT = 256
IMG_CHANNELS = 3


#Build the model
inputs = tf.keras.layers.Input((IMG_HEIGHT, IMG_WIDTH, IMG_CHANNELS))
s = tf.keras.layers.Lambda(lambda x: x / 255)(inputs)

#Contraction path
c1 = tf.keras.layers.Conv2D(16, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(s)
c1 = tf.keras.layers.Dropout(0.1)(c1)
c1 = tf.keras.layers.Conv2D(16, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(c1)
p1 = tf.keras.layers.MaxPooling2D((2, 2))(c1)

c2 = tf.keras.layers.Conv2D(32, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(p1)
c2 = tf.keras.layers.Dropout(0.1)(c2)
c2 = tf.keras.layers.Conv2D(32, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(c2)
p2 = tf.keras.layers.MaxPooling2D((2, 2))(c2)

c3 = tf.keras.layers.Conv2D(64, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(p2)
c3 = tf.keras.layers.Dropout(0.2)(c3)
c3 = tf.keras.layers.Conv2D(64, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(c3)
p3 = tf.keras.layers.MaxPooling2D((2, 2))(c3)

c4 = tf.keras.layers.Conv2D(128, (3, 3), activation='relu', kernel_initializer='he_normal', padding
='same')(p3)
c4 = tf.keras.layers.Dropout(0.2)(c4)
c4 = tf.keras.layers.Conv2D(128, (3, 3), activation='relu', kernel_initializer='he_normal', padding
='same')(c4)
p4 = tf.keras.layers.MaxPooling2D(pool_size=(2, 2))(c4)

c5 = tf.keras.layers.Conv2D(256, (3, 3), activation='relu', kernel_initializer='he_normal', padding
='same')(p4)
c5 = tf.keras.layers.Dropout(0.3)(c5)
c5 = tf.keras.layers.Conv2D(256, (3, 3), activation='relu', kernel_initializer='he_normal', padding
='same')(c5)

#Expansive path
u6 = tf.keras.layers.Conv2DTranspose(128, (2, 2), strides=(2, 2), padding='same')(c5)
u6 = tf.keras.layers.concatenate([u6, c4])
c6 = tf.keras.layers.Conv2D(128, (3, 3), activation='relu', kernel_initializer='he_normal', padding
='same')(u6)
c6 = tf.keras.layers.Dropout(0.2)(c6)
c6 = tf.keras.layers.Conv2D(128, (3, 3), activation='relu', kernel_initializer='he_normal', padding
='same')(c6)

u7 = tf.keras.layers.Conv2DTranspose(64, (2, 2), strides=(2, 2), padding='same')(c6)
u7 = tf.keras.layers.concatenate([u7, c3])
c7 = tf.keras.layers.Conv2D(64, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(u7)
c7 = tf.keras.layers.Dropout(0.2)(c7)
c7 = tf.keras.layers.Conv2D(64, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(c7)

u8 = tf.keras.layers.Conv2DTranspose(32, (2, 2), strides=(2, 2), padding='same')(c7)
u8 = tf.keras.layers.concatenate([u8, c2])
c8 = tf.keras.layers.Conv2D(32, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(u8)
c8 = tf.keras.layers.Dropout(0.1)(c8)
c8 = tf.keras.layers.Conv2D(32, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(c8)

u9 = tf.keras.layers.Conv2DTranspose(16, (2, 2), strides=(2, 2), padding='same')(c8)
u9 = tf.keras.layers.concatenate([u9, c1], axis=3)
c9 = tf.keras.layers.Conv2D(16, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(u9)
c9 = tf.keras.layers.Dropout(0.1)(c9)
c9 = tf.keras.layers.Conv2D(16, (3, 3), activation='relu', kernel_initializer='he_normal', padding=
'same')(c9)
```

```
outputs = tf.keras.layers.Conv2D(1, (1, 1), activation='sigmoid')(c9)

model = tf.keras.Model(inputs=[inputs], outputs=[outputs])
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy',dice_coef])
model.summary()
```

```
Model: "functional_1"
_________________________________________________________________________________________________
Layer (type)                 Output Shape              Param #     Connected to
=================================================================================================
input_1 (InputLayer)         [(None, 256, 256, 3)      0
_________________________________________________________________________________________________
lambda (Lambda)              (None, 256, 256, 3)       0           input_1[0][0]
_________________________________________________________________________________________________
conv2d (Conv2D)              (None, 256, 256, 16)      448         lambda[0][0]
_________________________________________________________________________________________________
dropout (Dropout)            (None, 256, 256, 16)      0           conv2d[0][0]
_________________________________________________________________________________________________
conv2d_1 (Conv2D)            (None, 256, 256, 16)      2320        dropout[0][0]
_________________________________________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 128, 128, 16)      0           conv2d_1[0][0]
_________________________________________________________________________________________________
conv2d_2 (Conv2D)            (None, 128, 128, 32)      4640        max_pooling2d[0][0]
_________________________________________________________________________________________________
dropout_1 (Dropout)          (None, 128, 128, 32)      0           conv2d_2[0][0]
_________________________________________________________________________________________________
conv2d_3 (Conv2D)            (None, 128, 128, 32)      9248        dropout_1[0][0]
_________________________________________________________________________________________________
max_pooling2d_1 (MaxPooling2D)  (None, 64, 64, 32)     0           conv2d_3[0][0]
_________________________________________________________________________________________________
conv2d_4 (Conv2D)            (None, 64, 64, 64)        18496       max_pooling2d_1[0][0]
_________________________________________________________________________________________________
dropout_2 (Dropout)          (None, 64, 64, 64)        0           conv2d_4[0][0]
_________________________________________________________________________________________________
conv2d_5 (Conv2D)            (None, 64, 64, 64)        36928       dropout_2[0][0]
_________________________________________________________________________________________________
max_pooling2d_2 (MaxPooling2D)  (None, 32, 32, 64)     0           conv2d_5[0][0]
_________________________________________________________________________________________________
conv2d_6 (Conv2D)            (None, 32, 32, 128)       73856       max_pooling2d_2[0][0]
_________________________________________________________________________________________________
dropout_3 (Dropout)          (None, 32, 32, 128)       0           conv2d_6[0][0]
_________________________________________________________________________________________________
conv2d_7 (Conv2D)            (None, 32, 32, 128)       147584      dropout_3[0][0]
_________________________________________________________________________________________________
max_pooling2d_3 (MaxPooling2D)  (None, 16, 16, 128)     0           conv2d_7[0][0]
_________________________________________________________________________________________________
conv2d_8 (Conv2D)            (None, 16, 16, 256)       295168      max_pooling2d_3[0][0]
_________________________________________________________________________________________________
dropout_4 (Dropout)          (None, 16, 16, 256)       0           conv2d_8[0][0]
_________________________________________________________________________________________________
conv2d_9 (Conv2D)            (None, 16, 16, 256)       590080      dropout_4[0][0]
_________________________________________________________________________________________________
conv2d_transpose (Conv2DTranspo (None, 32, 32, 128)    131200      conv2d_9[0][0]
_________________________________________________________________________________________________
concatenate (Concatenate)    (None, 32, 32, 256)       0           conv2d_transpose[0][0]
                                                                   conv2d_7[0][0]
_________________________________________________________________________________________________
conv2d_10 (Conv2D)           (None, 32, 32, 128)       295040      concatenate[0][0]
_________________________________________________________________________________________________
dropout_5 (Dropout)          (None, 32, 32, 128)       0           conv2d_10[0][0]
_________________________________________________________________________________________________
conv2d_11 (Conv2D)           (None, 32, 32, 128)       147584      dropout_5[0][0]
_________________________________________________________________________________________________
conv2d_transpose_1 (Conv2DTrans (None, 64, 64, 64)     32832       conv2d_11[0][0]
_________________________________________________________________________________________________
concatenate_1 (Concatenate)  (None, 64, 64, 128)       0           conv2d_transpose_1[0][0]
                                                                   conv2d_5[0][0]
_________________________________________________________________________________________________
conv2d_12 (Conv2D)           (None, 64, 64, 64)        73792       concatenate_1[0][0]
_________________________________________________________________________________________________
dropout_6 (Dropout)          (None, 64, 64, 64)        0           conv2d_12[0][0]
_________________________________________________________________________________________________
conv2d_13 (Conv2D)           (None, 64, 64, 64)        36928       dropout_6[0][0]
_________________________________________________________________________________________________
conv2d_transpose_2 (Conv2DTrans (None, 128, 128, 32)   8224        conv2d_13[0][0]
```

```
concatenate_2 (Concatenate)     (None, 128, 128, 64) 0           conv2d_transpose_2[0][0]
                                                                 conv2d_3[0][0]
__________________________________________________________________________________________________
conv2d_14 (Conv2D)              (None, 128, 128, 32) 18464       concatenate_2[0][0]
__________________________________________________________________________________________________
dropout_7 (Dropout)             (None, 128, 128, 32) 0           conv2d_14[0][0]
__________________________________________________________________________________________________
conv2d_15 (Conv2D)              (None, 128, 128, 32) 9248        dropout_7[0][0]
__________________________________________________________________________________________________
conv2d_transpose_3 (Conv2DTrans (None, 256, 256, 16) 2064        conv2d_15[0][0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 256, 256, 32) 0           conv2d_transpose_3[0][0]
                                                                 conv2d_1[0][0]
__________________________________________________________________________________________________
conv2d_16 (Conv2D)              (None, 256, 256, 16) 4624        concatenate_3[0][0]
__________________________________________________________________________________________________
dropout_8 (Dropout)             (None, 256, 256, 16) 0           conv2d_16[0][0]
__________________________________________________________________________________________________
conv2d_17 (Conv2D)              (None, 256, 256, 16) 2320        dropout_8[0][0]
__________________________________________________________________________________________________
conv2d_18 (Conv2D)              (None, 256, 256, 1)  17          conv2d_17[0][0]
==================================================================================================
Total params: 1,941,105
Trainable params: 1,941,105
Non-trainable params: 0
__________________________________________________________________________________________________
```

In [23]:

```
%load_ext tensorboard
```

```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
```

In [ ]:

```
import os
#os.mkdir("/content/drive/My Drive/model_save")
```

In [46]:

```
from tensorflow.keras.callbacks import ModelCheckpoint
filepath="/content/drive/My Drive/model_save/weights-{epoch:02d}-{val_dice_coef:.4f}.hdf5"
checkpoint = ModelCheckpoint(filepath=filepath, monitor='val_dice_coef',verbose=1, save_best_only=True, mode='max')
```

In [25]:

```
tf.keras.backend.clear_session()
# Tensorbaord
#! rm -rf ./logs/
logdir = os.path.join("/content/drive/My Drive/logs","simple_unet")
%tensorboard --logdir='/content/drive/My Drive/logs/simple_unet/'
tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)
model.fit(train_dataset,epochs=75,batch_size=64,validation_data=test_dataset,callbacks=[tensorboard_callback,checkpoint])
```

```
Epoch 1/75
 1/30 [>.............................] - ETA: 0s - loss: 0.6917 - accuracy: 0.8474 - dice_coef: 0.0283WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow/python/ops/summary_ops_v2.py:1277: stop (from tensorflow.python.eager.profiler) is deprecated and will be removed after 2020-07-01.
Instructions for updating:
use `tf.profiler.experimental.stop` instead.
 2/30 [=>............................] - ETA: 8s - loss: 0.6874 - accuracy: 0.9183 - dice_coef: 0.0247WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the batch time (batch time: 0.1388s vs `on_train_batch_end` time: 0.4665s). Check your callbacks.
30/30 [==============================] - ETA: 0s - loss: 0.2242 - accuracy: 0.9819 - dice_coef: 0.0114
Epoch 00001: val_dice_coef improved from -inf to 0.02057, saving model to /content/drive/My Drive/model_save/weights-01-0.0206.hdf5
```

```
Drive/model_save/weights-01-0.0206.hdf5
30/30 [==============================] - 50s 2s/step - loss: 0.2242 - accuracy: 0.9819 -
dice_coef: 0.0114 - val_loss: 0.1238 - val_accuracy: 0.9862 - val_dice_coef: 0.0206
Epoch 2/75
30/30 [==============================] - ETA: 0s - loss: 0.0751 - accuracy: 0.9866 - dice_coef: 0.
0167
Epoch 00002: val_dice_coef improved from 0.02057 to 0.03256, saving model to /content/drive/My Dri
ve/model_save/weights-02-0.0326.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0751 - accuracy: 0.9866 -
dice_coef: 0.0167 - val_loss: 0.0768 - val_accuracy: 0.9862 - val_dice_coef: 0.0326
Epoch 3/75
30/30 [==============================] - ETA: 0s - loss: 0.0669 - accuracy: 0.9866 - dice_coef: 0.
0233
Epoch 00003: val_dice_coef improved from 0.03256 to 0.03604, saving model to /content/drive/My Dri
ve/model_save/weights-03-0.0360.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0669 - accuracy: 0.9866 -
dice_coef: 0.0233 - val_loss: 0.0773 - val_accuracy: 0.9862 - val_dice_coef: 0.0360
Epoch 4/75
30/30 [==============================] - ETA: 0s - loss: 0.0640 - accuracy: 0.9866 - dice_coef: 0.
0343
Epoch 00004: val_dice_coef improved from 0.03604 to 0.04456, saving model to /content/drive/My Dri
ve/model_save/weights-04-0.0446.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0640 - accuracy: 0.9866 -
dice_coef: 0.0343 - val_loss: 0.0700 - val_accuracy: 0.9862 - val_dice_coef: 0.0446
Epoch 5/75
30/30 [==============================] - ETA: 0s - loss: 0.0620 - accuracy: 0.9866 - dice_coef: 0.
0426
Epoch 00005: val_dice_coef improved from 0.04456 to 0.05061, saving model to /content/drive/My Dri
ve/model_save/weights-05-0.0506.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0620 - accuracy: 0.9866 -
dice_coef: 0.0426 - val_loss: 0.0671 - val_accuracy: 0.9862 - val_dice_coef: 0.0506
Epoch 6/75
30/30 [==============================] - ETA: 0s - loss: 0.0615 - accuracy: 0.9866 - dice_coef: 0.
0440
Epoch 00006: val_dice_coef improved from 0.05061 to 0.05160, saving model to /content/drive/My Dri
ve/model_save/weights-06-0.0516.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0615 - accuracy: 0.9866 -
dice_coef: 0.0440 - val_loss: 0.0681 - val_accuracy: 0.9862 - val_dice_coef: 0.0516
Epoch 7/75
30/30 [==============================] - ETA: 0s - loss: 0.0609 - accuracy: 0.9866 - dice_coef: 0.
0472
Epoch 00007: val_dice_coef did not improve from 0.05160
30/30 [==============================] - 9s 305ms/step - loss: 0.0609 - accuracy: 0.9866 -
dice_coef: 0.0472 - val_loss: 0.0661 - val_accuracy: 0.9862 - val_dice_coef: 0.0486
Epoch 8/75
30/30 [==============================] - ETA: 0s - loss: 0.0603 - accuracy: 0.9866 - dice_coef: 0.
0491
Epoch 00008: val_dice_coef did not improve from 0.05160
30/30 [==============================] - 9s 304ms/step - loss: 0.0603 - accuracy: 0.9866 -
dice_coef: 0.0491 - val_loss: 0.0648 - val_accuracy: 0.9862 - val_dice_coef: 0.0501
Epoch 9/75
30/30 [==============================] - ETA: 0s - loss: 0.0598 - accuracy: 0.9866 - dice_coef: 0.
0515
Epoch 00009: val_dice_coef improved from 0.05160 to 0.05783, saving model to /content/drive/My Dri
ve/model_save/weights-09-0.0578.hdf5
30/30 [==============================] - 9s 312ms/step - loss: 0.0598 - accuracy: 0.9866 -
dice_coef: 0.0515 - val_loss: 0.0627 - val_accuracy: 0.9862 - val_dice_coef: 0.0578
Epoch 10/75
30/30 [==============================] - ETA: 0s - loss: 0.0596 - accuracy: 0.9866 - dice_coef: 0.
0525
Epoch 00010: val_dice_coef did not improve from 0.05783
30/30 [==============================] - 9s 304ms/step - loss: 0.0596 - accuracy: 0.9866 -
dice_coef: 0.0525 - val_loss: 0.0622 - val_accuracy: 0.9862 - val_dice_coef: 0.0567
Epoch 11/75
30/30 [==============================] - ETA: 0s - loss: 0.0591 - accuracy: 0.9866 - dice_coef: 0.
0563
Epoch 00011: val_dice_coef improved from 0.05783 to 0.07038, saving model to /content/drive/My Dri
ve/model_save/weights-11-0.0704.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0591 - accuracy: 0.9866 -
dice_coef: 0.0563 - val_loss: 0.0605 - val_accuracy: 0.9862 - val_dice_coef: 0.0704
Epoch 12/75
30/30 [==============================] - ETA: 0s - loss: 0.0585 - accuracy: 0.9866 - dice_coef: 0.
0601
Epoch 00012: val_dice_coef improved from 0.07038 to 0.08058, saving model to /content/drive/My Dri
ve/model_save/weights-12-0.0806.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0585 - accuracy: 0.9866 -
dice_coef: 0.0601 - val_loss: 0.0590 - val_accuracy: 0.9862 - val_dice_coef: 0.0806
Epoch 13/75
```

```
Epoch 13/75
30/30 [==============================] - ETA: 0s - loss: 0.0578 - accuracy: 0.9866 - dice_coef: 0.
0650
Epoch 00013: val_dice_coef improved from 0.08058 to 0.08273, saving model to /content/drive/My Dri
ve/model_save/weights-13-0.0827.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0578 - accuracy: 0.9866 -
dice_coef: 0.0650 - val_loss: 0.0578 - val_accuracy: 0.9862 - val_dice_coef: 0.0827
Epoch 14/75
30/30 [==============================] - ETA: 0s - loss: 0.0572 - accuracy: 0.9866 - dice_coef: 0.
0697
Epoch 00014: val_dice_coef improved from 0.08273 to 0.09184, saving model to /content/drive/My Dri
ve/model_save/weights-14-0.0918.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0572 - accuracy: 0.9866 -
dice_coef: 0.0697 - val_loss: 0.0572 - val_accuracy: 0.9862 - val_dice_coef: 0.0918
Epoch 15/75
30/30 [==============================] - ETA: 0s - loss: 0.0563 - accuracy: 0.9866 - dice_coef: 0.
0729
Epoch 00015: val_dice_coef improved from 0.09184 to 0.09853, saving model to /content/drive/My Dri
ve/model_save/weights-15-0.0985.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0563 - accuracy: 0.9866 -
dice_coef: 0.0729 - val_loss: 0.0565 - val_accuracy: 0.9862 - val_dice_coef: 0.0985
Epoch 16/75
30/30 [==============================] - ETA: 0s - loss: 0.0555 - accuracy: 0.9866 - dice_coef: 0.
0793
Epoch 00016: val_dice_coef did not improve from 0.09853
30/30 [==============================] - 9s 304ms/step - loss: 0.0555 - accuracy: 0.9866 -
dice_coef: 0.0793 - val_loss: 0.0572 - val_accuracy: 0.9862 - val_dice_coef: 0.0857
Epoch 17/75
30/30 [==============================] - ETA: 0s - loss: 0.0549 - accuracy: 0.9866 - dice_coef: 0.
0818
Epoch 00017: val_dice_coef did not improve from 0.09853
30/30 [==============================] - 9s 305ms/step - loss: 0.0549 - accuracy: 0.9866 -
dice_coef: 0.0818 - val_loss: 0.0554 - val_accuracy: 0.9862 - val_dice_coef: 0.0982
Epoch 18/75
30/30 [==============================] - ETA: 0s - loss: 0.0542 - accuracy: 0.9866 - dice_coef: 0.
0885
Epoch 00018: val_dice_coef did not improve from 0.09853
30/30 [==============================] - 9s 304ms/step - loss: 0.0542 - accuracy: 0.9866 -
dice_coef: 0.0885 - val_loss: 0.0546 - val_accuracy: 0.9862 - val_dice_coef: 0.0943
Epoch 19/75
30/30 [==============================] - ETA: 0s - loss: 0.0531 - accuracy: 0.9866 - dice_coef: 0.
0917
Epoch 00019: val_dice_coef improved from 0.09853 to 0.10610, saving model to /content/drive/My Dri
ve/model_save/weights-19-0.1061.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0531 - accuracy: 0.9866 -
dice_coef: 0.0917 - val_loss: 0.0534 - val_accuracy: 0.9862 - val_dice_coef: 0.1061
Epoch 20/75
30/30 [==============================] - ETA: 0s - loss: 0.0519 - accuracy: 0.9866 - dice_coef: 0.
1006
Epoch 00020: val_dice_coef improved from 0.10610 to 0.11835, saving model to /content/drive/My Dri
ve/model_save/weights-20-0.1184.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0519 - accuracy: 0.9866 -
dice_coef: 0.1006 - val_loss: 0.0534 - val_accuracy: 0.9862 - val_dice_coef: 0.1184
Epoch 21/75
30/30 [==============================] - ETA: 0s - loss: 0.0511 - accuracy: 0.9866 - dice_coef: 0.
1035
Epoch 00021: val_dice_coef improved from 0.11835 to 0.12607, saving model to /content/drive/My Dri
ve/model_save/weights-21-0.1261.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0511 - accuracy: 0.9866 -
dice_coef: 0.1035 - val_loss: 0.0536 - val_accuracy: 0.9862 - val_dice_coef: 0.1261
Epoch 22/75
30/30 [==============================] - ETA: 0s - loss: 0.0504 - accuracy: 0.9866 - dice_coef: 0.
1086
Epoch 00022: val_dice_coef improved from 0.12607 to 0.13090, saving model to /content/drive/My Dri
ve/model_save/weights-22-0.1309.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0504 - accuracy: 0.9866 -
dice_coef: 0.1086 - val_loss: 0.0521 - val_accuracy: 0.9862 - val_dice_coef: 0.1309
Epoch 23/75
30/30 [==============================] - ETA: 0s - loss: 0.0498 - accuracy: 0.9866 - dice_coef: 0.
1163
Epoch 00023: val_dice_coef improved from 0.13090 to 0.13116, saving model to /content/drive/My Dri
ve/model_save/weights-23-0.1312.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0498 - accuracy: 0.9866 -
dice_coef: 0.1163 - val_loss: 0.0515 - val_accuracy: 0.9862 - val_dice_coef: 0.1312
Epoch 24/75
30/30 [==============================] - ETA: 0s - loss: 0.0489 - accuracy: 0.9866 - dice_coef: 0.
1232
Epoch 00024: val_dice_coef improved from 0.13116 to 0.13500, saving model to /content/drive/My Dri
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Epoch 00024: val_dice_coef improved from 0.13116 to 0.13500, saving model to /content/drive/My Dri
ve/model_save/weights-24-0.1350.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0489 - accuracy: 0.9866 -
dice_coef: 0.1232 - val_loss: 0.0522 - val_accuracy: 0.9862 - val_dice_coef: 0.1350
Epoch 25/75
30/30 [==============================] - ETA: 0s - loss: 0.0490 - accuracy: 0.9866 - dice_coef: 0.
1210
Epoch 00025: val_dice_coef improved from 0.13500 to 0.14462, saving model to /content/drive/My Dri
ve/model_save/weights-25-0.1446.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0490 - accuracy: 0.9866 -
dice_coef: 0.1210 - val_loss: 0.0515 - val_accuracy: 0.9862 - val_dice_coef: 0.1446
Epoch 26/75
30/30 [==============================] - ETA: 0s - loss: 0.0481 - accuracy: 0.9866 - dice_coef: 0.
1294
Epoch 00026: val_dice_coef did not improve from 0.14462
30/30 [==============================] - 9s 304ms/step - loss: 0.0481 - accuracy: 0.9866 -
dice_coef: 0.1294 - val_loss: 0.0499 - val_accuracy: 0.9862 - val_dice_coef: 0.1432
Epoch 27/75
30/30 [==============================] - ETA: 0s - loss: 0.0481 - accuracy: 0.9866 - dice_coef: 0.
1287
Epoch 00027: val_dice_coef did not improve from 0.14462
30/30 [==============================] - 9s 304ms/step - loss: 0.0481 - accuracy: 0.9866 -
dice_coef: 0.1287 - val_loss: 0.0507 - val_accuracy: 0.9862 - val_dice_coef: 0.1377
Epoch 28/75
30/30 [==============================] - ETA: 0s - loss: 0.0472 - accuracy: 0.9866 - dice_coef: 0.
1383
Epoch 00028: val_dice_coef did not improve from 0.14462
30/30 [==============================] - 9s 303ms/step - loss: 0.0472 - accuracy: 0.9866 -
dice_coef: 0.1383 - val_loss: 0.0511 - val_accuracy: 0.9862 - val_dice_coef: 0.1262
Epoch 29/75
30/30 [==============================] - ETA: 0s - loss: 0.0465 - accuracy: 0.9866 - dice_coef: 0.
1440
Epoch 00029: val_dice_coef did not improve from 0.14462
30/30 [==============================] - 9s 304ms/step - loss: 0.0465 - accuracy: 0.9866 -
dice_coef: 0.1440 - val_loss: 0.0519 - val_accuracy: 0.9862 - val_dice_coef: 0.1309
Epoch 30/75
30/30 [==============================] - ETA: 0s - loss: 0.0463 - accuracy: 0.9866 - dice_coef: 0.
1478
Epoch 00030: val_dice_coef improved from 0.14462 to 0.14676, saving model to /content/drive/My Dri
ve/model_save/weights-30-0.1468.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0463 - accuracy: 0.9866 -
dice_coef: 0.1478 - val_loss: 0.0496 - val_accuracy: 0.9862 - val_dice_coef: 0.1468
Epoch 31/75
30/30 [==============================] - ETA: 0s - loss: 0.0467 - accuracy: 0.9866 - dice_coef: 0.
1453
Epoch 00031: val_dice_coef improved from 0.14676 to 0.15156, saving model to /content/drive/My Dri
ve/model_save/weights-31-0.1516.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0467 - accuracy: 0.9866 -
dice_coef: 0.1453 - val_loss: 0.0493 - val_accuracy: 0.9862 - val_dice_coef: 0.1516
Epoch 32/75
30/30 [==============================] - ETA: 0s - loss: 0.0450 - accuracy: 0.9866 - dice_coef: 0.
1620
Epoch 00032: val_dice_coef improved from 0.15156 to 0.15197, saving model to /content/drive/My Dri
ve/model_save/weights-32-0.1520.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0450 - accuracy: 0.9866 -
dice_coef: 0.1620 - val_loss: 0.0514 - val_accuracy: 0.9863 - val_dice_coef: 0.1520
Epoch 33/75
30/30 [==============================] - ETA: 0s - loss: 0.0442 - accuracy: 0.9866 - dice_coef: 0.
1678
Epoch 00033: val_dice_coef improved from 0.15197 to 0.16128, saving model to /content/drive/My Dri
ve/model_save/weights-33-0.1613.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0442 - accuracy: 0.9866 -
dice_coef: 0.1678 - val_loss: 0.0502 - val_accuracy: 0.9863 - val_dice_coef: 0.1613
Epoch 34/75
30/30 [==============================] - ETA: 0s - loss: 0.0438 - accuracy: 0.9867 - dice_coef: 0.
1754
Epoch 00034: val_dice_coef improved from 0.16128 to 0.16648, saving model to /content/drive/My Dri
ve/model_save/weights-34-0.1665.hdf5
30/30 [==============================] - 9s 312ms/step - loss: 0.0438 - accuracy: 0.9867 -
dice_coef: 0.1754 - val_loss: 0.0494 - val_accuracy: 0.9863 - val_dice_coef: 0.1665
Epoch 35/75
30/30 [==============================] - ETA: 0s - loss: 0.0436 - accuracy: 0.9867 - dice_coef: 0.
1765
Epoch 00035: val_dice_coef did not improve from 0.16648
30/30 [==============================] - 9s 304ms/step - loss: 0.0436 - accuracy: 0.9867 -
dice_coef: 0.1765 - val_loss: 0.0503 - val_accuracy: 0.9862 - val_dice_coef: 0.1595
Epoch 36/75
```

```
30/30 [==============================] - ETA: 0s - loss: 0.0435 - accuracy: 0.9867 - dice_coef: 0.
1821
Epoch 00036: val_dice_coef did not improve from 0.16648
30/30 [==============================] - 9s 304ms/step - loss: 0.0435 - accuracy: 0.9867 -
dice_coef: 0.1821 - val_loss: 0.0498 - val_accuracy: 0.9862 - val_dice_coef: 0.1606
Epoch 37/75
30/30 [==============================] - ETA: 0s - loss: 0.0433 - accuracy: 0.9867 - dice_coef: 0.
1836
Epoch 00037: val_dice_coef improved from 0.16648 to 0.17308, saving model to /content/drive/My Dri
ve/model_save/weights-37-0.1731.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0433 - accuracy: 0.9867 -
dice_coef: 0.1836 - val_loss: 0.0526 - val_accuracy: 0.9862 - val_dice_coef: 0.1731
Epoch 38/75
30/30 [==============================] - ETA: 0s - loss: 0.0419 - accuracy: 0.9869 - dice_coef: 0.
1989
Epoch 00038: val_dice_coef improved from 0.17308 to 0.17971, saving model to /content/drive/My Dri
ve/model_save/weights-38-0.1797.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0419 - accuracy: 0.9869 -
dice_coef: 0.1989 - val_loss: 0.0506 - val_accuracy: 0.9862 - val_dice_coef: 0.1797
Epoch 39/75
30/30 [==============================] - ETA: 0s - loss: 0.0406 - accuracy: 0.9871 - dice_coef: 0.
2171
Epoch 00039: val_dice_coef improved from 0.17971 to 0.18335, saving model to /content/drive/My Dri
ve/model_save/weights-39-0.1834.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0406 - accuracy: 0.9871 -
dice_coef: 0.2171 - val_loss: 0.0538 - val_accuracy: 0.9863 - val_dice_coef: 0.1834
Epoch 40/75
30/30 [==============================] - ETA: 0s - loss: 0.0409 - accuracy: 0.9871 - dice_coef: 0.
2139
Epoch 00040: val_dice_coef did not improve from 0.18335
30/30 [==============================] - 9s 304ms/step - loss: 0.0409 - accuracy: 0.9871 -
dice_coef: 0.2139 - val_loss: 0.0541 - val_accuracy: 0.9862 - val_dice_coef: 0.1718
Epoch 41/75
30/30 [==============================] - ETA: 0s - loss: 0.0408 - accuracy: 0.9872 - dice_coef: 0.
2188
Epoch 00041: val_dice_coef improved from 0.18335 to 0.18951, saving model to /content/drive/My Dri
ve/model_save/weights-41-0.1895.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0408 - accuracy: 0.9872 -
dice_coef: 0.2188 - val_loss: 0.0505 - val_accuracy: 0.9862 - val_dice_coef: 0.1895
Epoch 42/75
30/30 [==============================] - ETA: 0s - loss: 0.0406 - accuracy: 0.9871 - dice_coef: 0.
2198
Epoch 00042: val_dice_coef improved from 0.18951 to 0.19742, saving model to /content/drive/My Dri
ve/model_save/weights-42-0.1974.hdf5
30/30 [==============================] - 9s 312ms/step - loss: 0.0406 - accuracy: 0.9871 -
dice_coef: 0.2198 - val_loss: 0.0504 - val_accuracy: 0.9860 - val_dice_coef: 0.1974
Epoch 43/75
30/30 [==============================] - ETA: 0s - loss: 0.0398 - accuracy: 0.9873 - dice_coef: 0.
2320
Epoch 00043: val_dice_coef improved from 0.19742 to 0.20563, saving model to /content/drive/My Dri
ve/model_save/weights-43-0.2056.hdf5
30/30 [==============================] - 9s 313ms/step - loss: 0.0398 - accuracy: 0.9873 -
dice_coef: 0.2320 - val_loss: 0.0506 - val_accuracy: 0.9859 - val_dice_coef: 0.2056
Epoch 44/75
30/30 [==============================] - ETA: 0s - loss: 0.0393 - accuracy: 0.9875 - dice_coef: 0.
2420
Epoch 00044: val_dice_coef did not improve from 0.20563
30/30 [==============================] - 9s 304ms/step - loss: 0.0393 - accuracy: 0.9875 -
dice_coef: 0.2420 - val_loss: 0.0506 - val_accuracy: 0.9862 - val_dice_coef: 0.1967
Epoch 45/75
30/30 [==============================] - ETA: 0s - loss: 0.0376 - accuracy: 0.9878 - dice_coef: 0.
2664
Epoch 00045: val_dice_coef did not improve from 0.20563
30/30 [==============================] - 9s 304ms/step - loss: 0.0376 - accuracy: 0.9878 -
dice_coef: 0.2664 - val_loss: 0.0519 - val_accuracy: 0.9861 - val_dice_coef: 0.1976
Epoch 46/75
30/30 [==============================] - ETA: 0s - loss: 0.0367 - accuracy: 0.9880 - dice_coef: 0.
2819
Epoch 00046: val_dice_coef did not improve from 0.20563
30/30 [==============================] - 9s 304ms/step - loss: 0.0367 - accuracy: 0.9880 -
dice_coef: 0.2819 - val_loss: 0.0558 - val_accuracy: 0.9856 - val_dice_coef: 0.1909
Epoch 47/75
30/30 [==============================] - ETA: 0s - loss: 0.0369 - accuracy: 0.9880 - dice_coef: 0.
2776
Epoch 00047: val_dice_coef did not improve from 0.20563
30/30 [==============================] - 9s 304ms/step - loss: 0.0369 - accuracy: 0.9880 -
dice_coef: 0.2776 - val_loss: 0.0547 - val_accuracy: 0.9857 - val_dice_coef: 0.2053
```

```
Epoch 48/75
30/30 [==============================] - ETA: 0s - loss: 0.0376 - accuracy: 0.9879 - dice_coef: 0.
2711
Epoch 00048: val_dice_coef improved from 0.20563 to 0.20797, saving model to /content/drive/My Dri
ve/model_save/weights-48-0.2080.hdf5
30/30 [==============================] - 9s 311ms/step - loss: 0.0376 - accuracy: 0.9879 -
dice_coef: 0.2711 - val_loss: 0.0559 - val_accuracy: 0.9855 - val_dice_coef: 0.2080
Epoch 49/75
30/30 [==============================] - ETA: 0s - loss: 0.0361 - accuracy: 0.9882 - dice_coef: 0.
2932
Epoch 00049: val_dice_coef did not improve from 0.20797
30/30 [==============================] - 9s 304ms/step - loss: 0.0361 - accuracy: 0.9882 -
dice_coef: 0.2932 - val_loss: 0.0580 - val_accuracy: 0.9863 - val_dice_coef: 0.1930
Epoch 50/75
30/30 [==============================] - ETA: 0s - loss: 0.0365 - accuracy: 0.9880 - dice_coef: 0.
2858
Epoch 00050: val_dice_coef did not improve from 0.20797
30/30 [==============================] - 9s 304ms/step - loss: 0.0365 - accuracy: 0.9880 -
dice_coef: 0.2858 - val_loss: 0.0540 - val_accuracy: 0.9859 - val_dice_coef: 0.2057
Epoch 51/75
30/30 [==============================] - ETA: 0s - loss: 0.0354 - accuracy: 0.9883 - dice_coef: 0.
3035
Epoch 00051: val_dice_coef did not improve from 0.20797
30/30 [==============================] - 9s 304ms/step - loss: 0.0354 - accuracy: 0.9883 -
dice_coef: 0.3035 - val_loss: 0.0549 - val_accuracy: 0.9862 - val_dice_coef: 0.1945
Epoch 52/75
30/30 [==============================] - ETA: 0s - loss: 0.0341 - accuracy: 0.9886 - dice_coef: 0.
3265
Epoch 00052: val_dice_coef did not improve from 0.20797
30/30 [==============================] - 9s 304ms/step - loss: 0.0341 - accuracy: 0.9886 -
dice_coef: 0.3265 - val_loss: 0.0537 - val_accuracy: 0.9861 - val_dice_coef: 0.1916
Epoch 53/75
30/30 [==============================] - ETA: 0s - loss: 0.0339 - accuracy: 0.9886 - dice_coef: 0.
3269
Epoch 00053: val_dice_coef did not improve from 0.20797
30/30 [==============================] - 9s 304ms/step - loss: 0.0339 - accuracy: 0.9886 -
dice_coef: 0.3269 - val_loss: 0.0535 - val_accuracy: 0.9859 - val_dice_coef: 0.1998
Epoch 54/75
30/30 [==============================] - ETA: 0s - loss: 0.0335 - accuracy: 0.9888 - dice_coef: 0.
3343
Epoch 00054: val_dice_coef improved from 0.20797 to 0.22229, saving model to /content/drive/My Dri
ve/model_save/weights-54-0.2223.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0335 - accuracy: 0.9888 -
dice_coef: 0.3343 - val_loss: 0.0569 - val_accuracy: 0.9857 - val_dice_coef: 0.2223
Epoch 55/75
30/30 [==============================] - ETA: 0s - loss: 0.0330 - accuracy: 0.9889 - dice_coef: 0.
3470
Epoch 00055: val_dice_coef did not improve from 0.22229
30/30 [==============================] - 9s 304ms/step - loss: 0.0330 - accuracy: 0.9889 -
dice_coef: 0.3470 - val_loss: 0.0542 - val_accuracy: 0.9860 - val_dice_coef: 0.2021
Epoch 56/75
30/30 [==============================] - ETA: 0s - loss: 0.0325 - accuracy: 0.9889 - dice_coef: 0.
3516
Epoch 00056: val_dice_coef did not improve from 0.22229
30/30 [==============================] - 9s 304ms/step - loss: 0.0325 - accuracy: 0.9889 -
dice_coef: 0.3516 - val_loss: 0.0565 - val_accuracy: 0.9862 - val_dice_coef: 0.1870
Epoch 57/75
30/30 [==============================] - ETA: 0s - loss: 0.0316 - accuracy: 0.9892 - dice_coef: 0.
3643
Epoch 00057: val_dice_coef did not improve from 0.22229
30/30 [==============================] - 9s 304ms/step - loss: 0.0316 - accuracy: 0.9892 -
dice_coef: 0.3643 - val_loss: 0.0568 - val_accuracy: 0.9862 - val_dice_coef: 0.2142
Epoch 58/75
30/30 [==============================] - ETA: 0s - loss: 0.0307 - accuracy: 0.9895 - dice_coef: 0.
3820
Epoch 00058: val_dice_coef improved from 0.22229 to 0.25156, saving model to /content/drive/My Dri
ve/model_save/weights-58-0.2516.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0307 - accuracy: 0.9895 -
dice_coef: 0.3820 - val_loss: 0.0572 - val_accuracy: 0.9837 - val_dice_coef: 0.2516
Epoch 59/75
30/30 [==============================] - ETA: 0s - loss: 0.0315 - accuracy: 0.9894 - dice_coef: 0.
3732
Epoch 00059: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0315 - accuracy: 0.9894 -
dice_coef: 0.3732 - val_loss: 0.0543 - val_accuracy: 0.9851 - val_dice_coef: 0.2242
Epoch 60/75
30/30 [==============================] - ETA: 0s - loss: 0.0311 - accuracy: 0.9893 - dice_coef: 0.
```

```
3741
Epoch 00060: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0311 - accuracy: 0.9893 -
dice_coef: 0.3741 - val_loss: 0.0579 - val_accuracy: 0.9852 - val_dice_coef: 0.2286
Epoch 61/75
30/30 [==============================] - ETA: 0s - loss: 0.0308 - accuracy: 0.9895 - dice_coef: 0.
3834
Epoch 00061: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0308 - accuracy: 0.9895 -
dice_coef: 0.3834 - val_loss: 0.0600 - val_accuracy: 0.9852 - val_dice_coef: 0.2318
Epoch 62/75
30/30 [==============================] - ETA: 0s - loss: 0.0308 - accuracy: 0.9895 - dice_coef: 0.
3808
Epoch 00062: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0308 - accuracy: 0.9895 -
dice_coef: 0.3808 - val_loss: 0.0550 - val_accuracy: 0.9863 - val_dice_coef: 0.1988
Epoch 63/75
30/30 [==============================] - ETA: 0s - loss: 0.0302 - accuracy: 0.9896 - dice_coef: 0.
3961
Epoch 00063: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0302 - accuracy: 0.9896 -
dice_coef: 0.3961 - val_loss: 0.0572 - val_accuracy: 0.9866 - val_dice_coef: 0.2007
Epoch 64/75
30/30 [==============================] - ETA: 0s - loss: 0.0283 - accuracy: 0.9901 - dice_coef: 0.
4239
Epoch 00064: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 303ms/step - loss: 0.0283 - accuracy: 0.9901 -
dice_coef: 0.4239 - val_loss: 0.0560 - val_accuracy: 0.9866 - val_dice_coef: 0.2173
Epoch 65/75
30/30 [==============================] - ETA: 0s - loss: 0.0280 - accuracy: 0.9902 - dice_coef: 0.
4299
Epoch 00065: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 303ms/step - loss: 0.0280 - accuracy: 0.9902 -
dice_coef: 0.4299 - val_loss: 0.0568 - val_accuracy: 0.9862 - val_dice_coef: 0.2205
Epoch 66/75
30/30 [==============================] - ETA: 0s - loss: 0.0266 - accuracy: 0.9906 - dice_coef: 0.
4536
Epoch 00066: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 303ms/step - loss: 0.0266 - accuracy: 0.9906 -
dice_coef: 0.4536 - val_loss: 0.0591 - val_accuracy: 0.9862 - val_dice_coef: 0.2311
Epoch 67/75
30/30 [==============================] - ETA: 0s - loss: 0.0254 - accuracy: 0.9910 - dice_coef: 0.
4781
Epoch 00067: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0254 - accuracy: 0.9910 -
dice_coef: 0.4781 - val_loss: 0.0614 - val_accuracy: 0.9863 - val_dice_coef: 0.2178
Epoch 68/75
30/30 [==============================] - ETA: 0s - loss: 0.0254 - accuracy: 0.9910 - dice_coef: 0.
4818
Epoch 00068: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0254 - accuracy: 0.9910 -
dice_coef: 0.4818 - val_loss: 0.0582 - val_accuracy: 0.9859 - val_dice_coef: 0.2229
Epoch 69/75
30/30 [==============================] - ETA: 0s - loss: 0.0254 - accuracy: 0.9909 - dice_coef: 0.
4749
Epoch 00069: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0254 - accuracy: 0.9909 -
dice_coef: 0.4749 - val_loss: 0.0627 - val_accuracy: 0.9857 - val_dice_coef: 0.2245
Epoch 70/75
30/30 [==============================] - ETA: 0s - loss: 0.0253 - accuracy: 0.9910 - dice_coef: 0.
4851
Epoch 00070: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0253 - accuracy: 0.9910 -
dice_coef: 0.4851 - val_loss: 0.0622 - val_accuracy: 0.9862 - val_dice_coef: 0.2156
Epoch 71/75
30/30 [==============================] - ETA: 0s - loss: 0.0251 - accuracy: 0.9910 - dice_coef: 0.
4829
Epoch 00071: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0251 - accuracy: 0.9910 -
dice_coef: 0.4829 - val_loss: 0.0610 - val_accuracy: 0.9842 - val_dice_coef: 0.2508
Epoch 72/75
30/30 [==============================] - ETA: 0s - loss: 0.0262 - accuracy: 0.9907 - dice_coef: 0.
4646
Epoch 00072: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0262 - accuracy: 0.9907 -
dice_coef: 0.4646 - val_loss: 0.0586 - val_accuracy: 0.9836 - val_dice_coef: 0.2514
Epoch 73/75
```

```
30/30 [==============================] - ETA: 0s - loss: 0.0266 - accuracy: 0.9905 - dice_coef: 0.
4516
Epoch 00073: val_dice_coef did not improve from 0.25156
30/30 [==============================] - 9s 304ms/step - loss: 0.0266 - accuracy: 0.9905 -
dice_coef: 0.4516 - val_loss: 0.0608 - val_accuracy: 0.9829 - val_dice_coef: 0.2486
Epoch 74/75
30/30 [==============================] - ETA: 0s - loss: 0.0270 - accuracy: 0.9905 - dice_coef: 0.
4523
Epoch 00074: val_dice_coef improved from 0.25156 to 0.25621, saving model to /content/drive/My Dri
ve/model_save/weights-74-0.2562.hdf5
30/30 [==============================] - 9s 310ms/step - loss: 0.0270 - accuracy: 0.9905 -
dice_coef: 0.4523 - val_loss: 0.0603 - val_accuracy: 0.9838 - val_dice_coef: 0.2562
Epoch 75/75
30/30 [==============================] - ETA: 0s - loss: 0.0281 - accuracy: 0.9903 - dice_coef: 0.
4351
Epoch 00075: val_dice_coef did not improve from 0.25621
30/30 [==============================] - 9s 304ms/step - loss: 0.0281 - accuracy: 0.9903 -
dice_coef: 0.4351 - val_loss: 0.0574 - val_accuracy: 0.9835 - val_dice_coef: 0.2431
```

Out[25]:

```
<tensorflow.python.keras.callbacks.History at 0x7f4c5033f9b0>
```

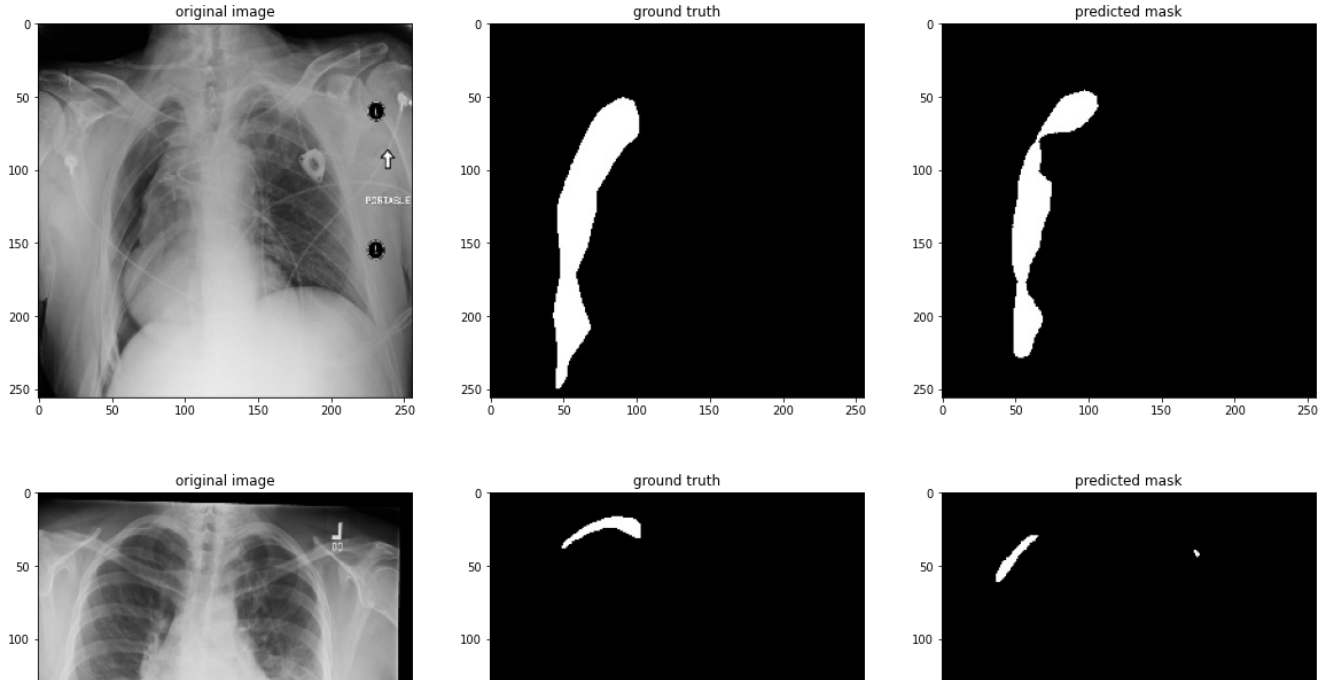
In [ ]:

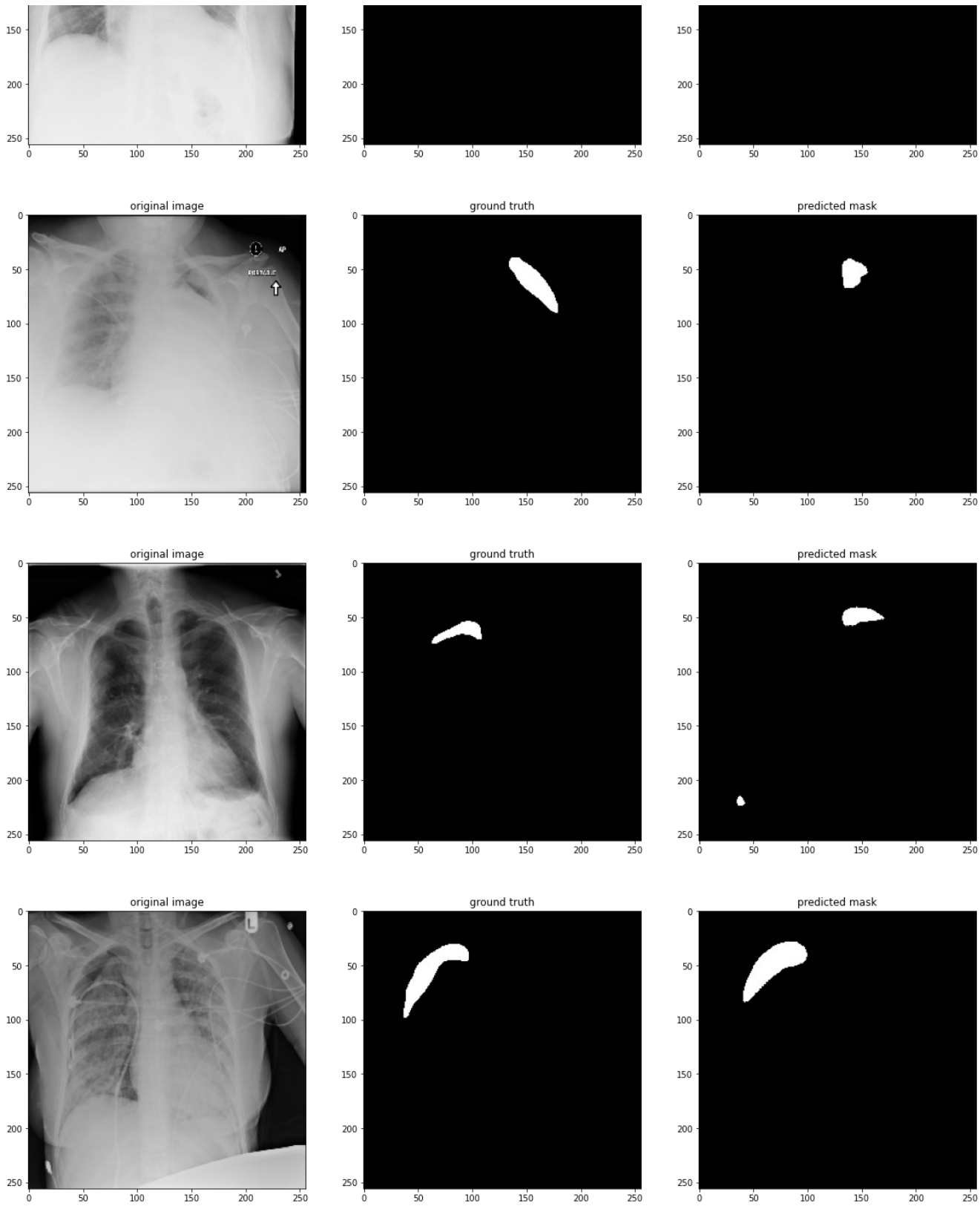
```
model.load_weights('/content/drive/My Drive/model_save/weights-74-0.25621.hdf5')
```

Random visualization of predicted masks for few xray images from the test data

In [ ]:

```
for i,j in test_dataset.take(5):
  a=model.predict(i)
  preds_val_t = (a[0] > 0.5).astype(np.uint8)
  plt.figure(figsize=(20,6))
  plt.subplot(131)
  plt.title("original image")
  plt.imshow(np.squeeze(i[0]),cmap='gray')
  plt.subplot(132)
  plt.title("ground truth")
  plt.imshow(np.squeeze(j[0]),cmap='gray')
  plt.subplot(133)
  plt.title("predicted mask")
  plt.imshow(np.squeeze(preds_val_t).astype(np.uint8),cmap='gray')
  plt.show()
```





We can observe that for few images the model does a good job but it still isnt upto the mark

Custom Unet model with Densenet121 backbone(chexnet weights)

Will be using Chexnet weights i.e we will be Using custom implemented Unet model with Densenet121(Chexnet weights)

In [31]:

```
#refered the architecture from the segmentation_model package

#We are not using the inbuilt package because of tensorflow compatability issues
```

```
#We are not using the inbuilt package because of tensorflow compatability issues
from tensorflow.keras import Model

dense_net_121 = tf.keras.applications.DenseNet121(input_shape=[256,256,3],include_top=False,pooling
='avg')
base_model_output = tf.keras.layers.Dense(units=14,activation='relu')(dense_net_121.output)
base_model = Model(inputs = dense_net_121.input,outputs=base_model_output)
base_model.load_weights('brucechou1983_CheXNet_Keras_0.3.0_weights.h5')
output_layer = tf.keras.layers.Dense(1,activation='sigmoid')(base_model.layers[-2].output)
model = Model(inputs=base_model.inputs, outputs=output_layer)
model1=tf.keras.layers.UpSampling2D((2,2))(model.layers[-3].output)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool4_conv').output])
model1=tf.keras.layers.Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool3_conv').output])
model1=tf.keras.layers.Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool2_conv').output])
model1=tf.keras.layers.Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('conv1/relu').output])
model1=tf.keras.layers.Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(1,(3,3),padding='same',use_bias=True,kernel_initializer='glorot_unifo
rm')(model1)
model1=tf.keras.layers.Activation('sigmoid')(model1)


unet_chexnet_model=Model(inputs=model.inputs, outputs=model1)
unet_chexnet_model.compile(optimizer='adam', loss='binary_crossentropy',
metrics=['accuracy',dice_coef])
unet_chexnet_model.summary()
```

```
Model: "functional_5"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)            [(None, 256, 256, 3) 0
__________________________________________________________________________________________________
zero_padding2d (ZeroPadding2D)  (None, 262, 262, 3)  0           input_1[0][0]
__________________________________________________________________________________________________
```

```
conv1/conv (Conv2D)              (None, 128, 128, 64) 9408        zero_padding2d[0][0]
__________________________________________________________________________________________________
conv1/bn (BatchNormalization)    (None, 128, 128, 64) 256         conv1/conv[0][0]
__________________________________________________________________________________________________
conv1/relu (Activation)          (None, 128, 128, 64) 0           conv1/bn[0][0]
__________________________________________________________________________________________________
zero_padding2d_1 (ZeroPadding2D (None, 130, 130, 64) 0           conv1/relu[0][0]
__________________________________________________________________________________________________
pool1 (MaxPooling2D)             (None, 64, 64, 64)   0           zero_padding2d_1[0][0]
__________________________________________________________________________________________________
conv2_block1_0_bn (BatchNormali (None, 64, 64, 64)   256         pool1[0][0]
__________________________________________________________________________________________________
conv2_block1_0_relu (Activation (None, 64, 64, 64)   0           conv2_block1_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block1_1_conv (Conv2D)     (None, 64, 64, 128)  8192        conv2_block1_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block1_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block1_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block1_1_relu (Activation (None, 64, 64, 128)  0           conv2_block1_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block1_2_conv (Conv2D)     (None, 64, 64, 32)   36864       conv2_block1_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block1_concat (Concatenat (None, 64, 64, 96)   0           pool1[0][0]
                                                                 conv2_block1_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block2_0_bn (BatchNormali (None, 64, 64, 96)   384         conv2_block1_concat[0][0]
__________________________________________________________________________________________________
conv2_block2_0_relu (Activation (None, 64, 64, 96)   0           conv2_block2_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block2_1_conv (Conv2D)     (None, 64, 64, 128)  12288       conv2_block2_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block2_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block2_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block2_1_relu (Activation (None, 64, 64, 128)  0           conv2_block2_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block2_2_conv (Conv2D)     (None, 64, 64, 32)   36864       conv2_block2_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block2_concat (Concatenat (None, 64, 64, 128)  0           conv2_block1_concat[0][0]
                                                                 conv2_block2_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block3_0_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block2_concat[0][0]
__________________________________________________________________________________________________
conv2_block3_0_relu (Activation (None, 64, 64, 128)  0           conv2_block3_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block3_1_conv (Conv2D)     (None, 64, 64, 128)  16384       conv2_block3_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block3_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block3_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block3_1_relu (Activation (None, 64, 64, 128)  0           conv2_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block3_2_conv (Conv2D)     (None, 64, 64, 32)   36864       conv2_block3_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block3_concat (Concatenat (None, 64, 64, 160)  0           conv2_block2_concat[0][0]
                                                                 conv2_block3_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block4_0_bn (BatchNormali (None, 64, 64, 160)  640         conv2_block3_concat[0][0]
__________________________________________________________________________________________________
conv2_block4_0_relu (Activation (None, 64, 64, 160)  0           conv2_block4_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block4_1_conv (Conv2D)     (None, 64, 64, 128)  20480       conv2_block4_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block4_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block4_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block4_1_relu (Activation (None, 64, 64, 128)  0           conv2_block4_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block4_2_conv (Conv2D)     (None, 64, 64, 32)   36864       conv2_block4_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block4_concat (Concatenat (None, 64, 64, 192)  0           conv2_block3_concat[0][0]
                                                                 conv2_block4_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block5_0_bn (BatchNormali (None, 64, 64, 192)  768         conv2_block4_concat[0][0]
__________________________________________________________________________________________________
conv2_block5_0_relu (Activation (None, 64, 64, 192)  0           conv2_block5_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block5_1_conv (Conv2D)     (None, 64, 64, 128)  24576       conv2_block5_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block5_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block5_1_conv[0][0]
```

conv2_block5_1_relu (Activation	(None, 64, 64, 128)	0	conv2_block5_1_bn[0][0]
conv2_block5_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block5_1_relu[0][0]
conv2_block5_concat (Concatenat	(None, 64, 64, 224)	0	conv2_block4_concat[0][0] conv2_block5_2_conv[0][0]
conv2_block6_0_bn (BatchNormali	(None, 64, 64, 224)	896	conv2_block5_concat[0][0]
conv2_block6_0_relu (Activation	(None, 64, 64, 224)	0	conv2_block6_0_bn[0][0]
conv2_block6_1_conv (Conv2D)	(None, 64, 64, 128)	28672	conv2_block6_0_relu[0][0]
conv2_block6_1_bn (BatchNormali	(None, 64, 64, 128)	512	conv2_block6_1_conv[0][0]
conv2_block6_1_relu (Activation	(None, 64, 64, 128)	0	conv2_block6_1_bn[0][0]
conv2_block6_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block6_1_relu[0][0]
conv2_block6_concat (Concatenat	(None, 64, 64, 256)	0	conv2_block5_concat[0][0] conv2_block6_2_conv[0][0]
pool2_bn (BatchNormalization)	(None, 64, 64, 256)	1024	conv2_block6_concat[0][0]
pool2_relu (Activation)	(None, 64, 64, 256)	0	pool2_bn[0][0]
pool2_conv (Conv2D)	(None, 64, 64, 128)	32768	pool2_relu[0][0]
pool2_pool (AveragePooling2D)	(None, 32, 32, 128)	0	pool2_conv[0][0]
conv3_block1_0_bn (BatchNormali	(None, 32, 32, 128)	512	pool2_pool[0][0]
conv3_block1_0_relu (Activation	(None, 32, 32, 128)	0	conv3_block1_0_bn[0][0]
conv3_block1_1_conv (Conv2D)	(None, 32, 32, 128)	16384	conv3_block1_0_relu[0][0]
conv3_block1_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block1_1_conv[0][0]
conv3_block1_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block1_1_bn[0][0]
conv3_block1_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block1_1_relu[0][0]
conv3_block1_concat (Concatenat	(None, 32, 32, 160)	0	pool2_pool[0][0] conv3_block1_2_conv[0][0]
conv3_block2_0_bn (BatchNormali	(None, 32, 32, 160)	640	conv3_block1_concat[0][0]
conv3_block2_0_relu (Activation	(None, 32, 32, 160)	0	conv3_block2_0_bn[0][0]
conv3_block2_1_conv (Conv2D)	(None, 32, 32, 128)	20480	conv3_block2_0_relu[0][0]
conv3_block2_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block2_1_conv[0][0]
conv3_block2_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block2_1_bn[0][0]
conv3_block2_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block2_1_relu[0][0]
conv3_block2_concat (Concatenat	(None, 32, 32, 192)	0	conv3_block1_concat[0][0] conv3_block2_2_conv[0][0]
conv3_block3_0_bn (BatchNormali	(None, 32, 32, 192)	768	conv3_block2_concat[0][0]
conv3_block3_0_relu (Activation	(None, 32, 32, 192)	0	conv3_block3_0_bn[0][0]
conv3_block3_1_conv (Conv2D)	(None, 32, 32, 128)	24576	conv3_block3_0_relu[0][0]
conv3_block3_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block3_1_conv[0][0]
conv3_block3_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block3_1_bn[0][0]
conv3_block3_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block3_1_relu[0][0]
conv3_block3_concat (Concatenat	(None, 32, 32, 224)	0	conv3_block2_concat[0][0] conv3_block3_2_conv[0][0]
conv3_block4_0_bn (BatchNormali	(None, 32, 32, 224)	896	conv3_block3_concat[0][0]

conv3_block4_0_relu (Activation	(None, 32, 32, 224)	0	conv3_block4_0_bn[0][0]	
conv3_block4_1_conv (Conv2D)	(None, 32, 32, 128)	28672	conv3_block4_0_relu[0][0]	
conv3_block4_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block4_1_conv[0][0]	
conv3_block4_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block4_1_bn[0][0]	
conv3_block4_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block4_1_relu[0][0]	
conv3_block4_concat (Concatenat	(None, 32, 32, 256)	0	conv3_block3_concat[0][0] conv3_block4_2_conv[0][0]	
conv3_block5_0_bn (BatchNormali	(None, 32, 32, 256)	1024	conv3_block4_concat[0][0]	
conv3_block5_0_relu (Activation	(None, 32, 32, 256)	0	conv3_block5_0_bn[0][0]	
conv3_block5_1_conv (Conv2D)	(None, 32, 32, 128)	32768	conv3_block5_0_relu[0][0]	
conv3_block5_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block5_1_conv[0][0]	
conv3_block5_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block5_1_bn[0][0]	
conv3_block5_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block5_1_relu[0][0]	
conv3_block5_concat (Concatenat	(None, 32, 32, 288)	0	conv3_block4_concat[0][0] conv3_block5_2_conv[0][0]	
conv3_block6_0_bn (BatchNormali	(None, 32, 32, 288)	1152	conv3_block5_concat[0][0]	
conv3_block6_0_relu (Activation	(None, 32, 32, 288)	0	conv3_block6_0_bn[0][0]	
conv3_block6_1_conv (Conv2D)	(None, 32, 32, 128)	36864	conv3_block6_0_relu[0][0]	
conv3_block6_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block6_1_conv[0][0]	
conv3_block6_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block6_1_bn[0][0]	
conv3_block6_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block6_1_relu[0][0]	
conv3_block6_concat (Concatenat	(None, 32, 32, 320)	0	conv3_block5_concat[0][0] conv3_block6_2_conv[0][0]	
conv3_block7_0_bn (BatchNormali	(None, 32, 32, 320)	1280	conv3_block6_concat[0][0]	
conv3_block7_0_relu (Activation	(None, 32, 32, 320)	0	conv3_block7_0_bn[0][0]	
conv3_block7_1_conv (Conv2D)	(None, 32, 32, 128)	40960	conv3_block7_0_relu[0][0]	
conv3_block7_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block7_1_conv[0][0]	
conv3_block7_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block7_1_bn[0][0]	
conv3_block7_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block7_1_relu[0][0]	
conv3_block7_concat (Concatenat	(None, 32, 32, 352)	0	conv3_block6_concat[0][0] conv3_block7_2_conv[0][0]	
conv3_block8_0_bn (BatchNormali	(None, 32, 32, 352)	1408	conv3_block7_concat[0][0]	
conv3_block8_0_relu (Activation	(None, 32, 32, 352)	0	conv3_block8_0_bn[0][0]	
conv3_block8_1_conv (Conv2D)	(None, 32, 32, 128)	45056	conv3_block8_0_relu[0][0]	
conv3_block8_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block8_1_conv[0][0]	
conv3_block8_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block8_1_bn[0][0]	
conv3_block8_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block8_1_relu[0][0]	
conv3_block8_concat (Concatenat	(None, 32, 32, 384)	0	conv3_block7_concat[0][0] conv3_block8_2_conv[0][0]	
conv3_block9_0_bn (BatchNormali	(None, 32, 32, 384)	1536	conv3_block8_concat[0][0]	
conv3_block9_0_relu (Activation	(None, 32, 32, 384)	0	conv3_block9_0_bn[0][0]	

conv3_block9_1_conv (Conv2D)	(None, 32, 32, 128)	49152	conv3_block9_0_relu[0][0]
conv3_block9_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block9_1_conv[0][0]
conv3_block9_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block9_1_bn[0][0]
conv3_block9_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block9_1_relu[0][0]
conv3_block9_concat (Concatenat	(None, 32, 32, 416)	0	conv3_block8_concat[0][0] conv3_block9_2_conv[0][0]
conv3_block10_0_bn (BatchNormal	(None, 32, 32, 416)	1664	conv3_block9_concat[0][0]
conv3_block10_0_relu (Activatio	(None, 32, 32, 416)	0	conv3_block10_0_bn[0][0]
conv3_block10_1_conv (Conv2D)	(None, 32, 32, 128)	53248	conv3_block10_0_relu[0][0]
conv3_block10_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block10_1_conv[0][0]
conv3_block10_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block10_1_bn[0][0]
conv3_block10_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block10_1_relu[0][0]
conv3_block10_concat (Concatena	(None, 32, 32, 448)	0	conv3_block9_concat[0][0] conv3_block10_2_conv[0][0]
conv3_block11_0_bn (BatchNormal	(None, 32, 32, 448)	1792	conv3_block10_concat[0][0]
conv3_block11_0_relu (Activatio	(None, 32, 32, 448)	0	conv3_block11_0_bn[0][0]
conv3_block11_1_conv (Conv2D)	(None, 32, 32, 128)	57344	conv3_block11_0_relu[0][0]
conv3_block11_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block11_1_conv[0][0]
conv3_block11_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block11_1_bn[0][0]
conv3_block11_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block11_1_relu[0][0]
conv3_block11_concat (Concatena	(None, 32, 32, 480)	0	conv3_block10_concat[0][0] conv3_block11_2_conv[0][0]
conv3_block12_0_bn (BatchNormal	(None, 32, 32, 480)	1920	conv3_block11_concat[0][0]
conv3_block12_0_relu (Activatio	(None, 32, 32, 480)	0	conv3_block12_0_bn[0][0]
conv3_block12_1_conv (Conv2D)	(None, 32, 32, 128)	61440	conv3_block12_0_relu[0][0]
conv3_block12_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block12_1_conv[0][0]
conv3_block12_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block12_1_bn[0][0]
conv3_block12_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block12_1_relu[0][0]
conv3_block12_concat (Concatena	(None, 32, 32, 512)	0	conv3_block11_concat[0][0] conv3_block12_2_conv[0][0]
pool3_bn (BatchNormalization)	(None, 32, 32, 512)	2048	conv3_block12_concat[0][0]
pool3_relu (Activation)	(None, 32, 32, 512)	0	pool3_bn[0][0]
pool3_conv (Conv2D)	(None, 32, 32, 256)	131072	pool3_relu[0][0]
pool3_pool (AveragePooling2D)	(None, 16, 16, 256)	0	pool3_conv[0][0]
conv4_block1_0_bn (BatchNormali	(None, 16, 16, 256)	1024	pool3_pool[0][0]
conv4_block1_0_relu (Activation	(None, 16, 16, 256)	0	conv4_block1_0_bn[0][0]
conv4_block1_1_conv (Conv2D)	(None, 16, 16, 128)	32768	conv4_block1_0_relu[0][0]
conv4_block1_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block1_1_conv[0][0]
conv4_block1_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block1_1_bn[0][0]
conv4_block1_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block1_1_relu[0][0]

```
conv4_block1_concat (Concatenat (None, 16, 16, 288)  0           pool3_pool[0][0]
                                                                  conv4_block1_2_conv[0][0]

conv4_block2_0_bn (BatchNormali (None, 16, 16, 288)  1152        conv4_block1_concat[0][0]

conv4_block2_0_relu (Activation (None, 16, 16, 288)  0           conv4_block2_0_bn[0][0]

conv4_block2_1_conv (Conv2D)    (None, 16, 16, 128)  36864       conv4_block2_0_relu[0][0]

conv4_block2_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block2_1_conv[0][0]

conv4_block2_1_relu (Activation (None, 16, 16, 128)  0           conv4_block2_1_bn[0][0]

conv4_block2_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block2_1_relu[0][0]

conv4_block2_concat (Concatenat (None, 16, 16, 320)  0           conv4_block1_concat[0][0]
                                                                  conv4_block2_2_conv[0][0]

conv4_block3_0_bn (BatchNormali (None, 16, 16, 320)  1280        conv4_block2_concat[0][0]

conv4_block3_0_relu (Activation (None, 16, 16, 320)  0           conv4_block3_0_bn[0][0]

conv4_block3_1_conv (Conv2D)    (None, 16, 16, 128)  40960       conv4_block3_0_relu[0][0]

conv4_block3_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block3_1_conv[0][0]

conv4_block3_1_relu (Activation (None, 16, 16, 128)  0           conv4_block3_1_bn[0][0]

conv4_block3_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block3_1_relu[0][0]

conv4_block3_concat (Concatenat (None, 16, 16, 352)  0           conv4_block2_concat[0][0]
                                                                  conv4_block3_2_conv[0][0]

conv4_block4_0_bn (BatchNormali (None, 16, 16, 352)  1408        conv4_block3_concat[0][0]

conv4_block4_0_relu (Activation (None, 16, 16, 352)  0           conv4_block4_0_bn[0][0]

conv4_block4_1_conv (Conv2D)    (None, 16, 16, 128)  45056       conv4_block4_0_relu[0][0]

conv4_block4_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block4_1_conv[0][0]

conv4_block4_1_relu (Activation (None, 16, 16, 128)  0           conv4_block4_1_bn[0][0]

conv4_block4_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block4_1_relu[0][0]

conv4_block4_concat (Concatenat (None, 16, 16, 384)  0           conv4_block3_concat[0][0]
                                                                  conv4_block4_2_conv[0][0]

conv4_block5_0_bn (BatchNormali (None, 16, 16, 384)  1536        conv4_block4_concat[0][0]

conv4_block5_0_relu (Activation (None, 16, 16, 384)  0           conv4_block5_0_bn[0][0]

conv4_block5_1_conv (Conv2D)    (None, 16, 16, 128)  49152       conv4_block5_0_relu[0][0]

conv4_block5_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block5_1_conv[0][0]

conv4_block5_1_relu (Activation (None, 16, 16, 128)  0           conv4_block5_1_bn[0][0]

conv4_block5_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block5_1_relu[0][0]

conv4_block5_concat (Concatenat (None, 16, 16, 416)  0           conv4_block4_concat[0][0]
                                                                  conv4_block5_2_conv[0][0]

conv4_block6_0_bn (BatchNormali (None, 16, 16, 416)  1664        conv4_block5_concat[0][0]

conv4_block6_0_relu (Activation (None, 16, 16, 416)  0           conv4_block6_0_bn[0][0]

conv4_block6_1_conv (Conv2D)    (None, 16, 16, 128)  53248       conv4_block6_0_relu[0][0]

conv4_block6_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block6_1_conv[0][0]

conv4_block6_1_relu (Activation (None, 16, 16, 128)  0           conv4_block6_1_bn[0][0]

conv4_block6_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block6_1_relu[0][0]

conv4_block6_concat (Concatenat (None, 16, 16, 448)  0           conv4_block5_concat[0][0]
                                                                  conv4_block6_2_conv[0][0]
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conv4_block7_0_bn (BatchNormali	(None, 16, 16, 448)	1792	conv4_block6_concat[0][0]	
conv4_block7_0_relu (Activation	(None, 16, 16, 448)	0	conv4_block7_0_bn[0][0]	
conv4_block7_1_conv (Conv2D)	(None, 16, 16, 128)	57344	conv4_block7_0_relu[0][0]	
conv4_block7_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block7_1_conv[0][0]	
conv4_block7_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block7_1_bn[0][0]	
conv4_block7_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block7_1_relu[0][0]	
conv4_block7_concat (Concatenat	(None, 16, 16, 480)	0	conv4_block6_concat[0][0] conv4_block7_2_conv[0][0]	
conv4_block8_0_bn (BatchNormali	(None, 16, 16, 480)	1920	conv4_block7_concat[0][0]	
conv4_block8_0_relu (Activation	(None, 16, 16, 480)	0	conv4_block8_0_bn[0][0]	
conv4_block8_1_conv (Conv2D)	(None, 16, 16, 128)	61440	conv4_block8_0_relu[0][0]	
conv4_block8_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block8_1_conv[0][0]	
conv4_block8_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block8_1_bn[0][0]	
conv4_block8_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block8_1_relu[0][0]	
conv4_block8_concat (Concatenat	(None, 16, 16, 512)	0	conv4_block7_concat[0][0] conv4_block8_2_conv[0][0]	
conv4_block9_0_bn (BatchNormali	(None, 16, 16, 512)	2048	conv4_block8_concat[0][0]	
conv4_block9_0_relu (Activation	(None, 16, 16, 512)	0	conv4_block9_0_bn[0][0]	
conv4_block9_1_conv (Conv2D)	(None, 16, 16, 128)	65536	conv4_block9_0_relu[0][0]	
conv4_block9_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block9_1_conv[0][0]	
conv4_block9_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block9_1_bn[0][0]	
conv4_block9_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block9_1_relu[0][0]	
conv4_block9_concat (Concatenat	(None, 16, 16, 544)	0	conv4_block8_concat[0][0] conv4_block9_2_conv[0][0]	
conv4_block10_0_bn (BatchNormal	(None, 16, 16, 544)	2176	conv4_block9_concat[0][0]	
conv4_block10_0_relu (Activatio	(None, 16, 16, 544)	0	conv4_block10_0_bn[0][0]	
conv4_block10_1_conv (Conv2D)	(None, 16, 16, 128)	69632	conv4_block10_0_relu[0][0]	
conv4_block10_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block10_1_conv[0][0]	
conv4_block10_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block10_1_bn[0][0]	
conv4_block10_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block10_1_relu[0][0]	
conv4_block10_concat (Concatena	(None, 16, 16, 576)	0	conv4_block9_concat[0][0] conv4_block10_2_conv[0][0]	
conv4_block11_0_bn (BatchNormal	(None, 16, 16, 576)	2304	conv4_block10_concat[0][0]	
conv4_block11_0_relu (Activatio	(None, 16, 16, 576)	0	conv4_block11_0_bn[0][0]	
conv4_block11_1_conv (Conv2D)	(None, 16, 16, 128)	73728	conv4_block11_0_relu[0][0]	
conv4_block11_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block11_1_conv[0][0]	
conv4_block11_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block11_1_bn[0][0]	
conv4_block11_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block11_1_relu[0][0]	
conv4_block11_concat (Concatena	(None, 16, 16, 608)	0	conv4_block10_concat[0][0] conv4_block11_2_conv[0][0]	
conv4_block12_0_bn (BatchNormal	(None, 16, 16, 608)	2432	conv4_block11_concat[0][0]	

conv4_block12_0_relu (Activatio	(None, 16, 16, 608)	0	conv4_block12_0_bn[0][0]	
conv4_block12_1_conv (Conv2D)	(None, 16, 16, 128)	77824	conv4_block12_0_relu[0][0]	
conv4_block12_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block12_1_conv[0][0]	
conv4_block12_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block12_1_bn[0][0]	
conv4_block12_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block12_1_relu[0][0]	
conv4_block12_concat (Concatena	(None, 16, 16, 640)	0	conv4_block11_concat[0][0] conv4_block12_2_conv[0][0]	
conv4_block13_0_bn (BatchNormal	(None, 16, 16, 640)	2560	conv4_block12_concat[0][0]	
conv4_block13_0_relu (Activatio	(None, 16, 16, 640)	0	conv4_block13_0_bn[0][0]	
conv4_block13_1_conv (Conv2D)	(None, 16, 16, 128)	81920	conv4_block13_0_relu[0][0]	
conv4_block13_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block13_1_conv[0][0]	
conv4_block13_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block13_1_bn[0][0]	
conv4_block13_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block13_1_relu[0][0]	
conv4_block13_concat (Concatena	(None, 16, 16, 672)	0	conv4_block12_concat[0][0] conv4_block13_2_conv[0][0]	
conv4_block14_0_bn (BatchNormal	(None, 16, 16, 672)	2688	conv4_block13_concat[0][0]	
conv4_block14_0_relu (Activatio	(None, 16, 16, 672)	0	conv4_block14_0_bn[0][0]	
conv4_block14_1_conv (Conv2D)	(None, 16, 16, 128)	86016	conv4_block14_0_relu[0][0]	
conv4_block14_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block14_1_conv[0][0]	
conv4_block14_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block14_1_bn[0][0]	
conv4_block14_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block14_1_relu[0][0]	
conv4_block14_concat (Concatena	(None, 16, 16, 704)	0	conv4_block13_concat[0][0] conv4_block14_2_conv[0][0]	
conv4_block15_0_bn (BatchNormal	(None, 16, 16, 704)	2816	conv4_block14_concat[0][0]	
conv4_block15_0_relu (Activatio	(None, 16, 16, 704)	0	conv4_block15_0_bn[0][0]	
conv4_block15_1_conv (Conv2D)	(None, 16, 16, 128)	90112	conv4_block15_0_relu[0][0]	
conv4_block15_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block15_1_conv[0][0]	
conv4_block15_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block15_1_bn[0][0]	
conv4_block15_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block15_1_relu[0][0]	
conv4_block15_concat (Concatena	(None, 16, 16, 736)	0	conv4_block14_concat[0][0] conv4_block15_2_conv[0][0]	
conv4_block16_0_bn (BatchNormal	(None, 16, 16, 736)	2944	conv4_block15_concat[0][0]	
conv4_block16_0_relu (Activatio	(None, 16, 16, 736)	0	conv4_block16_0_bn[0][0]	
conv4_block16_1_conv (Conv2D)	(None, 16, 16, 128)	94208	conv4_block16_0_relu[0][0]	
conv4_block16_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block16_1_conv[0][0]	
conv4_block16_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block16_1_bn[0][0]	
conv4_block16_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block16_1_relu[0][0]	
conv4_block16_concat (Concatena	(None, 16, 16, 768)	0	conv4_block15_concat[0][0] conv4_block16_2_conv[0][0]	
conv4_block17_0_bn (BatchNormal	(None, 16, 16, 768)	3072	conv4_block16_concat[0][0]	
conv4_block17_0_relu (Activatio	(None, 16, 16, 768)	0	conv4_block17_0_bn[0][0]	

conv4_block17_1_conv (Conv2D)	(None, 16, 16, 128)	98304	conv4_block17_0_relu[0][0]	
conv4_block17_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block17_1_conv[0][0]	
conv4_block17_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block17_1_bn[0][0]	
conv4_block17_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block17_1_relu[0][0]	
conv4_block17_concat (Concatena	(None, 16, 16, 800)	0	conv4_block16_concat[0][0] conv4_block17_2_conv[0][0]	
conv4_block18_0_bn (BatchNormal	(None, 16, 16, 800)	3200	conv4_block17_concat[0][0]	
conv4_block18_0_relu (Activatio	(None, 16, 16, 800)	0	conv4_block18_0_bn[0][0]	
conv4_block18_1_conv (Conv2D)	(None, 16, 16, 128)	102400	conv4_block18_0_relu[0][0]	
conv4_block18_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block18_1_conv[0][0]	
conv4_block18_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block18_1_bn[0][0]	
conv4_block18_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block18_1_relu[0][0]	
conv4_block18_concat (Concatena	(None, 16, 16, 832)	0	conv4_block17_concat[0][0] conv4_block18_2_conv[0][0]	
conv4_block19_0_bn (BatchNormal	(None, 16, 16, 832)	3328	conv4_block18_concat[0][0]	
conv4_block19_0_relu (Activatio	(None, 16, 16, 832)	0	conv4_block19_0_bn[0][0]	
conv4_block19_1_conv (Conv2D)	(None, 16, 16, 128)	106496	conv4_block19_0_relu[0][0]	
conv4_block19_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block19_1_conv[0][0]	
conv4_block19_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block19_1_bn[0][0]	
conv4_block19_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block19_1_relu[0][0]	
conv4_block19_concat (Concatena	(None, 16, 16, 864)	0	conv4_block18_concat[0][0] conv4_block19_2_conv[0][0]	
conv4_block20_0_bn (BatchNormal	(None, 16, 16, 864)	3456	conv4_block19_concat[0][0]	
conv4_block20_0_relu (Activatio	(None, 16, 16, 864)	0	conv4_block20_0_bn[0][0]	
conv4_block20_1_conv (Conv2D)	(None, 16, 16, 128)	110592	conv4_block20_0_relu[0][0]	
conv4_block20_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block20_1_conv[0][0]	
conv4_block20_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block20_1_bn[0][0]	
conv4_block20_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block20_1_relu[0][0]	
conv4_block20_concat (Concatena	(None, 16, 16, 896)	0	conv4_block19_concat[0][0] conv4_block20_2_conv[0][0]	
conv4_block21_0_bn (BatchNormal	(None, 16, 16, 896)	3584	conv4_block20_concat[0][0]	
conv4_block21_0_relu (Activatio	(None, 16, 16, 896)	0	conv4_block21_0_bn[0][0]	
conv4_block21_1_conv (Conv2D)	(None, 16, 16, 128)	114688	conv4_block21_0_relu[0][0]	
conv4_block21_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block21_1_conv[0][0]	
conv4_block21_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block21_1_bn[0][0]	
conv4_block21_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block21_1_relu[0][0]	
conv4_block21_concat (Concatena	(None, 16, 16, 928)	0	conv4_block20_concat[0][0] conv4_block21_2_conv[0][0]	
conv4_block22_0_bn (BatchNormal	(None, 16, 16, 928)	3712	conv4_block21_concat[0][0]	
conv4_block22_0_relu (Activatio	(None, 16, 16, 928)	0	conv4_block22_0_bn[0][0]	
conv4_block22_1_conv (Conv2D)	(None, 16, 16, 128)	118784	conv4_block22_0_relu[0][0]	

conv4_block22_1_conv (Conv2D)	(None, 16, 16, 128)	114764	conv4_block22_0_relu[0][0]
conv4_block22_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block22_1_conv[0][0]
conv4_block22_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block22_1_bn[0][0]
conv4_block22_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block22_1_relu[0][0]
conv4_block22_concat (Concatena	(None, 16, 16, 960)	0	conv4_block21_concat[0][0] conv4_block22_2_conv[0][0]
conv4_block23_0_bn (BatchNormal	(None, 16, 16, 960)	3840	conv4_block22_concat[0][0]
conv4_block23_0_relu (Activatio	(None, 16, 16, 960)	0	conv4_block23_0_bn[0][0]
conv4_block23_1_conv (Conv2D)	(None, 16, 16, 128)	122880	conv4_block23_0_relu[0][0]
conv4_block23_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block23_1_conv[0][0]
conv4_block23_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block23_1_bn[0][0]
conv4_block23_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block23_1_relu[0][0]
conv4_block23_concat (Concatena	(None, 16, 16, 992)	0	conv4_block22_concat[0][0] conv4_block23_2_conv[0][0]
conv4_block24_0_bn (BatchNormal	(None, 16, 16, 992)	3968	conv4_block23_concat[0][0]
conv4_block24_0_relu (Activatio	(None, 16, 16, 992)	0	conv4_block24_0_bn[0][0]
conv4_block24_1_conv (Conv2D)	(None, 16, 16, 128)	126976	conv4_block24_0_relu[0][0]
conv4_block24_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block24_1_conv[0][0]
conv4_block24_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block24_1_bn[0][0]
conv4_block24_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block24_1_relu[0][0]
conv4_block24_concat (Concatena	(None, 16, 16, 1024)	0	conv4_block23_concat[0][0] conv4_block24_2_conv[0][0]
pool4_bn (BatchNormalization)	(None, 16, 16, 1024)	4096	conv4_block24_concat[0][0]
pool4_relu (Activation)	(None, 16, 16, 1024)	0	pool4_bn[0][0]
pool4_conv (Conv2D)	(None, 16, 16, 512)	524288	pool4_relu[0][0]
pool4_pool (AveragePooling2D)	(None, 8, 8, 512)	0	pool4_conv[0][0]
conv5_block1_0_bn (BatchNormali	(None, 8, 8, 512)	2048	pool4_pool[0][0]
conv5_block1_0_relu (Activation	(None, 8, 8, 512)	0	conv5_block1_0_bn[0][0]
conv5_block1_1_conv (Conv2D)	(None, 8, 8, 128)	65536	conv5_block1_0_relu[0][0]
conv5_block1_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block1_1_conv[0][0]
conv5_block1_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block1_1_bn[0][0]
conv5_block1_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block1_1_relu[0][0]
conv5_block1_concat (Concatenat	(None, 8, 8, 544)	0	pool4_pool[0][0] conv5_block1_2_conv[0][0]
conv5_block2_0_bn (BatchNormali	(None, 8, 8, 544)	2176	conv5_block1_concat[0][0]
conv5_block2_0_relu (Activation	(None, 8, 8, 544)	0	conv5_block2_0_bn[0][0]
conv5_block2_1_conv (Conv2D)	(None, 8, 8, 128)	69632	conv5_block2_0_relu[0][0]
conv5_block2_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block2_1_conv[0][0]
conv5_block2_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block2_1_bn[0][0]
conv5_block2_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block2_1_relu[0][0]
conv5_block2_concat (Concatenat	(None, 8, 8, 576)	0	conv5_block1_concat[0][0] conv5_block2_2_conv[0][0]

			conv5_block2_2_conv[0][0]
conv5_block3_0_bn (BatchNormali	(None, 8, 8, 576)	2304	conv5_block2_concat[0][0]
conv5_block3_0_relu (Activation	(None, 8, 8, 576)	0	conv5_block3_0_bn[0][0]
conv5_block3_1_conv (Conv2D)	(None, 8, 8, 128)	73728	conv5_block3_0_relu[0][0]
conv5_block3_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block3_1_conv[0][0]
conv5_block3_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block3_1_bn[0][0]
conv5_block3_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block3_1_relu[0][0]
conv5_block3_concat (Concatenat	(None, 8, 8, 608)	0	conv5_block2_concat[0][0] conv5_block3_2_conv[0][0]
conv5_block4_0_bn (BatchNormali	(None, 8, 8, 608)	2432	conv5_block3_concat[0][0]
conv5_block4_0_relu (Activation	(None, 8, 8, 608)	0	conv5_block4_0_bn[0][0]
conv5_block4_1_conv (Conv2D)	(None, 8, 8, 128)	77824	conv5_block4_0_relu[0][0]
conv5_block4_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block4_1_conv[0][0]
conv5_block4_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block4_1_bn[0][0]
conv5_block4_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block4_1_relu[0][0]
conv5_block4_concat (Concatenat	(None, 8, 8, 640)	0	conv5_block3_concat[0][0] conv5_block4_2_conv[0][0]
conv5_block5_0_bn (BatchNormali	(None, 8, 8, 640)	2560	conv5_block4_concat[0][0]
conv5_block5_0_relu (Activation	(None, 8, 8, 640)	0	conv5_block5_0_bn[0][0]
conv5_block5_1_conv (Conv2D)	(None, 8, 8, 128)	81920	conv5_block5_0_relu[0][0]
conv5_block5_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block5_1_conv[0][0]
conv5_block5_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block5_1_bn[0][0]
conv5_block5_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block5_1_relu[0][0]
conv5_block5_concat (Concatenat	(None, 8, 8, 672)	0	conv5_block4_concat[0][0] conv5_block5_2_conv[0][0]
conv5_block6_0_bn (BatchNormali	(None, 8, 8, 672)	2688	conv5_block5_concat[0][0]
conv5_block6_0_relu (Activation	(None, 8, 8, 672)	0	conv5_block6_0_bn[0][0]
conv5_block6_1_conv (Conv2D)	(None, 8, 8, 128)	86016	conv5_block6_0_relu[0][0]
conv5_block6_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block6_1_conv[0][0]
conv5_block6_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block6_1_bn[0][0]
conv5_block6_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block6_1_relu[0][0]
conv5_block6_concat (Concatenat	(None, 8, 8, 704)	0	conv5_block5_concat[0][0] conv5_block6_2_conv[0][0]
conv5_block7_0_bn (BatchNormali	(None, 8, 8, 704)	2816	conv5_block6_concat[0][0]
conv5_block7_0_relu (Activation	(None, 8, 8, 704)	0	conv5_block7_0_bn[0][0]
conv5_block7_1_conv (Conv2D)	(None, 8, 8, 128)	90112	conv5_block7_0_relu[0][0]
conv5_block7_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block7_1_conv[0][0]
conv5_block7_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block7_1_bn[0][0]
conv5_block7_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block7_1_relu[0][0]
conv5_block7_concat (Concatenat	(None, 8, 8, 736)	0	conv5_block6_concat[0][0] conv5_block7_2_conv[0][0]
conv5_block8_0_bn (BatchNormali	(None, 8, 8, 736)	2944	conv5_block7_concat[0][0]

conv5_block8_0_bn (BatchNormali	(None, 8, 8, 736)	2944	conv5_block7_concat[0][0]
conv5_block8_0_relu (Activation	(None, 8, 8, 736)	0	conv5_block8_0_bn[0][0]
conv5_block8_1_conv (Conv2D)	(None, 8, 8, 128)	94208	conv5_block8_0_relu[0][0]
conv5_block8_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block8_1_conv[0][0]
conv5_block8_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block8_1_bn[0][0]
conv5_block8_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block8_1_relu[0][0]
conv5_block8_concat (Concatenat	(None, 8, 8, 768)	0	conv5_block7_concat[0][0] conv5_block8_2_conv[0][0]
conv5_block9_0_bn (BatchNormali	(None, 8, 8, 768)	3072	conv5_block8_concat[0][0]
conv5_block9_0_relu (Activation	(None, 8, 8, 768)	0	conv5_block9_0_bn[0][0]
conv5_block9_1_conv (Conv2D)	(None, 8, 8, 128)	98304	conv5_block9_0_relu[0][0]
conv5_block9_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block9_1_conv[0][0]
conv5_block9_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block9_1_bn[0][0]
conv5_block9_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block9_1_relu[0][0]
conv5_block9_concat (Concatenat	(None, 8, 8, 800)	0	conv5_block8_concat[0][0] conv5_block9_2_conv[0][0]
conv5_block10_0_bn (BatchNormal	(None, 8, 8, 800)	3200	conv5_block9_concat[0][0]
conv5_block10_0_relu (Activatio	(None, 8, 8, 800)	0	conv5_block10_0_bn[0][0]
conv5_block10_1_conv (Conv2D)	(None, 8, 8, 128)	102400	conv5_block10_0_relu[0][0]
conv5_block10_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block10_1_conv[0][0]
conv5_block10_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block10_1_bn[0][0]
conv5_block10_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block10_1_relu[0][0]
conv5_block10_concat (Concatena	(None, 8, 8, 832)	0	conv5_block9_concat[0][0] conv5_block10_2_conv[0][0]
conv5_block11_0_bn (BatchNormal	(None, 8, 8, 832)	3328	conv5_block10_concat[0][0]
conv5_block11_0_relu (Activatio	(None, 8, 8, 832)	0	conv5_block11_0_bn[0][0]
conv5_block11_1_conv (Conv2D)	(None, 8, 8, 128)	106496	conv5_block11_0_relu[0][0]
conv5_block11_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block11_1_conv[0][0]
conv5_block11_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block11_1_bn[0][0]
conv5_block11_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block11_1_relu[0][0]
conv5_block11_concat (Concatena	(None, 8, 8, 864)	0	conv5_block10_concat[0][0] conv5_block11_2_conv[0][0]
conv5_block12_0_bn (BatchNormal	(None, 8, 8, 864)	3456	conv5_block11_concat[0][0]
conv5_block12_0_relu (Activatio	(None, 8, 8, 864)	0	conv5_block12_0_bn[0][0]
conv5_block12_1_conv (Conv2D)	(None, 8, 8, 128)	110592	conv5_block12_0_relu[0][0]
conv5_block12_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block12_1_conv[0][0]
conv5_block12_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block12_1_bn[0][0]
conv5_block12_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block12_1_relu[0][0]
conv5_block12_concat (Concatena	(None, 8, 8, 896)	0	conv5_block11_concat[0][0] conv5_block12_2_conv[0][0]
conv5_block13_0_bn (BatchNormal	(None, 8, 8, 896)	3584	conv5_block12_concat[0][0]
conv5_block13_0_relu (Activatio	(None, 8, 8, 896)	0	conv5_block13_0_bn[0][0]

conv5_block13_0_relu (Activatio	(None, 8, 8, 896)	0	conv5_block13_0_bn[0][0]
conv5_block13_1_conv (Conv2D)	(None, 8, 8, 128)	114688	conv5_block13_0_relu[0][0]
conv5_block13_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block13_1_conv[0][0]
conv5_block13_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block13_1_bn[0][0]
conv5_block13_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block13_1_relu[0][0]
conv5_block13_concat (Concatena	(None, 8, 8, 928)	0	conv5_block12_concat[0][0] conv5_block13_2_conv[0][0]
conv5_block14_0_bn (BatchNormal	(None, 8, 8, 928)	3712	conv5_block13_concat[0][0]
conv5_block14_0_relu (Activatio	(None, 8, 8, 928)	0	conv5_block14_0_bn[0][0]
conv5_block14_1_conv (Conv2D)	(None, 8, 8, 128)	118784	conv5_block14_0_relu[0][0]
conv5_block14_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block14_1_conv[0][0]
conv5_block14_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block14_1_bn[0][0]
conv5_block14_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block14_1_relu[0][0]
conv5_block14_concat (Concatena	(None, 8, 8, 960)	0	conv5_block13_concat[0][0] conv5_block14_2_conv[0][0]
conv5_block15_0_bn (BatchNormal	(None, 8, 8, 960)	3840	conv5_block14_concat[0][0]
conv5_block15_0_relu (Activatio	(None, 8, 8, 960)	0	conv5_block15_0_bn[0][0]
conv5_block15_1_conv (Conv2D)	(None, 8, 8, 128)	122880	conv5_block15_0_relu[0][0]
conv5_block15_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block15_1_conv[0][0]
conv5_block15_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block15_1_bn[0][0]
conv5_block15_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block15_1_relu[0][0]
conv5_block15_concat (Concatena	(None, 8, 8, 992)	0	conv5_block14_concat[0][0] conv5_block15_2_conv[0][0]
conv5_block16_0_bn (BatchNormal	(None, 8, 8, 992)	3968	conv5_block15_concat[0][0]
conv5_block16_0_relu (Activatio	(None, 8, 8, 992)	0	conv5_block16_0_bn[0][0]
conv5_block16_1_conv (Conv2D)	(None, 8, 8, 128)	126976	conv5_block16_0_relu[0][0]
conv5_block16_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block16_1_conv[0][0]
conv5_block16_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block16_1_bn[0][0]
conv5_block16_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block16_1_relu[0][0]
conv5_block16_concat (Concatena	(None, 8, 8, 1024)	0	conv5_block15_concat[0][0] conv5_block16_2_conv[0][0]
bn (BatchNormalization)	(None, 8, 8, 1024)	4096	conv5_block16_concat[0][0]
relu (Activation)	(None, 8, 8, 1024)	0	bn[0][0]
up_sampling2d (UpSampling2D)	(None, 16, 16, 1024)	0	relu[0][0]
concatenate (Concatenate)	(None, 16, 16, 1536)	0	up_sampling2d[0][0] pool4_conv[0][0]
conv2d (Conv2D)	(None, 16, 16, 256)	3538944	concatenate[0][0]
batch_normalization (BatchNorma	(None, 16, 16, 256)	1024	conv2d[0][0]
activation (Activation)	(None, 16, 16, 256)	0	batch_normalization[0][0]
conv2d_1 (Conv2D)	(None, 16, 16, 256)	589824	activation[0][0]
batch_normalization_1 (BatchNor	(None, 16, 16, 256)	1024	conv2d_1[0][0]
[illegible]	[illegible]	[illegible]	[illegible]

```
activation_1 (Activation)       (None, 16, 16, 256)  0           batch_normalization_1[0][0]
__________________________________________________________________________________________________
up_sampling2d_1 (UpSampling2D)  (None, 32, 32, 256)  0           activation_1[0][0]
__________________________________________________________________________________________________
concatenate_1 (Concatenate)     (None, 32, 32, 512)  0           up_sampling2d_1[0][0]
                                                                 pool3_conv[0][0]
__________________________________________________________________________________________________
conv2d_2 (Conv2D)               (None, 32, 32, 128)  589824      concatenate_1[0][0]
__________________________________________________________________________________________________
batch_normalization_2 (BatchNor (None, 32, 32, 128)  512         conv2d_2[0][0]
__________________________________________________________________________________________________
activation_2 (Activation)       (None, 32, 32, 128)  0           batch_normalization_2[0][0]
__________________________________________________________________________________________________
conv2d_3 (Conv2D)               (None, 32, 32, 128)  147456      activation_2[0][0]
__________________________________________________________________________________________________
batch_normalization_3 (BatchNor (None, 32, 32, 128)  512         conv2d_3[0][0]
__________________________________________________________________________________________________
activation_3 (Activation)       (None, 32, 32, 128)  0           batch_normalization_3[0][0]
__________________________________________________________________________________________________
up_sampling2d_2 (UpSampling2D)  (None, 64, 64, 128)  0           activation_3[0][0]
__________________________________________________________________________________________________
concatenate_2 (Concatenate)     (None, 64, 64, 256)  0           up_sampling2d_2[0][0]
                                                                 pool2_conv[0][0]
__________________________________________________________________________________________________
conv2d_4 (Conv2D)               (None, 64, 64, 64)   147456      concatenate_2[0][0]
__________________________________________________________________________________________________
batch_normalization_4 (BatchNor (None, 64, 64, 64)   256         conv2d_4[0][0]
__________________________________________________________________________________________________
activation_4 (Activation)       (None, 64, 64, 64)   0           batch_normalization_4[0][0]
__________________________________________________________________________________________________
conv2d_5 (Conv2D)               (None, 64, 64, 64)   36864       activation_4[0][0]
__________________________________________________________________________________________________
batch_normalization_5 (BatchNor (None, 64, 64, 64)   256         conv2d_5[0][0]
__________________________________________________________________________________________________
activation_5 (Activation)       (None, 64, 64, 64)   0           batch_normalization_5[0][0]
__________________________________________________________________________________________________
up_sampling2d_3 (UpSampling2D)  (None, 128, 128, 64) 0           activation_5[0][0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 128, 128, 128 0           up_sampling2d_3[0][0]
                                                                 conv1/relu[0][0]
__________________________________________________________________________________________________
conv2d_6 (Conv2D)               (None, 128, 128, 32) 36864       concatenate_3[0][0]
__________________________________________________________________________________________________
batch_normalization_6 (BatchNor (None, 128, 128, 32) 128         conv2d_6[0][0]
__________________________________________________________________________________________________
activation_6 (Activation)       (None, 128, 128, 32) 0           batch_normalization_6[0][0]
__________________________________________________________________________________________________
conv2d_7 (Conv2D)               (None, 128, 128, 32) 9216        activation_6[0][0]
__________________________________________________________________________________________________
batch_normalization_7 (BatchNor (None, 128, 128, 32) 128         conv2d_7[0][0]
__________________________________________________________________________________________________
activation_7 (Activation)       (None, 128, 128, 32) 0           batch_normalization_7[0][0]
__________________________________________________________________________________________________
up_sampling2d_4 (UpSampling2D)  (None, 256, 256, 32) 0           activation_7[0][0]
__________________________________________________________________________________________________
conv2d_8 (Conv2D)               (None, 256, 256, 16) 4608        up_sampling2d_4[0][0]
__________________________________________________________________________________________________
batch_normalization_8 (BatchNor (None, 256, 256, 16) 64          conv2d_8[0][0]
__________________________________________________________________________________________________
activation_8 (Activation)       (None, 256, 256, 16) 0           batch_normalization_8[0][0]
__________________________________________________________________________________________________
conv2d_9 (Conv2D)               (None, 256, 256, 16) 2304        activation_8[0][0]
__________________________________________________________________________________________________
batch_normalization_9 (BatchNor (None, 256, 256, 16) 64          conv2d_9[0][0]
__________________________________________________________________________________________________
activation_9 (Activation)       (None, 256, 256, 16) 0           batch_normalization_9[0][0]
__________________________________________________________________________________________________
conv2d_10 (Conv2D)              (None, 256, 256, 1)  145         activation_9[0][0]
__________________________________________________________________________________________________
activation_10 (Activation)      (None, 256, 256, 1)  0           conv2d_10[0][0]
==================================================================================================
Total params: 12,144,977
Trainable params: 12,059,345
Non-trainable params: 85,632
__________________________________________________________________________________________________
```

In [32]:

```
train_dataset = train_ds.batch(16).cache().prefetch(1920)
test_dataset=val_ds.batch(16).cache().prefetch(1920)
```

We are decreasing the batch size because Google colab GPU tensor OOM(out of memory) error

In [33]:

```
tf.keras.backend.clear_session()
# Tensorbaord
logdir = os.path.join("/content/drive/My Drive/logs","unet_chexnet01")
tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)
%tensorboard --logdir='/content/drive/My Drive/logs/unet_chexnet01/'
unet_chexnet_model.fit(train_dataset,epochs=10,batch_size=16,validation_data=test_dataset,callbacks
=[tensorboard_callback,checkpoint])
```

```
Epoch 1/10
  2/120 [..............................] - ETA: 2:33 - loss: 0.7763 - accuracy: 0.5244 -
dice_coef: 0.0320WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the
batch time (batch time: 0.2528s vs `on_train_batch_end` time: 2.3434s). Check your callbacks.
120/120 [==============================] - ETA: 0s - loss: 0.1386 - accuracy: 0.9725 - dice_coef:
0.0682
Epoch 00001: val_dice_coef improved from -inf to 0.05896, saving model to /content/drive/My
Drive/model_save/weights-01-0.0590.hdf5
120/120 [==============================] - 63s 522ms/step - loss: 0.1386 - accuracy: 0.9725 - dice
_coef: 0.0682 - val_loss: 0.1317 - val_accuracy: 0.9858 - val_dice_coef: 0.0590
Epoch 2/10
119/120 [============================>.] - ETA: 0s - loss: 0.0462 - accuracy: 0.9868 - dice_coef:
0.1821
Epoch 00002: val_dice_coef improved from 0.05896 to 0.16600, saving model to /content/drive/My Dri
ve/model_save/weights-02-0.1660.hdf5
120/120 [==============================] - 28s 232ms/step - loss: 0.0462 - accuracy: 0.9868 - dice
_coef: 0.1821 - val_loss: 0.0771 - val_accuracy: 0.9758 - val_dice_coef: 0.1660
Epoch 3/10
119/120 [============================>.] - ETA: 0s - loss: 0.0353 - accuracy: 0.9886 - dice_coef:
0.2877
Epoch 00003: val_dice_coef improved from 0.16600 to 0.28349, saving model to /content/drive/My Dri
ve/model_save/weights-03-0.2835.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0353 - accuracy: 0.9886 - dice
_coef: 0.2882 - val_loss: 0.0436 - val_accuracy: 0.9845 - val_dice_coef: 0.2835
Epoch 4/10
119/120 [============================>.] - ETA: 0s - loss: 0.0294 - accuracy: 0.9897 - dice_coef:
0.3889
Epoch 00004: val_dice_coef improved from 0.28349 to 0.31612, saving model to /content/drive/My Dri
ve/model_save/weights-04-0.3161.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0294 - accuracy: 0.9897 - dice
_coef: 0.3894 - val_loss: 0.0489 - val_accuracy: 0.9840 - val_dice_coef: 0.3161
Epoch 5/10
119/120 [============================>.] - ETA: 0s - loss: 0.0260 - accuracy: 0.9907 - dice_coef:
0.4557
Epoch 00005: val_dice_coef improved from 0.31612 to 0.34715, saving model to /content/drive/My Dri
ve/model_save/weights-05-0.3471.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0260 - accuracy: 0.9907 - dice
_coef: 0.4550 - val_loss: 0.0471 - val_accuracy: 0.9851 - val_dice_coef: 0.3471
Epoch 6/10
119/120 [============================>.] - ETA: 0s - loss: 0.0247 - accuracy: 0.9910 - dice_coef:
0.4794
Epoch 00006: val_dice_coef improved from 0.34715 to 0.36597, saving model to /content/drive/My Dri
ve/model_save/weights-06-0.3660.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0247 - accuracy: 0.9910 - dice
_coef: 0.4795 - val_loss: 0.0480 - val_accuracy: 0.9840 - val_dice_coef: 0.3660
Epoch 7/10
120/120 [==============================] - ETA: 0s - loss: 0.0217 - accuracy: 0.9919 - dice_coef:
0.5342
Epoch 00007: val_dice_coef improved from 0.36597 to 0.39661, saving model to /content/drive/My Dri
ve/model_save/weights-07-0.3966.hdf5
120/120 [==============================] - 28s 234ms/step - loss: 0.0217 - accuracy: 0.9919 - dice
_coef: 0.5342 - val_loss: 0.0508 - val_accuracy: 0.9838 - val_dice_coef: 0.3966
Epoch 8/10
120/120 [==============================] - ETA: 0s - loss: 0.0187 - accuracy: 0.9929 - dice_coef:
0.5919
Epoch 00008: val_dice_coef improved from 0.39661 to 0.41880, saving model to /content/drive/My Dri
ve/model_save/weights-08-0.4188.hdf5
```

```
120/120 [==============================] - 28s 233ms/step - loss: 0.0187 - accuracy: 0.9929 - dice
_coef: 0.5919 - val_loss: 0.0524 - val_accuracy: 0.9831 - val_dice_coef: 0.4188
Epoch 9/10
119/120 [============================>.] - ETA: 0s - loss: 0.0176 - accuracy: 0.9933 - dice_coef:
0.6153
Epoch 00009: val_dice_coef improved from 0.41880 to 0.42960, saving model to /content/drive/My Dri
ve/model_save/weights-09-0.4296.hdf5
120/120 [==============================] - 28s 234ms/step - loss: 0.0176 - accuracy: 0.9933 - dice
_coef: 0.6157 - val_loss: 0.0538 - val_accuracy: 0.9827 - val_dice_coef: 0.4296
Epoch 10/10
119/120 [============================>.] - ETA: 0s - loss: 0.0165 - accuracy: 0.9936 - dice_coef:
0.6357
Epoch 00010: val_dice_coef did not improve from 0.42960
120/120 [==============================] - 25s 211ms/step - loss: 0.0165 - accuracy: 0.9936 - dice
_coef: 0.6362 - val_loss: 0.0545 - val_accuracy: 0.9833 - val_dice_coef: 0.4223
```

Out[33]:

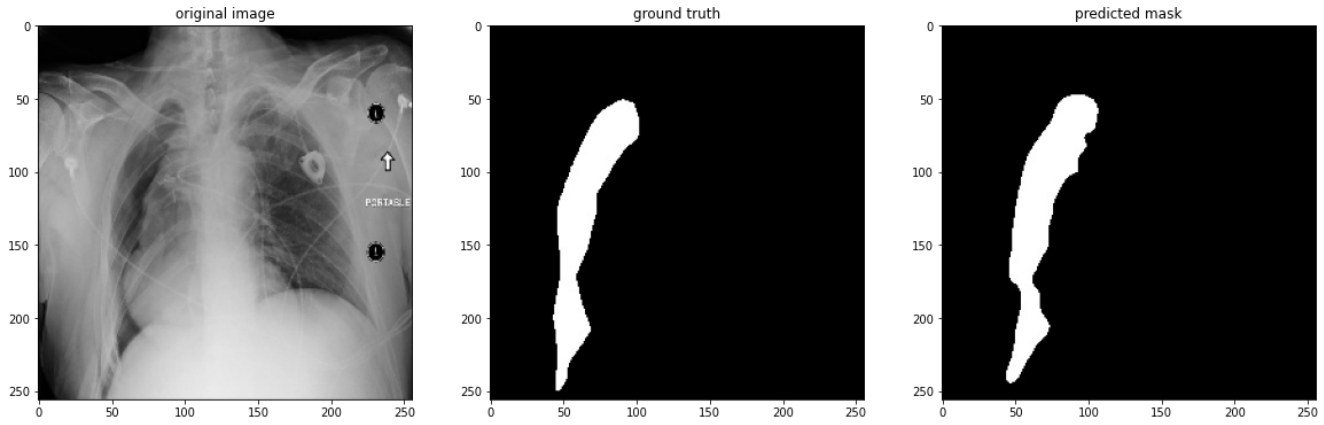
```
<tensorflow.python.keras.callbacks.History at 0x7f4bd02b23c8>
```

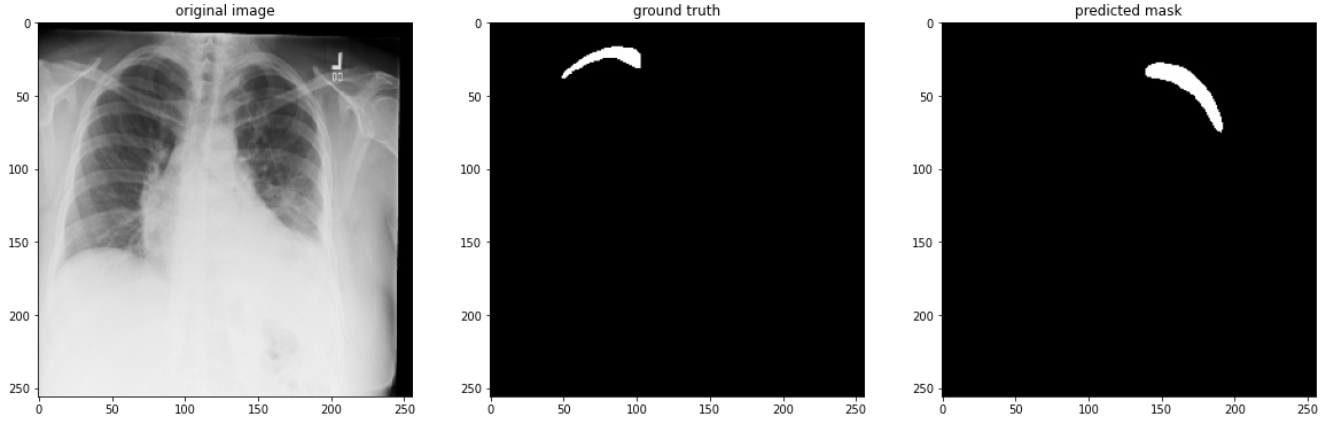
In [ ]:

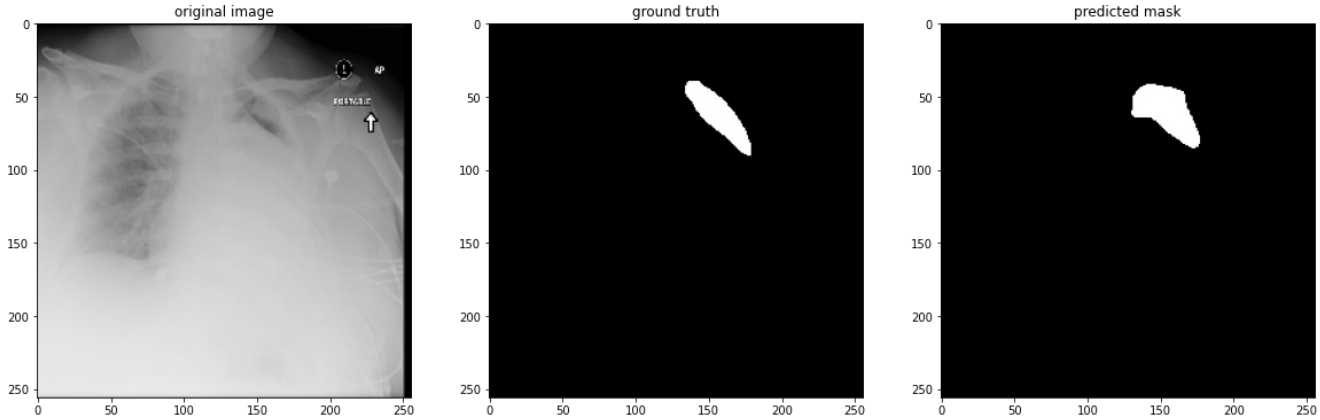
```
unet_chexnet_model.load_weights('/content/drive/My Drive/model_save/weights-09-0.4296.hdf5')
```

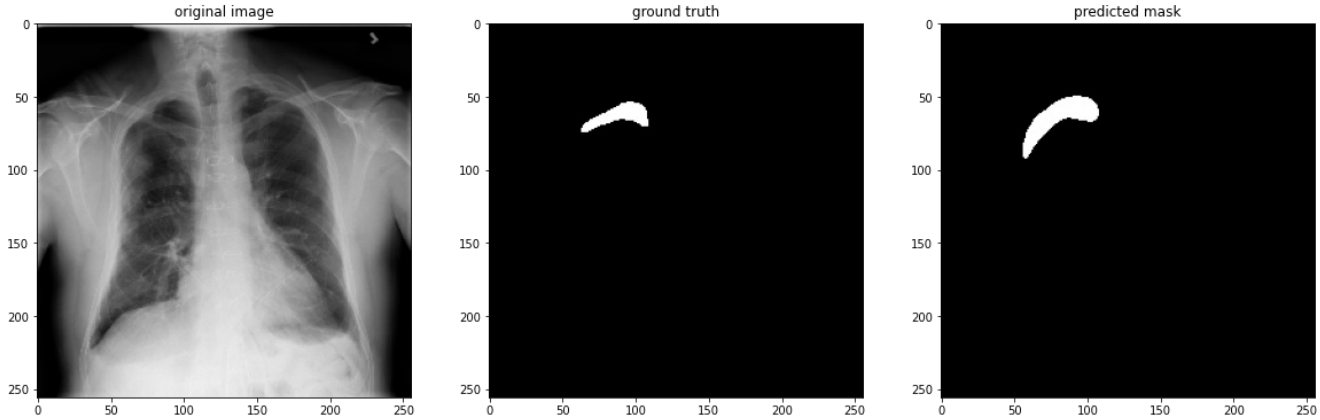
In [ ]:

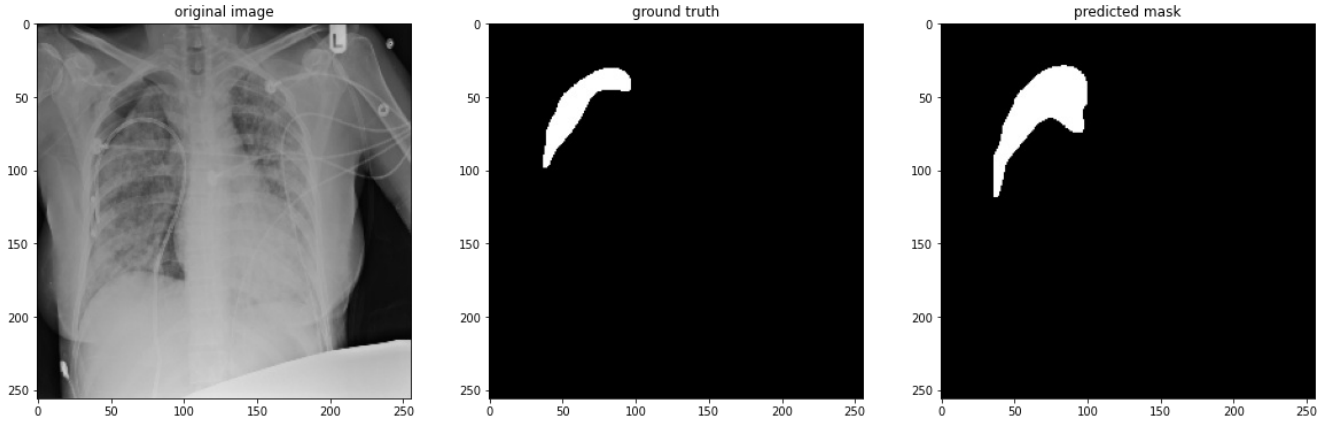
```
for i,j in test_dataset.take(5):
  a=unet_chexnet_model.predict(i)
  preds_val_t = (a[0]>0.5).astype(np.uint8)
  plt.figure(figsize=(20,6))
  plt.subplot(131)
  plt.title("original image")
  plt.imshow(np.squeeze(i[0]),cmap='gray')
  plt.subplot(132)
  plt.title("ground truth")
  plt.imshow(np.squeeze(j[0]),cmap='gray')
  plt.subplot(133)
  plt.title("predicted mask")
  plt.imshow(np.squeeze(preds_val_t).astype(np.uint8),cmap='gray')
  plt.show()
```











- So far with data augumentation we got decent results with an IOU score of 0.426. The model is also able to roughly segment the area affected even though it is not perfect.
- Data augumentation has been used here to avoid overfitting and maybe provide better performance by contrasting the images and other image augumentations .

- Let us try training the same model without augumentations and observe the performance.

Training Unet(Backbone-Chexnet) model without data augumentation

In [ ]:

```
def decode_img(img):
# convert the compressed string to a 3D uint8 tensor
#image_bytes = tf.io.read_file(img)
  image = tfio.image.decode_dicom_image(img, dtype=tf.uint8,color_dim=True,scale='preserve')
  image = tf.image.convert_image_dtype(image, tf.float32)#converting the image to tf.float32
  image=tf.squeeze(image,[0]) #squeezing the image because the file is of the shape(1,1024,1024,1)
and we want (1024,1024,3)
  b = tf.constant([1,1,3], tf.int32)
```

```
  image=tf.tile(image,b)#the image is of the shape (1024,1024,1) to make it (1024,1024,3) I am
using tf.tile
  image=tf.image.resize(image,size=[256,256]) # resize the image to the desired size
  return image
```

In [ ]:

```
def process_path(file_path,label):
  img = tf.io.read_file(file_path) #reading the image from the file path
  img = decode_img(img) #passing the image to the function
  return img,label
```

In [34]:

```
train_ds = tf.data.Dataset.from_tensor_slices((train_path,train_mask))
train_ds = train_ds.shuffle(len(train_path),seed=42)

test_ds = tf.data.Dataset.from_tensor_slices((test_path,test_mask))
test_ds = test_ds.shuffle(len(test_path),seed=42)
```

In [35]:

```
import keras.backend as K
AUTOTUNE = tf.data.experimental.AUTOTUNE
train_ds = train_ds.map(process_path,num_parallel_calls=AUTOTUNE) #mapping the file paths to the
above function
val_ds = test_ds.map(process_path,num_parallel_calls=AUTOTUNE)
```

In [36]:

```
def set_shapes(img, label, img_shape=(256,256,3)):
    img.set_shape(img_shape)
    label.set_shape((256,256,1))
    return img, label
```

In [37]:

```
train_ds = train_ds.map(set_shapes, num_parallel_calls=AUTOTUNE)
val_ds = val_ds.map(set_shapes, num_parallel_calls=AUTOTUNE)
```

In [48]:

```
train_dataset = train_ds.batch(16).cache().prefetch(1920)
test_dataset=val_ds.batch(16).cache().prefetch(1920)
```

In [ ]:

```
%load_ext tensorboard
```

In [47]:

```
from tensorflow.keras import Model

dense_net_121 = tf.keras.applications.DenseNet121(input_shape=[256,256,3],include_top=False,pooling
='avg')
base_model_output = tf.keras.layers.Dense(units=14,activation='relu')(dense_net_121.output)
base_model = Model(inputs = dense_net_121.input,outputs=base_model_output)
base_model.load_weights('brucechou1983_CheXNet_Keras_0.3.0_weights.h5')
output_layer = tf.keras.layers.Dense(1,activation='sigmoid')(base_model.layers[-2].output)
model = Model(inputs=base_model.inputs, outputs=output_layer)
model1=tf.keras.layers.UpSampling2D((2,2))(model.layers[-3].output)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool4_conv').output])
model1=tf.keras.layers.Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
```

```
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool3_conv').output])
model1=tf.keras.layers.Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool2_conv').output])
model1=tf.keras.layers.Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('conv1/relu').output])
model1=tf.keras.layers.Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(1,(3,3),padding='same',use_bias=True,kernel_initializer='glorot_uniform')(model1)
model1=tf.keras.layers.Activation('sigmoid')(model1)


unet_chexnet_model=Model(inputs=model.inputs, outputs=model1)
unet_chexnet_model.compile(optimizer=tf.keras.optimizers.Adam(lr=0.0001),
loss='binary_crossentropy', metrics=['accuracy',dice_coef])
unet_chexnet_model.summary()
```

```
Model: "functional_5"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)            [(None, 256, 256, 3) 0
__________________________________________________________________________________________________
zero_padding2d (ZeroPadding2D)  (None, 262, 262, 3)  0           input_1[0][0]
__________________________________________________________________________________________________
conv1/conv (Conv2D)             (None, 128, 128, 64) 9408        zero_padding2d[0][0]
__________________________________________________________________________________________________
conv1/bn (BatchNormalization)   (None, 128, 128, 64) 256         conv1/conv[0][0]
__________________________________________________________________________________________________
conv1/relu (Activation)         (None, 128, 128, 64) 0           conv1/bn[0][0]
__________________________________________________________________________________________________
zero_padding2d_1 (ZeroPadding2D (None, 130, 130, 64) 0           conv1/relu[0][0]
__________________________________________________________________________________________________
pool1 (MaxPooling2D)            (None, 64, 64, 64)   0           zero_padding2d_1[0][0]
__________________________________________________________________________________________________
conv2_block1_0_bn (BatchNormali (None, 64, 64, 64)   256         pool1[0][0]
__________________________________________________________________________________________________
conv2_block1_0_relu (Activation (None, 64, 64, 64)   0           conv2_block1_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block1_1_conv (Conv2D)    (None, 64, 64, 128)  8192        conv2_block1_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block1_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block1_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block1_1_relu (Activation (None, 64, 64, 128)  0           conv2_block1_1_bn[0][0]
```

conv2_block1_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block1_1_relu[0][0]	
conv2_block1_concat (Concatenat	(None, 64, 64, 96)	0	pool1[0][0] conv2_block1_2_conv[0][0]	
conv2_block2_0_bn (BatchNormali	(None, 64, 64, 96)	384	conv2_block1_concat[0][0]	
conv2_block2_0_relu (Activation	(None, 64, 64, 96)	0	conv2_block2_0_bn[0][0]	
conv2_block2_1_conv (Conv2D)	(None, 64, 64, 128)	12288	conv2_block2_0_relu[0][0]	
conv2_block2_1_bn (BatchNormali	(None, 64, 64, 128)	512	conv2_block2_1_conv[0][0]	
conv2_block2_1_relu (Activation	(None, 64, 64, 128)	0	conv2_block2_1_bn[0][0]	
conv2_block2_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block2_1_relu[0][0]	
conv2_block2_concat (Concatenat	(None, 64, 64, 128)	0	conv2_block1_concat[0][0] conv2_block2_2_conv[0][0]	
conv2_block3_0_bn (BatchNormali	(None, 64, 64, 128)	512	conv2_block2_concat[0][0]	
conv2_block3_0_relu (Activation	(None, 64, 64, 128)	0	conv2_block3_0_bn[0][0]	
conv2_block3_1_conv (Conv2D)	(None, 64, 64, 128)	16384	conv2_block3_0_relu[0][0]	
conv2_block3_1_bn (BatchNormali	(None, 64, 64, 128)	512	conv2_block3_1_conv[0][0]	
conv2_block3_1_relu (Activation	(None, 64, 64, 128)	0	conv2_block3_1_bn[0][0]	
conv2_block3_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block3_1_relu[0][0]	
conv2_block3_concat (Concatenat	(None, 64, 64, 160)	0	conv2_block2_concat[0][0] conv2_block3_2_conv[0][0]	
conv2_block4_0_bn (BatchNormali	(None, 64, 64, 160)	640	conv2_block3_concat[0][0]	
conv2_block4_0_relu (Activation	(None, 64, 64, 160)	0	conv2_block4_0_bn[0][0]	
conv2_block4_1_conv (Conv2D)	(None, 64, 64, 128)	20480	conv2_block4_0_relu[0][0]	
conv2_block4_1_bn (BatchNormali	(None, 64, 64, 128)	512	conv2_block4_1_conv[0][0]	
conv2_block4_1_relu (Activation	(None, 64, 64, 128)	0	conv2_block4_1_bn[0][0]	
conv2_block4_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block4_1_relu[0][0]	
conv2_block4_concat (Concatenat	(None, 64, 64, 192)	0	conv2_block3_concat[0][0] conv2_block4_2_conv[0][0]	
conv2_block5_0_bn (BatchNormali	(None, 64, 64, 192)	768	conv2_block4_concat[0][0]	
conv2_block5_0_relu (Activation	(None, 64, 64, 192)	0	conv2_block5_0_bn[0][0]	
conv2_block5_1_conv (Conv2D)	(None, 64, 64, 128)	24576	conv2_block5_0_relu[0][0]	
conv2_block5_1_bn (BatchNormali	(None, 64, 64, 128)	512	conv2_block5_1_conv[0][0]	
conv2_block5_1_relu (Activation	(None, 64, 64, 128)	0	conv2_block5_1_bn[0][0]	
conv2_block5_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block5_1_relu[0][0]	
conv2_block5_concat (Concatenat	(None, 64, 64, 224)	0	conv2_block4_concat[0][0] conv2_block5_2_conv[0][0]	
conv2_block6_0_bn (BatchNormali	(None, 64, 64, 224)	896	conv2_block5_concat[0][0]	
conv2_block6_0_relu (Activation	(None, 64, 64, 224)	0	conv2_block6_0_bn[0][0]	
conv2_block6_1_conv (Conv2D)	(None, 64, 64, 128)	28672	conv2_block6_0_relu[0][0]	
conv2_block6_1_bn (BatchNormali	(None, 64, 64, 128)	512	conv2_block6_1_conv[0][0]	
conv2_block6_1_relu (Activation	(None, 64, 64, 128)	0	conv2_block6_1_bn[0][0]	
conv2_block6_2_conv (Conv2D)	(None, 64, 64, 32)	36864	conv2_block6_1_relu[0][0]	

conv2_block6_concat (Concatenat	(None, 64, 64, 256)	0	conv2_block5_concat[0][0] conv2_block6_2_conv[0][0]
pool2_bn (BatchNormalization)	(None, 64, 64, 256)	1024	conv2_block6_concat[0][0]
pool2_relu (Activation)	(None, 64, 64, 256)	0	pool2_bn[0][0]
pool2_conv (Conv2D)	(None, 64, 64, 128)	32768	pool2_relu[0][0]
pool2_pool (AveragePooling2D)	(None, 32, 32, 128)	0	pool2_conv[0][0]
conv3_block1_0_bn (BatchNormali	(None, 32, 32, 128)	512	pool2_pool[0][0]
conv3_block1_0_relu (Activation	(None, 32, 32, 128)	0	conv3_block1_0_bn[0][0]
conv3_block1_1_conv (Conv2D)	(None, 32, 32, 128)	16384	conv3_block1_0_relu[0][0]
conv3_block1_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block1_1_conv[0][0]
conv3_block1_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block1_1_bn[0][0]
conv3_block1_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block1_1_relu[0][0]
conv3_block1_concat (Concatenat	(None, 32, 32, 160)	0	pool2_pool[0][0] conv3_block1_2_conv[0][0]
conv3_block2_0_bn (BatchNormali	(None, 32, 32, 160)	640	conv3_block1_concat[0][0]
conv3_block2_0_relu (Activation	(None, 32, 32, 160)	0	conv3_block2_0_bn[0][0]
conv3_block2_1_conv (Conv2D)	(None, 32, 32, 128)	20480	conv3_block2_0_relu[0][0]
conv3_block2_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block2_1_conv[0][0]
conv3_block2_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block2_1_bn[0][0]
conv3_block2_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block2_1_relu[0][0]
conv3_block2_concat (Concatenat	(None, 32, 32, 192)	0	conv3_block1_concat[0][0] conv3_block2_2_conv[0][0]
conv3_block3_0_bn (BatchNormali	(None, 32, 32, 192)	768	conv3_block2_concat[0][0]
conv3_block3_0_relu (Activation	(None, 32, 32, 192)	0	conv3_block3_0_bn[0][0]
conv3_block3_1_conv (Conv2D)	(None, 32, 32, 128)	24576	conv3_block3_0_relu[0][0]
conv3_block3_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block3_1_conv[0][0]
conv3_block3_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block3_1_bn[0][0]
conv3_block3_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block3_1_relu[0][0]
conv3_block3_concat (Concatenat	(None, 32, 32, 224)	0	conv3_block2_concat[0][0] conv3_block3_2_conv[0][0]
conv3_block4_0_bn (BatchNormali	(None, 32, 32, 224)	896	conv3_block3_concat[0][0]
conv3_block4_0_relu (Activation	(None, 32, 32, 224)	0	conv3_block4_0_bn[0][0]
conv3_block4_1_conv (Conv2D)	(None, 32, 32, 128)	28672	conv3_block4_0_relu[0][0]
conv3_block4_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block4_1_conv[0][0]
conv3_block4_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block4_1_bn[0][0]
conv3_block4_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block4_1_relu[0][0]
conv3_block4_concat (Concatenat	(None, 32, 32, 256)	0	conv3_block3_concat[0][0] conv3_block4_2_conv[0][0]
conv3_block5_0_bn (BatchNormali	(None, 32, 32, 256)	1024	conv3_block4_concat[0][0]
conv3_block5_0_relu (Activation	(None, 32, 32, 256)	0	conv3_block5_0_bn[0][0]
conv3_block5_1_conv (Conv2D)	(None, 32, 32, 128)	32768	conv3_block5_0_relu[0][0]

conv3_block5_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block5_1_conv[0][0]	
conv3_block5_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block5_1_bn[0][0]	
conv3_block5_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block5_1_relu[0][0]	
conv3_block5_concat (Concatenat	(None, 32, 32, 288)	0	conv3_block4_concat[0][0] conv3_block5_2_conv[0][0]	
conv3_block6_0_bn (BatchNormali	(None, 32, 32, 288)	1152	conv3_block5_concat[0][0]	
conv3_block6_0_relu (Activation	(None, 32, 32, 288)	0	conv3_block6_0_bn[0][0]	
conv3_block6_1_conv (Conv2D)	(None, 32, 32, 128)	36864	conv3_block6_0_relu[0][0]	
conv3_block6_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block6_1_conv[0][0]	
conv3_block6_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block6_1_bn[0][0]	
conv3_block6_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block6_1_relu[0][0]	
conv3_block6_concat (Concatenat	(None, 32, 32, 320)	0	conv3_block5_concat[0][0] conv3_block6_2_conv[0][0]	
conv3_block7_0_bn (BatchNormali	(None, 32, 32, 320)	1280	conv3_block6_concat[0][0]	
conv3_block7_0_relu (Activation	(None, 32, 32, 320)	0	conv3_block7_0_bn[0][0]	
conv3_block7_1_conv (Conv2D)	(None, 32, 32, 128)	40960	conv3_block7_0_relu[0][0]	
conv3_block7_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block7_1_conv[0][0]	
conv3_block7_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block7_1_bn[0][0]	
conv3_block7_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block7_1_relu[0][0]	
conv3_block7_concat (Concatenat	(None, 32, 32, 352)	0	conv3_block6_concat[0][0] conv3_block7_2_conv[0][0]	
conv3_block8_0_bn (BatchNormali	(None, 32, 32, 352)	1408	conv3_block7_concat[0][0]	
conv3_block8_0_relu (Activation	(None, 32, 32, 352)	0	conv3_block8_0_bn[0][0]	
conv3_block8_1_conv (Conv2D)	(None, 32, 32, 128)	45056	conv3_block8_0_relu[0][0]	
conv3_block8_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block8_1_conv[0][0]	
conv3_block8_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block8_1_bn[0][0]	
conv3_block8_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block8_1_relu[0][0]	
conv3_block8_concat (Concatenat	(None, 32, 32, 384)	0	conv3_block7_concat[0][0] conv3_block8_2_conv[0][0]	
conv3_block9_0_bn (BatchNormali	(None, 32, 32, 384)	1536	conv3_block8_concat[0][0]	
conv3_block9_0_relu (Activation	(None, 32, 32, 384)	0	conv3_block9_0_bn[0][0]	
conv3_block9_1_conv (Conv2D)	(None, 32, 32, 128)	49152	conv3_block9_0_relu[0][0]	
conv3_block9_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block9_1_conv[0][0]	
conv3_block9_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block9_1_bn[0][0]	
conv3_block9_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block9_1_relu[0][0]	
conv3_block9_concat (Concatenat	(None, 32, 32, 416)	0	conv3_block8_concat[0][0] conv3_block9_2_conv[0][0]	
conv3_block10_0_bn (BatchNormal	(None, 32, 32, 416)	1664	conv3_block9_concat[0][0]	
conv3_block10_0_relu (Activatio	(None, 32, 32, 416)	0	conv3_block10_0_bn[0][0]	
conv3_block10_1_conv (Conv2D)	(None, 32, 32, 128)	53248	conv3_block10_0_relu[0][0]	

conv3_block10_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block10_1_conv[0][0]
conv3_block10_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block10_1_bn[0][0]
conv3_block10_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block10_1_relu[0][0]
conv3_block10_concat (Concatena	(None, 32, 32, 448)	0	conv3_block9_concat[0][0] conv3_block10_2_conv[0][0]
conv3_block11_0_bn (BatchNormal	(None, 32, 32, 448)	1792	conv3_block10_concat[0][0]
conv3_block11_0_relu (Activatio	(None, 32, 32, 448)	0	conv3_block11_0_bn[0][0]
conv3_block11_1_conv (Conv2D)	(None, 32, 32, 128)	57344	conv3_block11_0_relu[0][0]
conv3_block11_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block11_1_conv[0][0]
conv3_block11_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block11_1_bn[0][0]
conv3_block11_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block11_1_relu[0][0]
conv3_block11_concat (Concatena	(None, 32, 32, 480)	0	conv3_block10_concat[0][0] conv3_block11_2_conv[0][0]
conv3_block12_0_bn (BatchNormal	(None, 32, 32, 480)	1920	conv3_block11_concat[0][0]
conv3_block12_0_relu (Activatio	(None, 32, 32, 480)	0	conv3_block12_0_bn[0][0]
conv3_block12_1_conv (Conv2D)	(None, 32, 32, 128)	61440	conv3_block12_0_relu[0][0]
conv3_block12_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block12_1_conv[0][0]
conv3_block12_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block12_1_bn[0][0]
conv3_block12_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block12_1_relu[0][0]
conv3_block12_concat (Concatena	(None, 32, 32, 512)	0	conv3_block11_concat[0][0] conv3_block12_2_conv[0][0]
pool3_bn (BatchNormalization)	(None, 32, 32, 512)	2048	conv3_block12_concat[0][0]
pool3_relu (Activation)	(None, 32, 32, 512)	0	pool3_bn[0][0]
pool3_conv (Conv2D)	(None, 32, 32, 256)	131072	pool3_relu[0][0]
pool3_pool (AveragePooling2D)	(None, 16, 16, 256)	0	pool3_conv[0][0]
conv4_block1_0_bn (BatchNormali	(None, 16, 16, 256)	1024	pool3_pool[0][0]
conv4_block1_0_relu (Activation	(None, 16, 16, 256)	0	conv4_block1_0_bn[0][0]
conv4_block1_1_conv (Conv2D)	(None, 16, 16, 128)	32768	conv4_block1_0_relu[0][0]
conv4_block1_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block1_1_conv[0][0]
conv4_block1_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block1_1_bn[0][0]
conv4_block1_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block1_1_relu[0][0]
conv4_block1_concat (Concatenat	(None, 16, 16, 288)	0	pool3_pool[0][0] conv4_block1_2_conv[0][0]
conv4_block2_0_bn (BatchNormali	(None, 16, 16, 288)	1152	conv4_block1_concat[0][0]
conv4_block2_0_relu (Activation	(None, 16, 16, 288)	0	conv4_block2_0_bn[0][0]
conv4_block2_1_conv (Conv2D)	(None, 16, 16, 128)	36864	conv4_block2_0_relu[0][0]
conv4_block2_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block2_1_conv[0][0]
conv4_block2_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block2_1_bn[0][0]
conv4_block2_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block2_1_relu[0][0]
conv4_block2_concat (Concatenat	(None, 16, 16, 320)	0	conv4_block1_concat[0][0] conv4_block2_2_conv[0][0]
conv4_block3_0_bn (BatchNormali	(None, 16, 16, 320)	1280	conv4_block2_concat[0][0]

```
conv4_block3_0_bn (BatchNormali (None, 16, 16, 320)  1280        conv4_block2_concat[0][0]
__________________________________________________________________________________________________
conv4_block3_0_relu (Activation (None, 16, 16, 320)  0           conv4_block3_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block3_1_conv (Conv2D)    (None, 16, 16, 128)  40960       conv4_block3_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block3_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block3_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block3_1_relu (Activation (None, 16, 16, 128)  0           conv4_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block3_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block3_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block3_concat (Concatenat (None, 16, 16, 352)  0           conv4_block2_concat[0][0]
                                                                 conv4_block3_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block4_0_bn (BatchNormali (None, 16, 16, 352)  1408        conv4_block3_concat[0][0]
__________________________________________________________________________________________________
conv4_block4_0_relu (Activation (None, 16, 16, 352)  0           conv4_block4_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block4_1_conv (Conv2D)    (None, 16, 16, 128)  45056       conv4_block4_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block4_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block4_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block4_1_relu (Activation (None, 16, 16, 128)  0           conv4_block4_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block4_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block4_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block4_concat (Concatenat (None, 16, 16, 384)  0           conv4_block3_concat[0][0]
                                                                 conv4_block4_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block5_0_bn (BatchNormali (None, 16, 16, 384)  1536        conv4_block4_concat[0][0]
__________________________________________________________________________________________________
conv4_block5_0_relu (Activation (None, 16, 16, 384)  0           conv4_block5_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block5_1_conv (Conv2D)    (None, 16, 16, 128)  49152       conv4_block5_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block5_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block5_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block5_1_relu (Activation (None, 16, 16, 128)  0           conv4_block5_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block5_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block5_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block5_concat (Concatenat (None, 16, 16, 416)  0           conv4_block4_concat[0][0]
                                                                 conv4_block5_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block6_0_bn (BatchNormali (None, 16, 16, 416)  1664        conv4_block5_concat[0][0]
__________________________________________________________________________________________________
conv4_block6_0_relu (Activation (None, 16, 16, 416)  0           conv4_block6_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block6_1_conv (Conv2D)    (None, 16, 16, 128)  53248       conv4_block6_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block6_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block6_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block6_1_relu (Activation (None, 16, 16, 128)  0           conv4_block6_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block6_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block6_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block6_concat (Concatenat (None, 16, 16, 448)  0           conv4_block5_concat[0][0]
                                                                 conv4_block6_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block7_0_bn (BatchNormali (None, 16, 16, 448)  1792        conv4_block6_concat[0][0]
__________________________________________________________________________________________________
conv4_block7_0_relu (Activation (None, 16, 16, 448)  0           conv4_block7_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block7_1_conv (Conv2D)    (None, 16, 16, 128)  57344       conv4_block7_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block7_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block7_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block7_1_relu (Activation (None, 16, 16, 128)  0           conv4_block7_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block7_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block7_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block7_concat (Concatenat (None, 16, 16, 480)  0           conv4_block6_concat[0][0]
                                                                 conv4_block7_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block8_0_bn (BatchNormali (None, 16, 16, 480)  1920        conv4_block7_concat[0][0]
__________________________________________________________________________________________________
conv4_block8_0_relu (Activation (None, 16, 16, 480)  0           conv4_block8_0_bn[0][0]
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conv4_block8_0_relu (Activation (None, 16, 16, 480)  0           conv4_block8_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block8_1_conv (Conv2D)    (None, 16, 16, 128)  61440       conv4_block8_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block8_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block8_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block8_1_relu (Activation (None, 16, 16, 128)  0           conv4_block8_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block8_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block8_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block8_concat (Concatenat (None, 16, 16, 512)  0           conv4_block7_concat[0][0]
                                                                 conv4_block8_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block9_0_bn (BatchNormali (None, 16, 16, 512)  2048        conv4_block8_concat[0][0]
__________________________________________________________________________________________________
conv4_block9_0_relu (Activation (None, 16, 16, 512)  0           conv4_block9_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block9_1_conv (Conv2D)    (None, 16, 16, 128)  65536       conv4_block9_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block9_1_bn (BatchNormali (None, 16, 16, 128)  512         conv4_block9_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block9_1_relu (Activation (None, 16, 16, 128)  0           conv4_block9_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block9_2_conv (Conv2D)    (None, 16, 16, 32)   36864       conv4_block9_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block9_concat (Concatenat (None, 16, 16, 544)  0           conv4_block8_concat[0][0]
                                                                 conv4_block9_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block10_0_bn (BatchNormal (None, 16, 16, 544)  2176        conv4_block9_concat[0][0]
__________________________________________________________________________________________________
conv4_block10_0_relu (Activatio (None, 16, 16, 544)  0           conv4_block10_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block10_1_conv (Conv2D)   (None, 16, 16, 128)  69632       conv4_block10_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block10_1_bn (BatchNormal (None, 16, 16, 128)  512         conv4_block10_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block10_1_relu (Activatio (None, 16, 16, 128)  0           conv4_block10_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block10_2_conv (Conv2D)   (None, 16, 16, 32)   36864       conv4_block10_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block10_concat (Concatena (None, 16, 16, 576)  0           conv4_block9_concat[0][0]
                                                                 conv4_block10_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block11_0_bn (BatchNormal (None, 16, 16, 576)  2304        conv4_block10_concat[0][0]
__________________________________________________________________________________________________
conv4_block11_0_relu (Activatio (None, 16, 16, 576)  0           conv4_block11_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block11_1_conv (Conv2D)   (None, 16, 16, 128)  73728       conv4_block11_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block11_1_bn (BatchNormal (None, 16, 16, 128)  512         conv4_block11_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block11_1_relu (Activatio (None, 16, 16, 128)  0           conv4_block11_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block11_2_conv (Conv2D)   (None, 16, 16, 32)   36864       conv4_block11_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block11_concat (Concatena (None, 16, 16, 608)  0           conv4_block10_concat[0][0]
                                                                 conv4_block11_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block12_0_bn (BatchNormal (None, 16, 16, 608)  2432        conv4_block11_concat[0][0]
__________________________________________________________________________________________________
conv4_block12_0_relu (Activatio (None, 16, 16, 608)  0           conv4_block12_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block12_1_conv (Conv2D)   (None, 16, 16, 128)  77824       conv4_block12_0_relu[0][0]
__________________________________________________________________________________________________
conv4_block12_1_bn (BatchNormal (None, 16, 16, 128)  512         conv4_block12_1_conv[0][0]
__________________________________________________________________________________________________
conv4_block12_1_relu (Activatio (None, 16, 16, 128)  0           conv4_block12_1_bn[0][0]
__________________________________________________________________________________________________
conv4_block12_2_conv (Conv2D)   (None, 16, 16, 32)   36864       conv4_block12_1_relu[0][0]
__________________________________________________________________________________________________
conv4_block12_concat (Concatena (None, 16, 16, 640)  0           conv4_block11_concat[0][0]
                                                                 conv4_block12_2_conv[0][0]
__________________________________________________________________________________________________
conv4_block13_0_bn (BatchNormal (None, 16, 16, 640)  2560        conv4_block12_concat[0][0]
__________________________________________________________________________________________________
conv4_block13_0_relu (Activatio (None, 16, 16, 640)  0           conv4_block13_0_bn[0][0]
__________________________________________________________________________________________________
conv4_block13_1_conv (Conv2D)   (None, 16, 16, 128)  81920       conv4_block13_0_relu[0][0]
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conv4_block13_1_conv (Conv2D)	(None, 16, 16, 128)	81920	conv4_block13_0_relu[0][0]
conv4_block13_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block13_1_conv[0][0]
conv4_block13_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block13_1_bn[0][0]
conv4_block13_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block13_1_relu[0][0]
conv4_block13_concat (Concatena	(None, 16, 16, 672)	0	conv4_block12_concat[0][0] conv4_block13_2_conv[0][0]
conv4_block14_0_bn (BatchNormal	(None, 16, 16, 672)	2688	conv4_block13_concat[0][0]
conv4_block14_0_relu (Activatio	(None, 16, 16, 672)	0	conv4_block14_0_bn[0][0]
conv4_block14_1_conv (Conv2D)	(None, 16, 16, 128)	86016	conv4_block14_0_relu[0][0]
conv4_block14_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block14_1_conv[0][0]
conv4_block14_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block14_1_bn[0][0]
conv4_block14_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block14_1_relu[0][0]
conv4_block14_concat (Concatena	(None, 16, 16, 704)	0	conv4_block13_concat[0][0] conv4_block14_2_conv[0][0]
conv4_block15_0_bn (BatchNormal	(None, 16, 16, 704)	2816	conv4_block14_concat[0][0]
conv4_block15_0_relu (Activatio	(None, 16, 16, 704)	0	conv4_block15_0_bn[0][0]
conv4_block15_1_conv (Conv2D)	(None, 16, 16, 128)	90112	conv4_block15_0_relu[0][0]
conv4_block15_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block15_1_conv[0][0]
conv4_block15_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block15_1_bn[0][0]
conv4_block15_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block15_1_relu[0][0]
conv4_block15_concat (Concatena	(None, 16, 16, 736)	0	conv4_block14_concat[0][0] conv4_block15_2_conv[0][0]
conv4_block16_0_bn (BatchNormal	(None, 16, 16, 736)	2944	conv4_block15_concat[0][0]
conv4_block16_0_relu (Activatio	(None, 16, 16, 736)	0	conv4_block16_0_bn[0][0]
conv4_block16_1_conv (Conv2D)	(None, 16, 16, 128)	94208	conv4_block16_0_relu[0][0]
conv4_block16_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block16_1_conv[0][0]
conv4_block16_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block16_1_bn[0][0]
conv4_block16_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block16_1_relu[0][0]
conv4_block16_concat (Concatena	(None, 16, 16, 768)	0	conv4_block15_concat[0][0] conv4_block16_2_conv[0][0]
conv4_block17_0_bn (BatchNormal	(None, 16, 16, 768)	3072	conv4_block16_concat[0][0]
conv4_block17_0_relu (Activatio	(None, 16, 16, 768)	0	conv4_block17_0_bn[0][0]
conv4_block17_1_conv (Conv2D)	(None, 16, 16, 128)	98304	conv4_block17_0_relu[0][0]
conv4_block17_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block17_1_conv[0][0]
conv4_block17_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block17_1_bn[0][0]
conv4_block17_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block17_1_relu[0][0]
conv4_block17_concat (Concatena	(None, 16, 16, 800)	0	conv4_block16_concat[0][0] conv4_block17_2_conv[0][0]
conv4_block18_0_bn (BatchNormal	(None, 16, 16, 800)	3200	conv4_block17_concat[0][0]
conv4_block18_0_relu (Activatio	(None, 16, 16, 800)	0	conv4_block18_0_bn[0][0]
conv4_block18_1_conv (Conv2D)	(None, 16, 16, 128)	102400	conv4_block18_0_relu[0][0]

conv4_block18_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block18_1_conv[0][0]
conv4_block18_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block18_1_bn[0][0]
conv4_block18_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block18_1_relu[0][0]
conv4_block18_concat (Concatena	(None, 16, 16, 832)	0	conv4_block17_concat[0][0] conv4_block18_2_conv[0][0]
conv4_block19_0_bn (BatchNormal	(None, 16, 16, 832)	3328	conv4_block18_concat[0][0]
conv4_block19_0_relu (Activatio	(None, 16, 16, 832)	0	conv4_block19_0_bn[0][0]
conv4_block19_1_conv (Conv2D)	(None, 16, 16, 128)	106496	conv4_block19_0_relu[0][0]
conv4_block19_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block19_1_conv[0][0]
conv4_block19_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block19_1_bn[0][0]
conv4_block19_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block19_1_relu[0][0]
conv4_block19_concat (Concatena	(None, 16, 16, 864)	0	conv4_block18_concat[0][0] conv4_block19_2_conv[0][0]
conv4_block20_0_bn (BatchNormal	(None, 16, 16, 864)	3456	conv4_block19_concat[0][0]
conv4_block20_0_relu (Activatio	(None, 16, 16, 864)	0	conv4_block20_0_bn[0][0]
conv4_block20_1_conv (Conv2D)	(None, 16, 16, 128)	110592	conv4_block20_0_relu[0][0]
conv4_block20_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block20_1_conv[0][0]
conv4_block20_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block20_1_bn[0][0]
conv4_block20_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block20_1_relu[0][0]
conv4_block20_concat (Concatena	(None, 16, 16, 896)	0	conv4_block19_concat[0][0] conv4_block20_2_conv[0][0]
conv4_block21_0_bn (BatchNormal	(None, 16, 16, 896)	3584	conv4_block20_concat[0][0]
conv4_block21_0_relu (Activatio	(None, 16, 16, 896)	0	conv4_block21_0_bn[0][0]
conv4_block21_1_conv (Conv2D)	(None, 16, 16, 128)	114688	conv4_block21_0_relu[0][0]
conv4_block21_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block21_1_conv[0][0]
conv4_block21_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block21_1_bn[0][0]
conv4_block21_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block21_1_relu[0][0]
conv4_block21_concat (Concatena	(None, 16, 16, 928)	0	conv4_block20_concat[0][0] conv4_block21_2_conv[0][0]
conv4_block22_0_bn (BatchNormal	(None, 16, 16, 928)	3712	conv4_block21_concat[0][0]
conv4_block22_0_relu (Activatio	(None, 16, 16, 928)	0	conv4_block22_0_bn[0][0]
conv4_block22_1_conv (Conv2D)	(None, 16, 16, 128)	118784	conv4_block22_0_relu[0][0]
conv4_block22_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block22_1_conv[0][0]
conv4_block22_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block22_1_bn[0][0]
conv4_block22_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block22_1_relu[0][0]
conv4_block22_concat (Concatena	(None, 16, 16, 960)	0	conv4_block21_concat[0][0] conv4_block22_2_conv[0][0]
conv4_block23_0_bn (BatchNormal	(None, 16, 16, 960)	3840	conv4_block22_concat[0][0]
conv4_block23_0_relu (Activatio	(None, 16, 16, 960)	0	conv4_block23_0_bn[0][0]
conv4_block23_1_conv (Conv2D)	(None, 16, 16, 128)	122880	conv4_block23_0_relu[0][0]
conv4_block23_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block23_1_conv[0][0]

conv4_block23_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block23_1_bn[0][0]	
conv4_block23_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block23_1_relu[0][0]	
conv4_block23_concat (Concatena	(None, 16, 16, 992)	0	conv4_block22_concat[0][0] conv4_block23_2_conv[0][0]	
conv4_block24_0_bn (BatchNormal	(None, 16, 16, 992)	3968	conv4_block23_concat[0][0]	
conv4_block24_0_relu (Activatio	(None, 16, 16, 992)	0	conv4_block24_0_bn[0][0]	
conv4_block24_1_conv (Conv2D)	(None, 16, 16, 128)	126976	conv4_block24_0_relu[0][0]	
conv4_block24_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block24_1_conv[0][0]	
conv4_block24_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block24_1_bn[0][0]	
conv4_block24_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block24_1_relu[0][0]	
conv4_block24_concat (Concatena	(None, 16, 16, 1024)	0	conv4_block23_concat[0][0] conv4_block24_2_conv[0][0]	
pool4_bn (BatchNormalization)	(None, 16, 16, 1024)	4096	conv4_block24_concat[0][0]	
pool4_relu (Activation)	(None, 16, 16, 1024)	0	pool4_bn[0][0]	
pool4_conv (Conv2D)	(None, 16, 16, 512)	524288	pool4_relu[0][0]	
pool4_pool (AveragePooling2D)	(None, 8, 8, 512)	0	pool4_conv[0][0]	
conv5_block1_0_bn (BatchNormali	(None, 8, 8, 512)	2048	pool4_pool[0][0]	
conv5_block1_0_relu (Activation	(None, 8, 8, 512)	0	conv5_block1_0_bn[0][0]	
conv5_block1_1_conv (Conv2D)	(None, 8, 8, 128)	65536	conv5_block1_0_relu[0][0]	
conv5_block1_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block1_1_conv[0][0]	
conv5_block1_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block1_1_bn[0][0]	
conv5_block1_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block1_1_relu[0][0]	
conv5_block1_concat (Concatenat	(None, 8, 8, 544)	0	pool4_pool[0][0] conv5_block1_2_conv[0][0]	
conv5_block2_0_bn (BatchNormali	(None, 8, 8, 544)	2176	conv5_block1_concat[0][0]	
conv5_block2_0_relu (Activation	(None, 8, 8, 544)	0	conv5_block2_0_bn[0][0]	
conv5_block2_1_conv (Conv2D)	(None, 8, 8, 128)	69632	conv5_block2_0_relu[0][0]	
conv5_block2_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block2_1_conv[0][0]	
conv5_block2_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block2_1_bn[0][0]	
conv5_block2_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block2_1_relu[0][0]	
conv5_block2_concat (Concatenat	(None, 8, 8, 576)	0	conv5_block1_concat[0][0] conv5_block2_2_conv[0][0]	
conv5_block3_0_bn (BatchNormali	(None, 8, 8, 576)	2304	conv5_block2_concat[0][0]	
conv5_block3_0_relu (Activation	(None, 8, 8, 576)	0	conv5_block3_0_bn[0][0]	
conv5_block3_1_conv (Conv2D)	(None, 8, 8, 128)	73728	conv5_block3_0_relu[0][0]	
conv5_block3_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block3_1_conv[0][0]	
conv5_block3_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block3_1_bn[0][0]	
conv5_block3_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block3_1_relu[0][0]	
conv5_block3_concat (Concatenat	(None, 8, 8, 608)	0	conv5_block2_concat[0][0] conv5_block3_2_conv[0][0]	
conv5_block4_0_bn (BatchNormali	(None, 8, 8, 608)	2432	conv5_block3_concat[0][0]	

```
conv5_block4_0_relu (Activation (None, 8, 8, 608)    0           conv5_block4_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block4_1_conv (Conv2D)    (None, 8, 8, 128)    77824       conv5_block4_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block4_1_bn (BatchNormali (None, 8, 8, 128)    512         conv5_block4_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block4_1_relu (Activation (None, 8, 8, 128)    0           conv5_block4_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block4_2_conv (Conv2D)    (None, 8, 8, 32)     36864       conv5_block4_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block4_concat (Concatenat (None, 8, 8, 640)    0           conv5_block3_concat[0][0]
                                                                 conv5_block4_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block5_0_bn (BatchNormali (None, 8, 8, 640)    2560        conv5_block4_concat[0][0]
__________________________________________________________________________________________________
conv5_block5_0_relu (Activation (None, 8, 8, 640)    0           conv5_block5_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block5_1_conv (Conv2D)    (None, 8, 8, 128)    81920       conv5_block5_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block5_1_bn (BatchNormali (None, 8, 8, 128)    512         conv5_block5_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block5_1_relu (Activation (None, 8, 8, 128)    0           conv5_block5_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block5_2_conv (Conv2D)    (None, 8, 8, 32)     36864       conv5_block5_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block5_concat (Concatenat (None, 8, 8, 672)    0           conv5_block4_concat[0][0]
                                                                 conv5_block5_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block6_0_bn (BatchNormali (None, 8, 8, 672)    2688        conv5_block5_concat[0][0]
__________________________________________________________________________________________________
conv5_block6_0_relu (Activation (None, 8, 8, 672)    0           conv5_block6_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block6_1_conv (Conv2D)    (None, 8, 8, 128)    86016       conv5_block6_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block6_1_bn (BatchNormali (None, 8, 8, 128)    512         conv5_block6_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block6_1_relu (Activation (None, 8, 8, 128)    0           conv5_block6_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block6_2_conv (Conv2D)    (None, 8, 8, 32)     36864       conv5_block6_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block6_concat (Concatenat (None, 8, 8, 704)    0           conv5_block5_concat[0][0]
                                                                 conv5_block6_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block7_0_bn (BatchNormali (None, 8, 8, 704)    2816        conv5_block6_concat[0][0]
__________________________________________________________________________________________________
conv5_block7_0_relu (Activation (None, 8, 8, 704)    0           conv5_block7_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block7_1_conv (Conv2D)    (None, 8, 8, 128)    90112       conv5_block7_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block7_1_bn (BatchNormali (None, 8, 8, 128)    512         conv5_block7_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block7_1_relu (Activation (None, 8, 8, 128)    0           conv5_block7_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block7_2_conv (Conv2D)    (None, 8, 8, 32)     36864       conv5_block7_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block7_concat (Concatenat (None, 8, 8, 736)    0           conv5_block6_concat[0][0]
                                                                 conv5_block7_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block8_0_bn (BatchNormali (None, 8, 8, 736)    2944        conv5_block7_concat[0][0]
__________________________________________________________________________________________________
conv5_block8_0_relu (Activation (None, 8, 8, 736)    0           conv5_block8_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block8_1_conv (Conv2D)    (None, 8, 8, 128)    94208       conv5_block8_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block8_1_bn (BatchNormali (None, 8, 8, 128)    512         conv5_block8_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block8_1_relu (Activation (None, 8, 8, 128)    0           conv5_block8_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block8_2_conv (Conv2D)    (None, 8, 8, 32)     36864       conv5_block8_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block8_concat (Concatenat (None, 8, 8, 768)    0           conv5_block7_concat[0][0]
                                                                 conv5_block8_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block9_0_bn (BatchNormali (None, 8, 8, 768)    3072        conv5_block8_concat[0][0]
__________________________________________________________________________________________________
conv5_block9_0_relu (Activation (None, 8, 8, 768)    0           conv5_block9_0_bn[0][0]
__________________________________________________________________________________________________
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conv5_block9_1_conv (Conv2D)    (None, 8, 8, 128)    98304       conv5_block9_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block9_1_bn (BatchNormali (None, 8, 8, 128)    512         conv5_block9_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block9_1_relu (Activation (None, 8, 8, 128)    0           conv5_block9_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block9_2_conv (Conv2D)    (None, 8, 8, 32)     36864       conv5_block9_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block9_concat (Concatenat (None, 8, 8, 800)    0           conv5_block8_concat[0][0]
                                                                 conv5_block9_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block10_0_bn (BatchNormal (None, 8, 8, 800)    3200        conv5_block9_concat[0][0]
__________________________________________________________________________________________________
conv5_block10_0_relu (Activatio (None, 8, 8, 800)    0           conv5_block10_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block10_1_conv (Conv2D)   (None, 8, 8, 128)    102400      conv5_block10_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block10_1_bn (BatchNormal (None, 8, 8, 128)    512         conv5_block10_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block10_1_relu (Activatio (None, 8, 8, 128)    0           conv5_block10_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block10_2_conv (Conv2D)   (None, 8, 8, 32)     36864       conv5_block10_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block10_concat (Concatena (None, 8, 8, 832)    0           conv5_block9_concat[0][0]
                                                                 conv5_block10_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block11_0_bn (BatchNormal (None, 8, 8, 832)    3328        conv5_block10_concat[0][0]
__________________________________________________________________________________________________
conv5_block11_0_relu (Activatio (None, 8, 8, 832)    0           conv5_block11_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block11_1_conv (Conv2D)   (None, 8, 8, 128)    106496      conv5_block11_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block11_1_bn (BatchNormal (None, 8, 8, 128)    512         conv5_block11_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block11_1_relu (Activatio (None, 8, 8, 128)    0           conv5_block11_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block11_2_conv (Conv2D)   (None, 8, 8, 32)     36864       conv5_block11_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block11_concat (Concatena (None, 8, 8, 864)    0           conv5_block10_concat[0][0]
                                                                 conv5_block11_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block12_0_bn (BatchNormal (None, 8, 8, 864)    3456        conv5_block11_concat[0][0]
__________________________________________________________________________________________________
conv5_block12_0_relu (Activatio (None, 8, 8, 864)    0           conv5_block12_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block12_1_conv (Conv2D)   (None, 8, 8, 128)    110592      conv5_block12_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block12_1_bn (BatchNormal (None, 8, 8, 128)    512         conv5_block12_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block12_1_relu (Activatio (None, 8, 8, 128)    0           conv5_block12_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block12_2_conv (Conv2D)   (None, 8, 8, 32)     36864       conv5_block12_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block12_concat (Concatena (None, 8, 8, 896)    0           conv5_block11_concat[0][0]
                                                                 conv5_block12_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block13_0_bn (BatchNormal (None, 8, 8, 896)    3584        conv5_block12_concat[0][0]
__________________________________________________________________________________________________
conv5_block13_0_relu (Activatio (None, 8, 8, 896)    0           conv5_block13_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block13_1_conv (Conv2D)   (None, 8, 8, 128)    114688      conv5_block13_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block13_1_bn (BatchNormal (None, 8, 8, 128)    512         conv5_block13_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block13_1_relu (Activatio (None, 8, 8, 128)    0           conv5_block13_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block13_2_conv (Conv2D)   (None, 8, 8, 32)     36864       conv5_block13_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block13_concat (Concatena (None, 8, 8, 928)    0           conv5_block12_concat[0][0]
                                                                 conv5_block13_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block14_0_bn (BatchNormal (None, 8, 8, 928)    3712        conv5_block13_concat[0][0]
__________________________________________________________________________________________________
conv5_block14_0_relu (Activatio (None, 8, 8, 928)    0           conv5_block14_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block14_1_conv (Conv2D)   (None, 8, 8, 128)    118784      conv5_block14_0_relu[0][0]
__________________________________________________________________________________________________
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conv5_block14_1_bn (BatchNormal (None, 8, 8, 128)    512         conv5_block14_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block14_1_relu (Activatio (None, 8, 8, 128)    0           conv5_block14_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block14_2_conv (Conv2D)   (None, 8, 8, 32)     36864       conv5_block14_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block14_concat (Concatena (None, 8, 8, 960)    0           conv5_block13_concat[0][0]
                                                                 conv5_block14_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block15_0_bn (BatchNormal (None, 8, 8, 960)    3840        conv5_block14_concat[0][0]
__________________________________________________________________________________________________
conv5_block15_0_relu (Activatio (None, 8, 8, 960)    0           conv5_block15_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block15_1_conv (Conv2D)   (None, 8, 8, 128)    122880      conv5_block15_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block15_1_bn (BatchNormal (None, 8, 8, 128)    512         conv5_block15_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block15_1_relu (Activatio (None, 8, 8, 128)    0           conv5_block15_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block15_2_conv (Conv2D)   (None, 8, 8, 32)     36864       conv5_block15_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block15_concat (Concatena (None, 8, 8, 992)    0           conv5_block14_concat[0][0]
                                                                 conv5_block15_2_conv[0][0]
__________________________________________________________________________________________________
conv5_block16_0_bn (BatchNormal (None, 8, 8, 992)    3968        conv5_block15_concat[0][0]
__________________________________________________________________________________________________
conv5_block16_0_relu (Activatio (None, 8, 8, 992)    0           conv5_block16_0_bn[0][0]
__________________________________________________________________________________________________
conv5_block16_1_conv (Conv2D)   (None, 8, 8, 128)    126976      conv5_block16_0_relu[0][0]
__________________________________________________________________________________________________
conv5_block16_1_bn (BatchNormal (None, 8, 8, 128)    512         conv5_block16_1_conv[0][0]
__________________________________________________________________________________________________
conv5_block16_1_relu (Activatio (None, 8, 8, 128)    0           conv5_block16_1_bn[0][0]
__________________________________________________________________________________________________
conv5_block16_2_conv (Conv2D)   (None, 8, 8, 32)     36864       conv5_block16_1_relu[0][0]
__________________________________________________________________________________________________
conv5_block16_concat (Concatena (None, 8, 8, 1024)   0           conv5_block15_concat[0][0]
                                                                 conv5_block16_2_conv[0][0]
__________________________________________________________________________________________________
bn (BatchNormalization)         (None, 8, 8, 1024)   4096        conv5_block16_concat[0][0]
__________________________________________________________________________________________________
relu (Activation)               (None, 8, 8, 1024)   0           bn[0][0]
__________________________________________________________________________________________________
up_sampling2d (UpSampling2D)    (None, 16, 16, 1024) 0           relu[0][0]
__________________________________________________________________________________________________
concatenate (Concatenate)       (None, 16, 16, 1536) 0           up_sampling2d[0][0]
                                                                 pool4_conv[0][0]
__________________________________________________________________________________________________
conv2d (Conv2D)                 (None, 16, 16, 256)  3538944     concatenate[0][0]
__________________________________________________________________________________________________
batch_normalization (BatchNorma (None, 16, 16, 256)  1024        conv2d[0][0]
__________________________________________________________________________________________________
activation (Activation)         (None, 16, 16, 256)  0           batch_normalization[0][0]
__________________________________________________________________________________________________
conv2d_1 (Conv2D)               (None, 16, 16, 256)  589824      activation[0][0]
__________________________________________________________________________________________________
batch_normalization_1 (BatchNor (None, 16, 16, 256)  1024        conv2d_1[0][0]
__________________________________________________________________________________________________
activation_1 (Activation)       (None, 16, 16, 256)  0           batch_normalization_1[0][0]
__________________________________________________________________________________________________
up_sampling2d_1 (UpSampling2D)  (None, 32, 32, 256)  0           activation_1[0][0]
__________________________________________________________________________________________________
concatenate_1 (Concatenate)     (None, 32, 32, 512)  0           up_sampling2d_1[0][0]
                                                                 pool3_conv[0][0]
__________________________________________________________________________________________________
conv2d_2 (Conv2D)               (None, 32, 32, 128)  589824      concatenate_1[0][0]
__________________________________________________________________________________________________
batch_normalization_2 (BatchNor (None, 32, 32, 128)  512         conv2d_2[0][0]
__________________________________________________________________________________________________
activation_2 (Activation)       (None, 32, 32, 128)  0           batch_normalization_2[0][0]
__________________________________________________________________________________________________
conv2d_3 (Conv2D)               (None, 32, 32, 128)  147456      activation_2[0][0]
__________________________________________________________________________________________________
batch_normalization_3 (BatchNor (None, 32, 32, 128)  512         conv2d_3[0][0]
__________________________________________________________________________________________________
activation_3 (Activation)       (None, 32, 32, 128)  0           batch_normalization_3[0][0]
__________________________________________________________________________________________________
```

```
up_sampling2d_2 (UpSampling2D)  (None, 64, 64, 128)  0           activation_3[0][0]
__________________________________________________________________________________________________
concatenate_2 (Concatenate)     (None, 64, 64, 256)  0           up_sampling2d_2[0][0]
                                                                 pool2_conv[0][0]
__________________________________________________________________________________________________
conv2d_4 (Conv2D)               (None, 64, 64, 64)   147456      concatenate_2[0][0]
__________________________________________________________________________________________________
batch_normalization_4 (BatchNor (None, 64, 64, 64)   256         conv2d_4[0][0]
__________________________________________________________________________________________________
activation_4 (Activation)       (None, 64, 64, 64)   0           batch_normalization_4[0][0]
__________________________________________________________________________________________________
conv2d_5 (Conv2D)               (None, 64, 64, 64)   36864       activation_4[0][0]
__________________________________________________________________________________________________
batch_normalization_5 (BatchNor (None, 64, 64, 64)   256         conv2d_5[0][0]
__________________________________________________________________________________________________
activation_5 (Activation)       (None, 64, 64, 64)   0           batch_normalization_5[0][0]
__________________________________________________________________________________________________
up_sampling2d_3 (UpSampling2D)  (None, 128, 128, 64) 0           activation_5[0][0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 128, 128, 128 0           up_sampling2d_3[0][0]
                                                                 conv1/relu[0][0]
__________________________________________________________________________________________________
conv2d_6 (Conv2D)               (None, 128, 128, 32) 36864       concatenate_3[0][0]
__________________________________________________________________________________________________
batch_normalization_6 (BatchNor (None, 128, 128, 32) 128         conv2d_6[0][0]
__________________________________________________________________________________________________
activation_6 (Activation)       (None, 128, 128, 32) 0           batch_normalization_6[0][0]
__________________________________________________________________________________________________
conv2d_7 (Conv2D)               (None, 128, 128, 32) 9216        activation_6[0][0]
__________________________________________________________________________________________________
batch_normalization_7 (BatchNor (None, 128, 128, 32) 128         conv2d_7[0][0]
__________________________________________________________________________________________________
activation_7 (Activation)       (None, 128, 128, 32) 0           batch_normalization_7[0][0]
__________________________________________________________________________________________________
up_sampling2d_4 (UpSampling2D)  (None, 256, 256, 32) 0           activation_7[0][0]
__________________________________________________________________________________________________
conv2d_8 (Conv2D)               (None, 256, 256, 16) 4608        up_sampling2d_4[0][0]
__________________________________________________________________________________________________
batch_normalization_8 (BatchNor (None, 256, 256, 16) 64          conv2d_8[0][0]
__________________________________________________________________________________________________
activation_8 (Activation)       (None, 256, 256, 16) 0           batch_normalization_8[0][0]
__________________________________________________________________________________________________
conv2d_9 (Conv2D)               (None, 256, 256, 16) 2304        activation_8[0][0]
__________________________________________________________________________________________________
batch_normalization_9 (BatchNor (None, 256, 256, 16) 64          conv2d_9[0][0]
__________________________________________________________________________________________________
activation_9 (Activation)       (None, 256, 256, 16) 0           batch_normalization_9[0][0]
__________________________________________________________________________________________________
conv2d_10 (Conv2D)              (None, 256, 256, 1)  145         activation_9[0][0]
__________________________________________________________________________________________________
activation_10 (Activation)      (None, 256, 256, 1)  0           conv2d_10[0][0]
==================================================================================================
Total params: 12,144,977
Trainable params: 12,059,345
Non-trainable params: 85,632
__________________________________________________________________________________________________
```

In [49]:

```
tf.keras.backend.clear_session()
# Tensorboard
logdir = os.path.join("/content/drive/My Drive/logs","unet_chexnet01_no_augmentation")
tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)
%tensorboard --logdir='/content/drive/My Drive/logs/unet_chexnet01_no_augmentation/'
unet_chexnet_model.fit(train_dataset,epochs=20,batch_size=16,validation_data=test_dataset,callbacks
=[tensorboard_callback,checkpoint])
```

```
Epoch 1/20
  2/120 [..............................] - ETA: 2:45 - loss: 1.0264 - accuracy: 0.1737 -
dice_coef: 0.0306WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the
batch time (batch time: 0.2862s vs `on_train_batch_end` time: 2.5232s). Check your callbacks.
119/120 [============================>.] - ETA: 0s - loss: 0.5989 - accuracy: 0.7612 - dice_coef:
0.0281
Epoch 00001: val_dice_coef improved from -inf to 0.03011, saving model to /content/drive/My
Drive/model save/weights-01-0.0301.hdf5
```

```
120/120 [==============================] - 61s 507ms/step - loss: 0.5988 - accuracy: 0.7613 - dice
_coef: 0.0280 - val_loss: 0.5783 - val_accuracy: 0.9531 - val_dice_coef: 0.0301
Epoch 2/20
120/120 [==============================] - ETA: 0s - loss: 0.3528 - accuracy: 0.9843 - dice_coef:
0.0337
Epoch 00002: val_dice_coef improved from 0.03011 to 0.03630, saving model to /content/drive/My Dri
ve/model_save/weights-02-0.0363.hdf5
120/120 [==============================] - 28s 236ms/step - loss: 0.3528 - accuracy: 0.9843 - dice
_coef: 0.0337 - val_loss: 0.3680 - val_accuracy: 0.9863 - val_dice_coef: 0.0363
Epoch 3/20
120/120 [==============================] - ETA: 0s - loss: 0.2364 - accuracy: 0.9871 - dice_coef:
0.0446
Epoch 00003: val_dice_coef improved from 0.03630 to 0.04387, saving model to /content/drive/My Dri
ve/model_save/weights-03-0.0439.hdf5
120/120 [==============================] - 28s 234ms/step - loss: 0.2364 - accuracy: 0.9871 - dice
_coef: 0.0446 - val_loss: 0.2384 - val_accuracy: 0.9874 - val_dice_coef: 0.0439
Epoch 4/20
120/120 [==============================] - ETA: 0s - loss: 0.1680 - accuracy: 0.9881 - dice_coef:
0.0628
Epoch 00004: val_dice_coef improved from 0.04387 to 0.04979, saving model to /content/drive/My Dri
ve/model_save/weights-04-0.0498.hdf5
120/120 [==============================] - 28s 234ms/step - loss: 0.1680 - accuracy: 0.9881 - dice
_coef: 0.0628 - val_loss: 0.1629 - val_accuracy: 0.9873 - val_dice_coef: 0.0498
Epoch 5/20
119/120 [============================>.] - ETA: 0s - loss: 0.1203 - accuracy: 0.9890 - dice_coef:
0.0896
Epoch 00005: val_dice_coef improved from 0.04979 to 0.06263, saving model to /content/drive/My Dri
ve/model_save/weights-05-0.0626.hdf5
120/120 [==============================] - 28s 235ms/step - loss: 0.1203 - accuracy: 0.9890 - dice
_coef: 0.0895 - val_loss: 0.1196 - val_accuracy: 0.9875 - val_dice_coef: 0.0626
Epoch 6/20
120/120 [==============================] - ETA: 0s - loss: 0.0899 - accuracy: 0.9897 - dice_coef:
0.1245
Epoch 00006: val_dice_coef improved from 0.06263 to 0.09105, saving model to /content/drive/My Dri
ve/model_save/weights-06-0.0910.hdf5
120/120 [==============================] - 28s 232ms/step - loss: 0.0899 - accuracy: 0.9897 - dice
_coef: 0.1245 - val_loss: 0.0917 - val_accuracy: 0.9880 - val_dice_coef: 0.0910
Epoch 7/20
120/120 [==============================] - ETA: 0s - loss: 0.0712 - accuracy: 0.9905 - dice_coef:
0.1657
Epoch 00007: val_dice_coef improved from 0.09105 to 0.12438, saving model to /content/drive/My Dri
ve/model_save/weights-07-0.1244.hdf5
120/120 [==============================] - 28s 232ms/step - loss: 0.0712 - accuracy: 0.9905 - dice
_coef: 0.1657 - val_loss: 0.0757 - val_accuracy: 0.9879 - val_dice_coef: 0.1244
Epoch 8/20
120/120 [==============================] - ETA: 0s - loss: 0.0587 - accuracy: 0.9912 - dice_coef:
0.2091
Epoch 00008: val_dice_coef improved from 0.12438 to 0.14933, saving model to /content/drive/My Dri
ve/model_save/weights-08-0.1493.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0587 - accuracy: 0.9912 - dice
_coef: 0.2091 - val_loss: 0.0646 - val_accuracy: 0.9879 - val_dice_coef: 0.1493
Epoch 9/20
119/120 [============================>.] - ETA: 0s - loss: 0.0497 - accuracy: 0.9919 - dice_coef:
0.2554
Epoch 00009: val_dice_coef improved from 0.14933 to 0.14953, saving model to /content/drive/My Dri
ve/model_save/weights-09-0.1495.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0497 - accuracy: 0.9919 - dice
_coef: 0.2549 - val_loss: 0.0594 - val_accuracy: 0.9880 - val_dice_coef: 0.1495
Epoch 10/20
120/120 [==============================] - ETA: 0s - loss: 0.0430 - accuracy: 0.9925 - dice_coef:
0.3011
Epoch 00010: val_dice_coef did not improve from 0.14953
120/120 [==============================] - 25s 211ms/step - loss: 0.0430 - accuracy: 0.9925 - dice
_coef: 0.3011 - val_loss: 0.0570 - val_accuracy: 0.9879 - val_dice_coef: 0.1479
Epoch 11/20
119/120 [============================>.] - ETA: 0s - loss: 0.0377 - accuracy: 0.9930 - dice_coef:
0.3449
Epoch 00011: val_dice_coef improved from 0.14953 to 0.20995, saving model to /content/drive/My Dri
ve/model_save/weights-11-0.2100.hdf5
120/120 [==============================] - 28s 236ms/step - loss: 0.0377 - accuracy: 0.9930 - dice
_coef: 0.3443 - val_loss: 0.0517 - val_accuracy: 0.9881 - val_dice_coef: 0.2100
Epoch 12/20
119/120 [============================>.] - ETA: 0s - loss: 0.0334 - accuracy: 0.9934 - dice_coef:
0.3861
Epoch 00012: val_dice_coef improved from 0.20995 to 0.26179, saving model to /content/drive/My Dri
ve/model_save/weights-12-0.2618.hdf5
120/120 [==============================] - 28s 237ms/step - loss: 0.0334 - accuracy: 0.9934 - dice
```

```
_coef: 0.3856 - val_loss: 0.0487 - val_accuracy: 0.9882 - val_dice_coef: 0.2618
Epoch 13/20
120/120 [==============================] - ETA: 0s - loss: 0.0298 - accuracy: 0.9938 - dice_coef:
0.4254
Epoch 00013: val_dice_coef improved from 0.26179 to 0.30367, saving model to /content/drive/My Dri
ve/model_save/weights-13-0.3037.hdf5
120/120 [==============================] - 28s 235ms/step - loss: 0.0298 - accuracy: 0.9938 - dice
_coef: 0.4254 - val_loss: 0.0480 - val_accuracy: 0.9875 - val_dice_coef: 0.3037
Epoch 14/20
120/120 [==============================] - ETA: 0s - loss: 0.0265 - accuracy: 0.9944 - dice_coef:
0.4702
Epoch 00014: val_dice_coef improved from 0.30367 to 0.31143, saving model to /content/drive/My Dri
ve/model_save/weights-14-0.3114.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0265 - accuracy: 0.9944 - dice
_coef: 0.4702 - val_loss: 0.0481 - val_accuracy: 0.9875 - val_dice_coef: 0.3114
Epoch 15/20
120/120 [==============================] - ETA: 0s - loss: 0.0236 - accuracy: 0.9949 - dice_coef:
0.5122
Epoch 00015: val_dice_coef improved from 0.31143 to 0.33414, saving model to /content/drive/My Dri
ve/model_save/weights-15-0.3341.hdf5
120/120 [==============================] - 28s 232ms/step - loss: 0.0236 - accuracy: 0.9949 - dice
_coef: 0.5122 - val_loss: 0.0485 - val_accuracy: 0.9870 - val_dice_coef: 0.3341
Epoch 16/20
120/120 [==============================] - ETA: 0s - loss: 0.0214 - accuracy: 0.9952 - dice_coef:
0.5444
Epoch 00016: val_dice_coef did not improve from 0.33414
120/120 [==============================] - 25s 210ms/step - loss: 0.0214 - accuracy: 0.9952 - dice
_coef: 0.5444 - val_loss: 0.0493 - val_accuracy: 0.9867 - val_dice_coef: 0.3309
Epoch 17/20
119/120 [============================>.] - ETA: 0s - loss: 0.0199 - accuracy: 0.9953 - dice_coef:
0.5710
Epoch 00017: val_dice_coef improved from 0.33414 to 0.36691, saving model to /content/drive/My Dri
ve/model_save/weights-17-0.3669.hdf5
120/120 [==============================] - 28s 232ms/step - loss: 0.0199 - accuracy: 0.9953 - dice
_coef: 0.5704 - val_loss: 0.0495 - val_accuracy: 0.9859 - val_dice_coef: 0.3669
Epoch 18/20
119/120 [============================>.] - ETA: 0s - loss: 0.0183 - accuracy: 0.9956 - dice_coef:
0.5980
Epoch 00018: val_dice_coef did not improve from 0.36691
120/120 [==============================] - 25s 211ms/step - loss: 0.0183 - accuracy: 0.9956 - dice
_coef: 0.5971 - val_loss: 0.0487 - val_accuracy: 0.9865 - val_dice_coef: 0.3631
Epoch 19/20
120/120 [==============================] - ETA: 0s - loss: 0.0170 - accuracy: 0.9957 - dice_coef:
0.6195
Epoch 00019: val_dice_coef did not improve from 0.36691
120/120 [==============================] - 25s 210ms/step - loss: 0.0170 - accuracy: 0.9957 - dice
_coef: 0.6195 - val_loss: 0.0485 - val_accuracy: 0.9867 - val_dice_coef: 0.3608
Epoch 20/20
120/120 [==============================] - ETA: 0s - loss: 0.0159 - accuracy: 0.9959 - dice_coef:
0.6401
Epoch 00020: val_dice_coef improved from 0.36691 to 0.37502, saving model to /content/drive/My Dri
ve/model_save/weights-20-0.3750.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0159 - accuracy: 0.9959 - dice
_coef: 0.6401 - val_loss: 0.0530 - val_accuracy: 0.9848 - val_dice_coef: 0.3750
```

Out[49]:

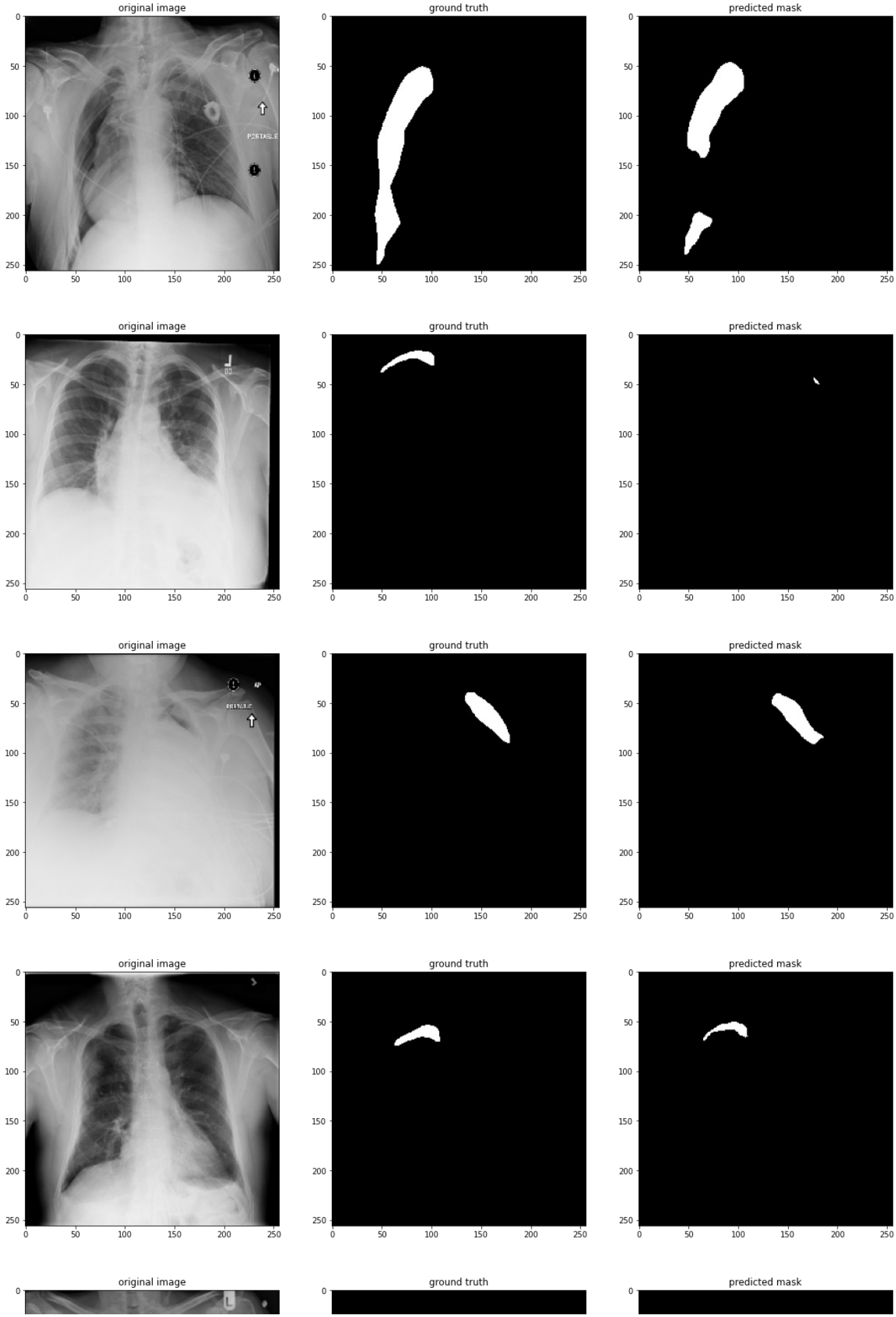
```
<tensorflow.python.keras.callbacks.History at 0x7f484d0fa0f0>
```

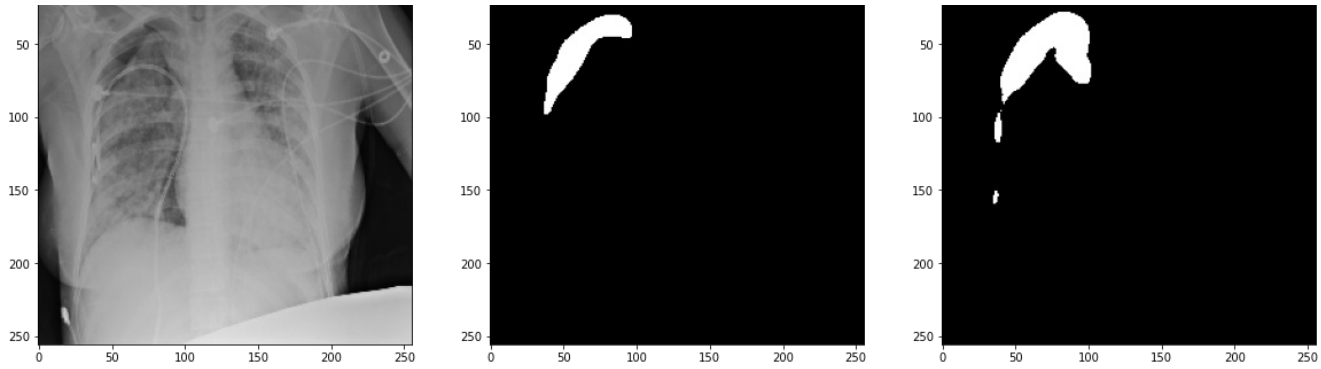
Random visualization of images

In [ ]:

```
unet_chexnet_model.load_weights('/content/drive/My Drive/model_save/weights-20-0.3750.hdf5')
for i,j in test_dataset.take(5):
  a=unet_chexnet_model.predict(i)
  preds_val_t = (a[0]>0.5).astype(np.uint8)
  plt.figure(figsize=(20,6))
  plt.subplot(131)
  plt.title("original image")
  plt.imshow(np.squeeze(i[0]),cmap='gray')
  plt.subplot(132)
  plt.title("ground truth")
  plt.imshow(np.squeeze(j[0]),cmap='gray')
```

```
plt.subplot(133)
plt.title("predicted mask")
plt.imshow(np.squeeze(preds_val_t).astype(np.uint8),cmap='gray')
plt.show()
```





- The model has done well with augumentation but the major drawback is that the model overfits .
- The models performance keeps increasing but at the cost of highly overfitting
- Let us try the same model with a different approach by adding few dropout layers to decrease the overfitting

Training Unet(Backbone-Chexnet)(with Dropout layers) model without data augumentation

In [ ]:

```
from tensorflow.keras import Model

dense_net_121 = tf.keras.applications.DenseNet121(input_shape=[256,256,3],include_top=False,pooling
='avg')
base_model_output = tf.keras.layers.Dense(units=14,activation='relu')(dense_net_121.output)
base_model = Model(inputs = dense_net_121.input,outputs=base_model_output)
base_model.load_weights('brucechou1983_CheXNet_Keras_0.3.0_weights.h5')
output_layer = tf.keras.layers.Dense(1,activation='sigmoid')(base_model.layers[-2].output)
model = Model(inputs=base_model.inputs, outputs=output_layer)
model1=tf.keras.layers.UpSampling2D((2,2))(model.layers[-3].output)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool4_conv').output])
model1=tf.keras.layers.Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool3_conv').output])
model1=tf.keras.layers.Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_un
iform')(model1)

model1= tf.keras.layers.Dropout(0.5)(model1)


model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('pool2_conv').output])
model1=tf.keras.layers.Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)

model1= tf.keras.layers.Dropout(0.5)(model1)


model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.concatenate([model1,model.get_layer('conv1/relu').output])
model1=tf.keras.layers.Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
```

```
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)

model1= tf.keras.layers.Dropout(0.7)(model1)


model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.UpSampling2D((2,2))(model1)
model1=tf.keras.layers.Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_uni
form')(model1)
model1=tf.keras.layers.BatchNormalization()(model1)
model1=tf.keras.layers.Activation('relu')(model1)
model1=tf.keras.layers.Conv2D(1,(3,3),padding='same',use_bias=True,kernel_initializer='glorot_unifo
rm')(model1)
model1=tf.keras.layers.Activation('sigmoid')(model1)


unet_chexnet_model=Model(inputs=model.inputs, outputs=model1)
unet_chexnet_model.compile(optimizer=tf.keras.optimizers.Adam(lr=0.0001),
loss='binary_crossentropy', metrics=['accuracy',dice_coef])
unet_chexnet_model.summary()
```

```
Model: "functional_5"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)            [(None, 256, 256, 3) 0
__________________________________________________________________________________________________
zero_padding2d (ZeroPadding2D)  (None, 262, 262, 3)  0           input_1[0][0]
__________________________________________________________________________________________________
conv1/conv (Conv2D)             (None, 128, 128, 64) 9408        zero_padding2d[0][0]
__________________________________________________________________________________________________
conv1/bn (BatchNormalization)   (None, 128, 128, 64) 256         conv1/conv[0][0]
__________________________________________________________________________________________________
conv1/relu (Activation)         (None, 128, 128, 64) 0           conv1/bn[0][0]
__________________________________________________________________________________________________
zero_padding2d_1 (ZeroPadding2D (None, 130, 130, 64) 0           conv1/relu[0][0]
__________________________________________________________________________________________________
pool1 (MaxPooling2D)            (None, 64, 64, 64)   0           zero_padding2d_1[0][0]
__________________________________________________________________________________________________
conv2_block1_0_bn (BatchNormali (None, 64, 64, 64)   256         pool1[0][0]
__________________________________________________________________________________________________
conv2_block1_0_relu (Activation (None, 64, 64, 64)   0           conv2_block1_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block1_1_conv (Conv2D)    (None, 64, 64, 128)  8192        conv2_block1_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block1_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block1_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block1_1_relu (Activation (None, 64, 64, 128)  0           conv2_block1_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block1_2_conv (Conv2D)    (None, 64, 64, 32)   36864       conv2_block1_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block1_concat (Concatenat (None, 64, 64, 96)   0           pool1[0][0]
                                                                 conv2_block1_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block2_0_bn (BatchNormali (None, 64, 64, 96)   384         conv2_block1_concat[0][0]
__________________________________________________________________________________________________
conv2_block2_0_relu (Activation (None, 64, 64, 96)   0           conv2_block2_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block2_1_conv (Conv2D)    (None, 64, 64, 128)  12288       conv2_block2_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block2_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block2_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block2_1_relu (Activation (None, 64, 64, 128)  0           conv2_block2_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block2_2_conv (Conv2D)    (None, 64, 64, 32)   36864       conv2_block2_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block2_concat (Concatenat (None, 64, 64, 128)  0           conv2_block1_concat[0][0]
```

```
                                                                 conv2_block2_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block3_0_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block2_concat[0][0]
__________________________________________________________________________________________________
conv2_block3_0_relu (Activation (None, 64, 64, 128)  0           conv2_block3_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block3_1_conv (Conv2D)    (None, 64, 64, 128)  16384       conv2_block3_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block3_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block3_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block3_1_relu (Activation (None, 64, 64, 128)  0           conv2_block3_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block3_2_conv (Conv2D)    (None, 64, 64, 32)   36864       conv2_block3_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block3_concat (Concatenat (None, 64, 64, 160)  0           conv2_block2_concat[0][0]
                                                                 conv2_block3_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block4_0_bn (BatchNormali (None, 64, 64, 160)  640         conv2_block3_concat[0][0]
__________________________________________________________________________________________________
conv2_block4_0_relu (Activation (None, 64, 64, 160)  0           conv2_block4_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block4_1_conv (Conv2D)    (None, 64, 64, 128)  20480       conv2_block4_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block4_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block4_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block4_1_relu (Activation (None, 64, 64, 128)  0           conv2_block4_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block4_2_conv (Conv2D)    (None, 64, 64, 32)   36864       conv2_block4_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block4_concat (Concatenat (None, 64, 64, 192)  0           conv2_block3_concat[0][0]
                                                                 conv2_block4_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block5_0_bn (BatchNormali (None, 64, 64, 192)  768         conv2_block4_concat[0][0]
__________________________________________________________________________________________________
conv2_block5_0_relu (Activation (None, 64, 64, 192)  0           conv2_block5_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block5_1_conv (Conv2D)    (None, 64, 64, 128)  24576       conv2_block5_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block5_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block5_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block5_1_relu (Activation (None, 64, 64, 128)  0           conv2_block5_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block5_2_conv (Conv2D)    (None, 64, 64, 32)   36864       conv2_block5_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block5_concat (Concatenat (None, 64, 64, 224)  0           conv2_block4_concat[0][0]
                                                                 conv2_block5_2_conv[0][0]
__________________________________________________________________________________________________
conv2_block6_0_bn (BatchNormali (None, 64, 64, 224)  896         conv2_block5_concat[0][0]
__________________________________________________________________________________________________
conv2_block6_0_relu (Activation (None, 64, 64, 224)  0           conv2_block6_0_bn[0][0]
__________________________________________________________________________________________________
conv2_block6_1_conv (Conv2D)    (None, 64, 64, 128)  28672       conv2_block6_0_relu[0][0]
__________________________________________________________________________________________________
conv2_block6_1_bn (BatchNormali (None, 64, 64, 128)  512         conv2_block6_1_conv[0][0]
__________________________________________________________________________________________________
conv2_block6_1_relu (Activation (None, 64, 64, 128)  0           conv2_block6_1_bn[0][0]
__________________________________________________________________________________________________
conv2_block6_2_conv (Conv2D)    (None, 64, 64, 32)   36864       conv2_block6_1_relu[0][0]
__________________________________________________________________________________________________
conv2_block6_concat (Concatenat (None, 64, 64, 256)  0           conv2_block5_concat[0][0]
                                                                 conv2_block6_2_conv[0][0]
__________________________________________________________________________________________________
pool2_bn (BatchNormalization)   (None, 64, 64, 256)  1024        conv2_block6_concat[0][0]
__________________________________________________________________________________________________
pool2_relu (Activation)         (None, 64, 64, 256)  0           pool2_bn[0][0]
__________________________________________________________________________________________________
pool2_conv (Conv2D)             (None, 64, 64, 128)  32768       pool2_relu[0][0]
__________________________________________________________________________________________________
pool2_pool (AveragePooling2D)   (None, 32, 32, 128)  0           pool2_conv[0][0]
__________________________________________________________________________________________________
conv3_block1_0_bn (BatchNormali (None, 32, 32, 128)  512         pool2_pool[0][0]
__________________________________________________________________________________________________
conv3_block1_0_relu (Activation (None, 32, 32, 128)  0           conv3_block1_0_bn[0][0]
__________________________________________________________________________________________________
conv3_block1_1_conv (Conv2D)    (None, 32, 32, 128)  16384       conv3_block1_0_relu[0][0]
__________________________________________________________________________________________________
conv3_block1_1_bn (BatchNormali (None, 32, 32, 128)  512         conv3_block1_1_conv[0][0]
```

conv3_block1_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block1_1_bn[0][0]	
conv3_block1_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block1_1_relu[0][0]	
conv3_block1_concat (Concatenat	(None, 32, 32, 160)	0	pool2_pool[0][0] conv3_block1_2_conv[0][0]	
conv3_block2_0_bn (BatchNormali	(None, 32, 32, 160)	640	conv3_block1_concat[0][0]	
conv3_block2_0_relu (Activation	(None, 32, 32, 160)	0	conv3_block2_0_bn[0][0]	
conv3_block2_1_conv (Conv2D)	(None, 32, 32, 128)	20480	conv3_block2_0_relu[0][0]	
conv3_block2_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block2_1_conv[0][0]	
conv3_block2_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block2_1_bn[0][0]	
conv3_block2_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block2_1_relu[0][0]	
conv3_block2_concat (Concatenat	(None, 32, 32, 192)	0	conv3_block1_concat[0][0] conv3_block2_2_conv[0][0]	
conv3_block3_0_bn (BatchNormali	(None, 32, 32, 192)	768	conv3_block2_concat[0][0]	
conv3_block3_0_relu (Activation	(None, 32, 32, 192)	0	conv3_block3_0_bn[0][0]	
conv3_block3_1_conv (Conv2D)	(None, 32, 32, 128)	24576	conv3_block3_0_relu[0][0]	
conv3_block3_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block3_1_conv[0][0]	
conv3_block3_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block3_1_bn[0][0]	
conv3_block3_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block3_1_relu[0][0]	
conv3_block3_concat (Concatenat	(None, 32, 32, 224)	0	conv3_block2_concat[0][0] conv3_block3_2_conv[0][0]	
conv3_block4_0_bn (BatchNormali	(None, 32, 32, 224)	896	conv3_block3_concat[0][0]	
conv3_block4_0_relu (Activation	(None, 32, 32, 224)	0	conv3_block4_0_bn[0][0]	
conv3_block4_1_conv (Conv2D)	(None, 32, 32, 128)	28672	conv3_block4_0_relu[0][0]	
conv3_block4_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block4_1_conv[0][0]	
conv3_block4_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block4_1_bn[0][0]	
conv3_block4_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block4_1_relu[0][0]	
conv3_block4_concat (Concatenat	(None, 32, 32, 256)	0	conv3_block3_concat[0][0] conv3_block4_2_conv[0][0]	
conv3_block5_0_bn (BatchNormali	(None, 32, 32, 256)	1024	conv3_block4_concat[0][0]	
conv3_block5_0_relu (Activation	(None, 32, 32, 256)	0	conv3_block5_0_bn[0][0]	
conv3_block5_1_conv (Conv2D)	(None, 32, 32, 128)	32768	conv3_block5_0_relu[0][0]	
conv3_block5_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block5_1_conv[0][0]	
conv3_block5_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block5_1_bn[0][0]	
conv3_block5_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block5_1_relu[0][0]	
conv3_block5_concat (Concatenat	(None, 32, 32, 288)	0	conv3_block4_concat[0][0] conv3_block5_2_conv[0][0]	
conv3_block6_0_bn (BatchNormali	(None, 32, 32, 288)	1152	conv3_block5_concat[0][0]	
conv3_block6_0_relu (Activation	(None, 32, 32, 288)	0	conv3_block6_0_bn[0][0]	
conv3_block6_1_conv (Conv2D)	(None, 32, 32, 128)	36864	conv3_block6_0_relu[0][0]	
conv3_block6_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block6_1_conv[0][0]	
conv3_block6_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block6_1_bn[0][0]	

conv3_block6_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block6_1_relu[0][0]
conv3_block6_concat (Concatenat	(None, 32, 32, 320)	0	conv3_block5_concat[0][0] conv3_block6_2_conv[0][0]
conv3_block7_0_bn (BatchNormali	(None, 32, 32, 320)	1280	conv3_block6_concat[0][0]
conv3_block7_0_relu (Activation	(None, 32, 32, 320)	0	conv3_block7_0_bn[0][0]
conv3_block7_1_conv (Conv2D)	(None, 32, 32, 128)	40960	conv3_block7_0_relu[0][0]
conv3_block7_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block7_1_conv[0][0]
conv3_block7_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block7_1_bn[0][0]
conv3_block7_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block7_1_relu[0][0]
conv3_block7_concat (Concatenat	(None, 32, 32, 352)	0	conv3_block6_concat[0][0] conv3_block7_2_conv[0][0]
conv3_block8_0_bn (BatchNormali	(None, 32, 32, 352)	1408	conv3_block7_concat[0][0]
conv3_block8_0_relu (Activation	(None, 32, 32, 352)	0	conv3_block8_0_bn[0][0]
conv3_block8_1_conv (Conv2D)	(None, 32, 32, 128)	45056	conv3_block8_0_relu[0][0]
conv3_block8_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block8_1_conv[0][0]
conv3_block8_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block8_1_bn[0][0]
conv3_block8_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block8_1_relu[0][0]
conv3_block8_concat (Concatenat	(None, 32, 32, 384)	0	conv3_block7_concat[0][0] conv3_block8_2_conv[0][0]
conv3_block9_0_bn (BatchNormali	(None, 32, 32, 384)	1536	conv3_block8_concat[0][0]
conv3_block9_0_relu (Activation	(None, 32, 32, 384)	0	conv3_block9_0_bn[0][0]
conv3_block9_1_conv (Conv2D)	(None, 32, 32, 128)	49152	conv3_block9_0_relu[0][0]
conv3_block9_1_bn (BatchNormali	(None, 32, 32, 128)	512	conv3_block9_1_conv[0][0]
conv3_block9_1_relu (Activation	(None, 32, 32, 128)	0	conv3_block9_1_bn[0][0]
conv3_block9_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block9_1_relu[0][0]
conv3_block9_concat (Concatenat	(None, 32, 32, 416)	0	conv3_block8_concat[0][0] conv3_block9_2_conv[0][0]
conv3_block10_0_bn (BatchNormal	(None, 32, 32, 416)	1664	conv3_block9_concat[0][0]
conv3_block10_0_relu (Activatio	(None, 32, 32, 416)	0	conv3_block10_0_bn[0][0]
conv3_block10_1_conv (Conv2D)	(None, 32, 32, 128)	53248	conv3_block10_0_relu[0][0]
conv3_block10_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block10_1_conv[0][0]
conv3_block10_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block10_1_bn[0][0]
conv3_block10_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block10_1_relu[0][0]
conv3_block10_concat (Concatena	(None, 32, 32, 448)	0	conv3_block9_concat[0][0] conv3_block10_2_conv[0][0]
conv3_block11_0_bn (BatchNormal	(None, 32, 32, 448)	1792	conv3_block10_concat[0][0]
conv3_block11_0_relu (Activatio	(None, 32, 32, 448)	0	conv3_block11_0_bn[0][0]
conv3_block11_1_conv (Conv2D)	(None, 32, 32, 128)	57344	conv3_block11_0_relu[0][0]
conv3_block11_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block11_1_conv[0][0]
conv3_block11_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block11_1_bn[0][0]
conv3_block11_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block11_1_relu[0][0]

conv3_block11_concat (Concatena	(None, 32, 32, 480)	0	conv3_block10_concat[0][0] conv3_block11_2_conv[0][0]
conv3_block12_0_bn (BatchNormal	(None, 32, 32, 480)	1920	conv3_block11_concat[0][0]
conv3_block12_0_relu (Activatio	(None, 32, 32, 480)	0	conv3_block12_0_bn[0][0]
conv3_block12_1_conv (Conv2D)	(None, 32, 32, 128)	61440	conv3_block12_0_relu[0][0]
conv3_block12_1_bn (BatchNormal	(None, 32, 32, 128)	512	conv3_block12_1_conv[0][0]
conv3_block12_1_relu (Activatio	(None, 32, 32, 128)	0	conv3_block12_1_bn[0][0]
conv3_block12_2_conv (Conv2D)	(None, 32, 32, 32)	36864	conv3_block12_1_relu[0][0]
conv3_block12_concat (Concatena	(None, 32, 32, 512)	0	conv3_block11_concat[0][0] conv3_block12_2_conv[0][0]
pool3_bn (BatchNormalization)	(None, 32, 32, 512)	2048	conv3_block12_concat[0][0]
pool3_relu (Activation)	(None, 32, 32, 512)	0	pool3_bn[0][0]
pool3_conv (Conv2D)	(None, 32, 32, 256)	131072	pool3_relu[0][0]
pool3_pool (AveragePooling2D)	(None, 16, 16, 256)	0	pool3_conv[0][0]
conv4_block1_0_bn (BatchNormali	(None, 16, 16, 256)	1024	pool3_pool[0][0]
conv4_block1_0_relu (Activation	(None, 16, 16, 256)	0	conv4_block1_0_bn[0][0]
conv4_block1_1_conv (Conv2D)	(None, 16, 16, 128)	32768	conv4_block1_0_relu[0][0]
conv4_block1_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block1_1_conv[0][0]
conv4_block1_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block1_1_bn[0][0]
conv4_block1_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block1_1_relu[0][0]
conv4_block1_concat (Concatenat	(None, 16, 16, 288)	0	pool3_pool[0][0] conv4_block1_2_conv[0][0]
conv4_block2_0_bn (BatchNormali	(None, 16, 16, 288)	1152	conv4_block1_concat[0][0]
conv4_block2_0_relu (Activation	(None, 16, 16, 288)	0	conv4_block2_0_bn[0][0]
conv4_block2_1_conv (Conv2D)	(None, 16, 16, 128)	36864	conv4_block2_0_relu[0][0]
conv4_block2_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block2_1_conv[0][0]
conv4_block2_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block2_1_bn[0][0]
conv4_block2_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block2_1_relu[0][0]
conv4_block2_concat (Concatenat	(None, 16, 16, 320)	0	conv4_block1_concat[0][0] conv4_block2_2_conv[0][0]
conv4_block3_0_bn (BatchNormali	(None, 16, 16, 320)	1280	conv4_block2_concat[0][0]
conv4_block3_0_relu (Activation	(None, 16, 16, 320)	0	conv4_block3_0_bn[0][0]
conv4_block3_1_conv (Conv2D)	(None, 16, 16, 128)	40960	conv4_block3_0_relu[0][0]
conv4_block3_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block3_1_conv[0][0]
conv4_block3_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block3_1_bn[0][0]
conv4_block3_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block3_1_relu[0][0]
conv4_block3_concat (Concatenat	(None, 16, 16, 352)	0	conv4_block2_concat[0][0] conv4_block3_2_conv[0][0]
conv4_block4_0_bn (BatchNormali	(None, 16, 16, 352)	1408	conv4_block3_concat[0][0]
conv4_block4_0_relu (Activation	(None, 16, 16, 352)	0	conv4_block4_0_bn[0][0]
conv4_block4_1_conv (Conv2D)	(None, 16, 16, 128)	45056	conv4_block4_0_relu[0][0]

conv4_block4_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block4_1_conv[0][0]	
conv4_block4_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block4_1_bn[0][0]	
conv4_block4_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block4_1_relu[0][0]	
conv4_block4_concat (Concatenat	(None, 16, 16, 384)	0	conv4_block3_concat[0][0] conv4_block4_2_conv[0][0]	
conv4_block5_0_bn (BatchNormali	(None, 16, 16, 384)	1536	conv4_block4_concat[0][0]	
conv4_block5_0_relu (Activation	(None, 16, 16, 384)	0	conv4_block5_0_bn[0][0]	
conv4_block5_1_conv (Conv2D)	(None, 16, 16, 128)	49152	conv4_block5_0_relu[0][0]	
conv4_block5_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block5_1_conv[0][0]	
conv4_block5_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block5_1_bn[0][0]	
conv4_block5_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block5_1_relu[0][0]	
conv4_block5_concat (Concatenat	(None, 16, 16, 416)	0	conv4_block4_concat[0][0] conv4_block5_2_conv[0][0]	
conv4_block6_0_bn (BatchNormali	(None, 16, 16, 416)	1664	conv4_block5_concat[0][0]	
conv4_block6_0_relu (Activation	(None, 16, 16, 416)	0	conv4_block6_0_bn[0][0]	
conv4_block6_1_conv (Conv2D)	(None, 16, 16, 128)	53248	conv4_block6_0_relu[0][0]	
conv4_block6_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block6_1_conv[0][0]	
conv4_block6_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block6_1_bn[0][0]	
conv4_block6_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block6_1_relu[0][0]	
conv4_block6_concat (Concatenat	(None, 16, 16, 448)	0	conv4_block5_concat[0][0] conv4_block6_2_conv[0][0]	
conv4_block7_0_bn (BatchNormali	(None, 16, 16, 448)	1792	conv4_block6_concat[0][0]	
conv4_block7_0_relu (Activation	(None, 16, 16, 448)	0	conv4_block7_0_bn[0][0]	
conv4_block7_1_conv (Conv2D)	(None, 16, 16, 128)	57344	conv4_block7_0_relu[0][0]	
conv4_block7_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block7_1_conv[0][0]	
conv4_block7_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block7_1_bn[0][0]	
conv4_block7_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block7_1_relu[0][0]	
conv4_block7_concat (Concatenat	(None, 16, 16, 480)	0	conv4_block6_concat[0][0] conv4_block7_2_conv[0][0]	
conv4_block8_0_bn (BatchNormali	(None, 16, 16, 480)	1920	conv4_block7_concat[0][0]	
conv4_block8_0_relu (Activation	(None, 16, 16, 480)	0	conv4_block8_0_bn[0][0]	
conv4_block8_1_conv (Conv2D)	(None, 16, 16, 128)	61440	conv4_block8_0_relu[0][0]	
conv4_block8_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block8_1_conv[0][0]	
conv4_block8_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block8_1_bn[0][0]	
conv4_block8_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block8_1_relu[0][0]	
conv4_block8_concat (Concatenat	(None, 16, 16, 512)	0	conv4_block7_concat[0][0] conv4_block8_2_conv[0][0]	
conv4_block9_0_bn (BatchNormali	(None, 16, 16, 512)	2048	conv4_block8_concat[0][0]	
conv4_block9_0_relu (Activation	(None, 16, 16, 512)	0	conv4_block9_0_bn[0][0]	
conv4_block9_1_conv (Conv2D)	(None, 16, 16, 128)	65536	conv4_block9_0_relu[0][0]	
conv4_block9_1_bn (BatchNormali	(None, 16, 16, 128)	512	conv4_block9_1_conv[0][0]	

conv4_block9_1_relu (Activation	(None, 16, 16, 128)	0	conv4_block9_1_bn[0][0]	
conv4_block9_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block9_1_relu[0][0]	
conv4_block9_concat (Concatenat	(None, 16, 16, 544)	0	conv4_block8_concat[0][0] conv4_block9_2_conv[0][0]	
conv4_block10_0_bn (BatchNormal	(None, 16, 16, 544)	2176	conv4_block9_concat[0][0]	
conv4_block10_0_relu (Activatio	(None, 16, 16, 544)	0	conv4_block10_0_bn[0][0]	
conv4_block10_1_conv (Conv2D)	(None, 16, 16, 128)	69632	conv4_block10_0_relu[0][0]	
conv4_block10_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block10_1_conv[0][0]	
conv4_block10_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block10_1_bn[0][0]	
conv4_block10_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block10_1_relu[0][0]	
conv4_block10_concat (Concatena	(None, 16, 16, 576)	0	conv4_block9_concat[0][0] conv4_block10_2_conv[0][0]	
conv4_block11_0_bn (BatchNormal	(None, 16, 16, 576)	2304	conv4_block10_concat[0][0]	
conv4_block11_0_relu (Activatio	(None, 16, 16, 576)	0	conv4_block11_0_bn[0][0]	
conv4_block11_1_conv (Conv2D)	(None, 16, 16, 128)	73728	conv4_block11_0_relu[0][0]	
conv4_block11_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block11_1_conv[0][0]	
conv4_block11_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block11_1_bn[0][0]	
conv4_block11_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block11_1_relu[0][0]	
conv4_block11_concat (Concatena	(None, 16, 16, 608)	0	conv4_block10_concat[0][0] conv4_block11_2_conv[0][0]	
conv4_block12_0_bn (BatchNormal	(None, 16, 16, 608)	2432	conv4_block11_concat[0][0]	
conv4_block12_0_relu (Activatio	(None, 16, 16, 608)	0	conv4_block12_0_bn[0][0]	
conv4_block12_1_conv (Conv2D)	(None, 16, 16, 128)	77824	conv4_block12_0_relu[0][0]	
conv4_block12_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block12_1_conv[0][0]	
conv4_block12_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block12_1_bn[0][0]	
conv4_block12_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block12_1_relu[0][0]	
conv4_block12_concat (Concatena	(None, 16, 16, 640)	0	conv4_block11_concat[0][0] conv4_block12_2_conv[0][0]	
conv4_block13_0_bn (BatchNormal	(None, 16, 16, 640)	2560	conv4_block12_concat[0][0]	
conv4_block13_0_relu (Activatio	(None, 16, 16, 640)	0	conv4_block13_0_bn[0][0]	
conv4_block13_1_conv (Conv2D)	(None, 16, 16, 128)	81920	conv4_block13_0_relu[0][0]	
conv4_block13_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block13_1_conv[0][0]	
conv4_block13_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block13_1_bn[0][0]	
conv4_block13_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block13_1_relu[0][0]	
conv4_block13_concat (Concatena	(None, 16, 16, 672)	0	conv4_block12_concat[0][0] conv4_block13_2_conv[0][0]	
conv4_block14_0_bn (BatchNormal	(None, 16, 16, 672)	2688	conv4_block13_concat[0][0]	
conv4_block14_0_relu (Activatio	(None, 16, 16, 672)	0	conv4_block14_0_bn[0][0]	
conv4_block14_1_conv (Conv2D)	(None, 16, 16, 128)	86016	conv4_block14_0_relu[0][0]	
conv4_block14_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block14_1_conv[0][0]	
conv4_block14_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block14_1_bn[0][0]	

conv4_block14_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block14_1_relu[0][0]
conv4_block14_concat (Concatena	(None, 16, 16, 704)	0	conv4_block13_concat[0][0] conv4_block14_2_conv[0][0]
conv4_block15_0_bn (BatchNormal	(None, 16, 16, 704)	2816	conv4_block14_concat[0][0]
conv4_block15_0_relu (Activatio	(None, 16, 16, 704)	0	conv4_block15_0_bn[0][0]
conv4_block15_1_conv (Conv2D)	(None, 16, 16, 128)	90112	conv4_block15_0_relu[0][0]
conv4_block15_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block15_1_conv[0][0]
conv4_block15_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block15_1_bn[0][0]
conv4_block15_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block15_1_relu[0][0]
conv4_block15_concat (Concatena	(None, 16, 16, 736)	0	conv4_block14_concat[0][0] conv4_block15_2_conv[0][0]
conv4_block16_0_bn (BatchNormal	(None, 16, 16, 736)	2944	conv4_block15_concat[0][0]
conv4_block16_0_relu (Activatio	(None, 16, 16, 736)	0	conv4_block16_0_bn[0][0]
conv4_block16_1_conv (Conv2D)	(None, 16, 16, 128)	94208	conv4_block16_0_relu[0][0]
conv4_block16_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block16_1_conv[0][0]
conv4_block16_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block16_1_bn[0][0]
conv4_block16_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block16_1_relu[0][0]
conv4_block16_concat (Concatena	(None, 16, 16, 768)	0	conv4_block15_concat[0][0] conv4_block16_2_conv[0][0]
conv4_block17_0_bn (BatchNormal	(None, 16, 16, 768)	3072	conv4_block16_concat[0][0]
conv4_block17_0_relu (Activatio	(None, 16, 16, 768)	0	conv4_block17_0_bn[0][0]
conv4_block17_1_conv (Conv2D)	(None, 16, 16, 128)	98304	conv4_block17_0_relu[0][0]
conv4_block17_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block17_1_conv[0][0]
conv4_block17_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block17_1_bn[0][0]
conv4_block17_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block17_1_relu[0][0]
conv4_block17_concat (Concatena	(None, 16, 16, 800)	0	conv4_block16_concat[0][0] conv4_block17_2_conv[0][0]
conv4_block18_0_bn (BatchNormal	(None, 16, 16, 800)	3200	conv4_block17_concat[0][0]
conv4_block18_0_relu (Activatio	(None, 16, 16, 800)	0	conv4_block18_0_bn[0][0]
conv4_block18_1_conv (Conv2D)	(None, 16, 16, 128)	102400	conv4_block18_0_relu[0][0]
conv4_block18_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block18_1_conv[0][0]
conv4_block18_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block18_1_bn[0][0]
conv4_block18_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block18_1_relu[0][0]
conv4_block18_concat (Concatena	(None, 16, 16, 832)	0	conv4_block17_concat[0][0] conv4_block18_2_conv[0][0]
conv4_block19_0_bn (BatchNormal	(None, 16, 16, 832)	3328	conv4_block18_concat[0][0]
conv4_block19_0_relu (Activatio	(None, 16, 16, 832)	0	conv4_block19_0_bn[0][0]
conv4_block19_1_conv (Conv2D)	(None, 16, 16, 128)	106496	conv4_block19_0_relu[0][0]
conv4_block19_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block19_1_conv[0][0]
conv4_block19_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block19_1_bn[0][0]
conv4_block19_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block19_1_relu[0][0]

conv4_block19_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block19_1_relu[0][0]
conv4_block19_concat (Concatena	(None, 16, 16, 864)	0	conv4_block18_concat[0][0] conv4_block19_2_conv[0][0]
conv4_block20_0_bn (BatchNormal	(None, 16, 16, 864)	3456	conv4_block19_concat[0][0]
conv4_block20_0_relu (Activatio	(None, 16, 16, 864)	0	conv4_block20_0_bn[0][0]
conv4_block20_1_conv (Conv2D)	(None, 16, 16, 128)	110592	conv4_block20_0_relu[0][0]
conv4_block20_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block20_1_conv[0][0]
conv4_block20_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block20_1_bn[0][0]
conv4_block20_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block20_1_relu[0][0]
conv4_block20_concat (Concatena	(None, 16, 16, 896)	0	conv4_block19_concat[0][0] conv4_block20_2_conv[0][0]
conv4_block21_0_bn (BatchNormal	(None, 16, 16, 896)	3584	conv4_block20_concat[0][0]
conv4_block21_0_relu (Activatio	(None, 16, 16, 896)	0	conv4_block21_0_bn[0][0]
conv4_block21_1_conv (Conv2D)	(None, 16, 16, 128)	114688	conv4_block21_0_relu[0][0]
conv4_block21_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block21_1_conv[0][0]
conv4_block21_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block21_1_bn[0][0]
conv4_block21_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block21_1_relu[0][0]
conv4_block21_concat (Concatena	(None, 16, 16, 928)	0	conv4_block20_concat[0][0] conv4_block21_2_conv[0][0]
conv4_block22_0_bn (BatchNormal	(None, 16, 16, 928)	3712	conv4_block21_concat[0][0]
conv4_block22_0_relu (Activatio	(None, 16, 16, 928)	0	conv4_block22_0_bn[0][0]
conv4_block22_1_conv (Conv2D)	(None, 16, 16, 128)	118784	conv4_block22_0_relu[0][0]
conv4_block22_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block22_1_conv[0][0]
conv4_block22_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block22_1_bn[0][0]
conv4_block22_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block22_1_relu[0][0]
conv4_block22_concat (Concatena	(None, 16, 16, 960)	0	conv4_block21_concat[0][0] conv4_block22_2_conv[0][0]
conv4_block23_0_bn (BatchNormal	(None, 16, 16, 960)	3840	conv4_block22_concat[0][0]
conv4_block23_0_relu (Activatio	(None, 16, 16, 960)	0	conv4_block23_0_bn[0][0]
conv4_block23_1_conv (Conv2D)	(None, 16, 16, 128)	122880	conv4_block23_0_relu[0][0]
conv4_block23_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block23_1_conv[0][0]
conv4_block23_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block23_1_bn[0][0]
conv4_block23_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block23_1_relu[0][0]
conv4_block23_concat (Concatena	(None, 16, 16, 992)	0	conv4_block22_concat[0][0] conv4_block23_2_conv[0][0]
conv4_block24_0_bn (BatchNormal	(None, 16, 16, 992)	3968	conv4_block23_concat[0][0]
conv4_block24_0_relu (Activatio	(None, 16, 16, 992)	0	conv4_block24_0_bn[0][0]
conv4_block24_1_conv (Conv2D)	(None, 16, 16, 128)	126976	conv4_block24_0_relu[0][0]
conv4_block24_1_bn (BatchNormal	(None, 16, 16, 128)	512	conv4_block24_1_conv[0][0]
conv4_block24_1_relu (Activatio	(None, 16, 16, 128)	0	conv4_block24_1_bn[0][0]
conv4_block24_2_conv (Conv2D)	(None, 16, 16, 32)	36864	conv4_block24_1_relu[0][0]
conv4_block24_concat (Concatena	(None, 16, 16, 1024)	0	conv4_block23_concat[0][0]

conv4_block24_concat (Concatena	(None, 16, 16, 1024)	0	conv4_block23_concat[0][0] conv4_block24_2_conv[0][0]
pool4_bn (BatchNormalization)	(None, 16, 16, 1024)	4096	conv4_block24_concat[0][0]
pool4_relu (Activation)	(None, 16, 16, 1024)	0	pool4_bn[0][0]
pool4_conv (Conv2D)	(None, 16, 16, 512)	524288	pool4_relu[0][0]
pool4_pool (AveragePooling2D)	(None, 8, 8, 512)	0	pool4_conv[0][0]
conv5_block1_0_bn (BatchNormali	(None, 8, 8, 512)	2048	pool4_pool[0][0]
conv5_block1_0_relu (Activation	(None, 8, 8, 512)	0	conv5_block1_0_bn[0][0]
conv5_block1_1_conv (Conv2D)	(None, 8, 8, 128)	65536	conv5_block1_0_relu[0][0]
conv5_block1_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block1_1_conv[0][0]
conv5_block1_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block1_1_bn[0][0]
conv5_block1_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block1_1_relu[0][0]
conv5_block1_concat (Concatenat	(None, 8, 8, 544)	0	pool4_pool[0][0] conv5_block1_2_conv[0][0]
conv5_block2_0_bn (BatchNormali	(None, 8, 8, 544)	2176	conv5_block1_concat[0][0]
conv5_block2_0_relu (Activation	(None, 8, 8, 544)	0	conv5_block2_0_bn[0][0]
conv5_block2_1_conv (Conv2D)	(None, 8, 8, 128)	69632	conv5_block2_0_relu[0][0]
conv5_block2_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block2_1_conv[0][0]
conv5_block2_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block2_1_bn[0][0]
conv5_block2_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block2_1_relu[0][0]
conv5_block2_concat (Concatenat	(None, 8, 8, 576)	0	conv5_block1_concat[0][0] conv5_block2_2_conv[0][0]
conv5_block3_0_bn (BatchNormali	(None, 8, 8, 576)	2304	conv5_block2_concat[0][0]
conv5_block3_0_relu (Activation	(None, 8, 8, 576)	0	conv5_block3_0_bn[0][0]
conv5_block3_1_conv (Conv2D)	(None, 8, 8, 128)	73728	conv5_block3_0_relu[0][0]
conv5_block3_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block3_1_conv[0][0]
conv5_block3_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block3_1_bn[0][0]
conv5_block3_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block3_1_relu[0][0]
conv5_block3_concat (Concatenat	(None, 8, 8, 608)	0	conv5_block2_concat[0][0] conv5_block3_2_conv[0][0]
conv5_block4_0_bn (BatchNormali	(None, 8, 8, 608)	2432	conv5_block3_concat[0][0]
conv5_block4_0_relu (Activation	(None, 8, 8, 608)	0	conv5_block4_0_bn[0][0]
conv5_block4_1_conv (Conv2D)	(None, 8, 8, 128)	77824	conv5_block4_0_relu[0][0]
conv5_block4_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block4_1_conv[0][0]
conv5_block4_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block4_1_bn[0][0]
conv5_block4_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block4_1_relu[0][0]
conv5_block4_concat (Concatenat	(None, 8, 8, 640)	0	conv5_block3_concat[0][0] conv5_block4_2_conv[0][0]
conv5_block5_0_bn (BatchNormali	(None, 8, 8, 640)	2560	conv5_block4_concat[0][0]
conv5_block5_0_relu (Activation	(None, 8, 8, 640)	0	conv5_block5_0_bn[0][0]
conv5_block5_1_conv (Conv2D)	(None, 8, 8, 128)	81920	conv5_block5_0_relu[0][0]
conv5_block5_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block5_1_conv[0][0]

conv5_block5_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block5_1_conv[0][0]
conv5_block5_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block5_1_bn[0][0]
conv5_block5_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block5_1_relu[0][0]
conv5_block5_concat (Concatenat	(None, 8, 8, 672)	0	conv5_block4_concat[0][0] conv5_block5_2_conv[0][0]
conv5_block6_0_bn (BatchNormali	(None, 8, 8, 672)	2688	conv5_block5_concat[0][0]
conv5_block6_0_relu (Activation	(None, 8, 8, 672)	0	conv5_block6_0_bn[0][0]
conv5_block6_1_conv (Conv2D)	(None, 8, 8, 128)	86016	conv5_block6_0_relu[0][0]
conv5_block6_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block6_1_conv[0][0]
conv5_block6_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block6_1_bn[0][0]
conv5_block6_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block6_1_relu[0][0]
conv5_block6_concat (Concatenat	(None, 8, 8, 704)	0	conv5_block5_concat[0][0] conv5_block6_2_conv[0][0]
conv5_block7_0_bn (BatchNormali	(None, 8, 8, 704)	2816	conv5_block6_concat[0][0]
conv5_block7_0_relu (Activation	(None, 8, 8, 704)	0	conv5_block7_0_bn[0][0]
conv5_block7_1_conv (Conv2D)	(None, 8, 8, 128)	90112	conv5_block7_0_relu[0][0]
conv5_block7_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block7_1_conv[0][0]
conv5_block7_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block7_1_bn[0][0]
conv5_block7_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block7_1_relu[0][0]
conv5_block7_concat (Concatenat	(None, 8, 8, 736)	0	conv5_block6_concat[0][0] conv5_block7_2_conv[0][0]
conv5_block8_0_bn (BatchNormali	(None, 8, 8, 736)	2944	conv5_block7_concat[0][0]
conv5_block8_0_relu (Activation	(None, 8, 8, 736)	0	conv5_block8_0_bn[0][0]
conv5_block8_1_conv (Conv2D)	(None, 8, 8, 128)	94208	conv5_block8_0_relu[0][0]
conv5_block8_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block8_1_conv[0][0]
conv5_block8_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block8_1_bn[0][0]
conv5_block8_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block8_1_relu[0][0]
conv5_block8_concat (Concatenat	(None, 8, 8, 768)	0	conv5_block7_concat[0][0] conv5_block8_2_conv[0][0]
conv5_block9_0_bn (BatchNormali	(None, 8, 8, 768)	3072	conv5_block8_concat[0][0]
conv5_block9_0_relu (Activation	(None, 8, 8, 768)	0	conv5_block9_0_bn[0][0]
conv5_block9_1_conv (Conv2D)	(None, 8, 8, 128)	98304	conv5_block9_0_relu[0][0]
conv5_block9_1_bn (BatchNormali	(None, 8, 8, 128)	512	conv5_block9_1_conv[0][0]
conv5_block9_1_relu (Activation	(None, 8, 8, 128)	0	conv5_block9_1_bn[0][0]
conv5_block9_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block9_1_relu[0][0]
conv5_block9_concat (Concatenat	(None, 8, 8, 800)	0	conv5_block8_concat[0][0] conv5_block9_2_conv[0][0]
conv5_block10_0_bn (BatchNormal	(None, 8, 8, 800)	3200	conv5_block9_concat[0][0]
conv5_block10_0_relu (Activatio	(None, 8, 8, 800)	0	conv5_block10_0_bn[0][0]
conv5_block10_1_conv (Conv2D)	(None, 8, 8, 128)	102400	conv5_block10_0_relu[0][0]
conv5_block10_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block10_1_conv[0][0]
conv5_block10_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block10_1_bn[0][0]

conv5_block10_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block10_1_bn[0][0]
conv5_block10_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block10_1_relu[0][0]
conv5_block10_concat (Concatena	(None, 8, 8, 832)	0	conv5_block9_concat[0][0] conv5_block10_2_conv[0][0]
conv5_block11_0_bn (BatchNormal	(None, 8, 8, 832)	3328	conv5_block10_concat[0][0]
conv5_block11_0_relu (Activatio	(None, 8, 8, 832)	0	conv5_block11_0_bn[0][0]
conv5_block11_1_conv (Conv2D)	(None, 8, 8, 128)	106496	conv5_block11_0_relu[0][0]
conv5_block11_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block11_1_conv[0][0]
conv5_block11_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block11_1_bn[0][0]
conv5_block11_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block11_1_relu[0][0]
conv5_block11_concat (Concatena	(None, 8, 8, 864)	0	conv5_block10_concat[0][0] conv5_block11_2_conv[0][0]
conv5_block12_0_bn (BatchNormal	(None, 8, 8, 864)	3456	conv5_block11_concat[0][0]
conv5_block12_0_relu (Activatio	(None, 8, 8, 864)	0	conv5_block12_0_bn[0][0]
conv5_block12_1_conv (Conv2D)	(None, 8, 8, 128)	110592	conv5_block12_0_relu[0][0]
conv5_block12_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block12_1_conv[0][0]
conv5_block12_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block12_1_bn[0][0]
conv5_block12_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block12_1_relu[0][0]
conv5_block12_concat (Concatena	(None, 8, 8, 896)	0	conv5_block11_concat[0][0] conv5_block12_2_conv[0][0]
conv5_block13_0_bn (BatchNormal	(None, 8, 8, 896)	3584	conv5_block12_concat[0][0]
conv5_block13_0_relu (Activatio	(None, 8, 8, 896)	0	conv5_block13_0_bn[0][0]
conv5_block13_1_conv (Conv2D)	(None, 8, 8, 128)	114688	conv5_block13_0_relu[0][0]
conv5_block13_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block13_1_conv[0][0]
conv5_block13_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block13_1_bn[0][0]
conv5_block13_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block13_1_relu[0][0]
conv5_block13_concat (Concatena	(None, 8, 8, 928)	0	conv5_block12_concat[0][0] conv5_block13_2_conv[0][0]
conv5_block14_0_bn (BatchNormal	(None, 8, 8, 928)	3712	conv5_block13_concat[0][0]
conv5_block14_0_relu (Activatio	(None, 8, 8, 928)	0	conv5_block14_0_bn[0][0]
conv5_block14_1_conv (Conv2D)	(None, 8, 8, 128)	118784	conv5_block14_0_relu[0][0]
conv5_block14_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block14_1_conv[0][0]
conv5_block14_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block14_1_bn[0][0]
conv5_block14_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block14_1_relu[0][0]
conv5_block14_concat (Concatena	(None, 8, 8, 960)	0	conv5_block13_concat[0][0] conv5_block14_2_conv[0][0]
conv5_block15_0_bn (BatchNormal	(None, 8, 8, 960)	3840	conv5_block14_concat[0][0]
conv5_block15_0_relu (Activatio	(None, 8, 8, 960)	0	conv5_block15_0_bn[0][0]
conv5_block15_1_conv (Conv2D)	(None, 8, 8, 128)	122880	conv5_block15_0_relu[0][0]
conv5_block15_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block15_1_conv[0][0]
conv5_block15_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block15_1_bn[0][0]
[illegible]	[illegible]	[illegible]	[illegible]

conv5_block15_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block15_1_relu[0][0]
conv5_block15_concat (Concatena	(None, 8, 8, 992)	0	conv5_block14_concat[0][0] conv5_block15_2_conv[0][0]
conv5_block16_0_bn (BatchNormal	(None, 8, 8, 992)	3968	conv5_block15_concat[0][0]
conv5_block16_0_relu (Activatio	(None, 8, 8, 992)	0	conv5_block16_0_bn[0][0]
conv5_block16_1_conv (Conv2D)	(None, 8, 8, 128)	126976	conv5_block16_0_relu[0][0]
conv5_block16_1_bn (BatchNormal	(None, 8, 8, 128)	512	conv5_block16_1_conv[0][0]
conv5_block16_1_relu (Activatio	(None, 8, 8, 128)	0	conv5_block16_1_bn[0][0]
conv5_block16_2_conv (Conv2D)	(None, 8, 8, 32)	36864	conv5_block16_1_relu[0][0]
conv5_block16_concat (Concatena	(None, 8, 8, 1024)	0	conv5_block15_concat[0][0] conv5_block16_2_conv[0][0]
bn (BatchNormalization)	(None, 8, 8, 1024)	4096	conv5_block16_concat[0][0]
relu (Activation)	(None, 8, 8, 1024)	0	bn[0][0]
up_sampling2d (UpSampling2D)	(None, 16, 16, 1024)	0	relu[0][0]
concatenate (Concatenate)	(None, 16, 16, 1536)	0	up_sampling2d[0][0] pool4_conv[0][0]
conv2d (Conv2D)	(None, 16, 16, 256)	3538944	concatenate[0][0]
batch_normalization (BatchNorma	(None, 16, 16, 256)	1024	conv2d[0][0]
activation (Activation)	(None, 16, 16, 256)	0	batch_normalization[0][0]
conv2d_1 (Conv2D)	(None, 16, 16, 256)	589824	activation[0][0]
batch_normalization_1 (BatchNor	(None, 16, 16, 256)	1024	conv2d_1[0][0]
activation_1 (Activation)	(None, 16, 16, 256)	0	batch_normalization_1[0][0]
up_sampling2d_1 (UpSampling2D)	(None, 32, 32, 256)	0	activation_1[0][0]
concatenate_1 (Concatenate)	(None, 32, 32, 512)	0	up_sampling2d_1[0][0] pool3_conv[0][0]
conv2d_2 (Conv2D)	(None, 32, 32, 128)	589824	concatenate_1[0][0]
batch_normalization_2 (BatchNor	(None, 32, 32, 128)	512	conv2d_2[0][0]
activation_2 (Activation)	(None, 32, 32, 128)	0	batch_normalization_2[0][0]
conv2d_3 (Conv2D)	(None, 32, 32, 128)	147456	activation_2[0][0]
dropout (Dropout)	(None, 32, 32, 128)	0	conv2d_3[0][0]
batch_normalization_3 (BatchNor	(None, 32, 32, 128)	512	dropout[0][0]
activation_3 (Activation)	(None, 32, 32, 128)	0	batch_normalization_3[0][0]
up_sampling2d_2 (UpSampling2D)	(None, 64, 64, 128)	0	activation_3[0][0]
concatenate_2 (Concatenate)	(None, 64, 64, 256)	0	up_sampling2d_2[0][0] pool2_conv[0][0]
conv2d_4 (Conv2D)	(None, 64, 64, 64)	147456	concatenate_2[0][0]
dropout_1 (Dropout)	(None, 64, 64, 64)	0	conv2d_4[0][0]
batch_normalization_4 (BatchNor	(None, 64, 64, 64)	256	dropout_1[0][0]
activation_4 (Activation)	(None, 64, 64, 64)	0	batch_normalization_4[0][0]
conv2d_5 (Conv2D)	(None, 64, 64, 64)	36864	activation_4[0][0]
batch_normalization_5 (BatchNor	(None, 64, 64, 64)	256	conv2d_5[0][0]

```
activation_5 (Activation)       (None, 64, 64, 64)   0           batch_normalization_5[0][0]
__________________________________________________________________________________________________
up_sampling2d_3 (UpSampling2D)  (None, 128, 128, 64) 0           activation_5[0][0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 128, 128, 128 0           up_sampling2d_3[0][0]
                                                                 conv1/relu[0][0]
__________________________________________________________________________________________________
conv2d_6 (Conv2D)               (None, 128, 128, 32) 36864       concatenate_3[0][0]
__________________________________________________________________________________________________
batch_normalization_6 (BatchNor (None, 128, 128, 32) 128         conv2d_6[0][0]
__________________________________________________________________________________________________
activation_6 (Activation)       (None, 128, 128, 32) 0           batch_normalization_6[0][0]
__________________________________________________________________________________________________
conv2d_7 (Conv2D)               (None, 128, 128, 32) 9216        activation_6[0][0]
__________________________________________________________________________________________________
dropout_2 (Dropout)             (None, 128, 128, 32) 0           conv2d_7[0][0]
__________________________________________________________________________________________________
batch_normalization_7 (BatchNor (None, 128, 128, 32) 128         dropout_2[0][0]
__________________________________________________________________________________________________
activation_7 (Activation)       (None, 128, 128, 32) 0           batch_normalization_7[0][0]
__________________________________________________________________________________________________
up_sampling2d_4 (UpSampling2D)  (None, 256, 256, 32) 0           activation_7[0][0]
__________________________________________________________________________________________________
conv2d_8 (Conv2D)               (None, 256, 256, 16) 4608        up_sampling2d_4[0][0]
__________________________________________________________________________________________________
batch_normalization_8 (BatchNor (None, 256, 256, 16) 64          conv2d_8[0][0]
__________________________________________________________________________________________________
activation_8 (Activation)       (None, 256, 256, 16) 0           batch_normalization_8[0][0]
__________________________________________________________________________________________________
conv2d_9 (Conv2D)               (None, 256, 256, 16) 2304        activation_8[0][0]
__________________________________________________________________________________________________
batch_normalization_9 (BatchNor (None, 256, 256, 16) 64          conv2d_9[0][0]
__________________________________________________________________________________________________
activation_9 (Activation)       (None, 256, 256, 16) 0           batch_normalization_9[0][0]
__________________________________________________________________________________________________
conv2d_10 (Conv2D)              (None, 256, 256, 1)  145         activation_9[0][0]
__________________________________________________________________________________________________
activation_10 (Activation)      (None, 256, 256, 1)  0           conv2d_10[0][0]
==================================================================================================
Total params: 12,144,977
Trainable params: 12,059,345
Non-trainable params: 85,632
__________________________________________________________________________________________________
```

In [ ]:

```
from tensorflow.keras.callbacks import ModelCheckpoint
filepath="/content/drive/My Drive/model_save/weights-{epoch:02d}-{val_dice_coef:.4f}.hdf5"
checkpoint = ModelCheckpoint(filepath=filepath, monitor='val_dice_coef',verbose=1, save_best_only=True, mode='max')
```

In [ ]:

```
tf.keras.backend.clear_session()
# Tensorbaord
logdir = os.path.join("/content/drive/My Drive/logs","unet_chexnet01_(Dropout)no_augmentation")
tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)
%tensorboard --logdir='/content/drive/My Drive/logs/unet_chexnet01_(Dropout)no_augmentation/'
unet_chexnet_model.fit(train_dataset,epochs=20,batch_size=16,validation_data=test_dataset,callbacks=[tensorboard_callback,checkpoint])
```

```
Reusing TensorBoard on port 6006 (pid 631), started 0:26:41 ago. (Use '!kill 631' to kill it.)


Epoch 1/20
  2/120 [..............................] - ETA: 2:00 - loss: 0.0509 - accuracy: 0.9878 -
dice_coef: 0.2348WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the
batch time (batch time: 0.1404s vs `on_train_batch_end` time: 1.9076s). Check your callbacks.
119/120 [============================>.] - ETA: 0s - loss: 0.0413 - accuracy: 0.9899 - dice_coef:
0.2693
Epoch 00001: val_dice_coef improved from -inf to 0.32580, saving model to /content/drive/My
Drive/model_save/weights-01-0.3258.hdf5
120/120 [==============================] - 32s 263ms/step - loss: 0.0412 - accuracy: 0.9899 - dice
_coef: 0.2701 - val_loss: 0.0516 - val_accuracy: 0.9881 - val_dice_coef: 0.3258
Epoch 2/20
```

```
Epoch 2/20
119/120 [============================>.] - ETA: 0s - loss: 0.0326 - accuracy: 0.9908 - dice_coef:
0.3590
Epoch 00002: val_dice_coef improved from 0.32580 to 0.35414, saving model to /content/drive/My Dri
ve/model_save/weights-02-0.3541.hdf5
120/120 [==============================] - 28s 234ms/step - loss: 0.0326 - accuracy: 0.9908 - dice
_coef: 0.3598 - val_loss: 0.0549 - val_accuracy: 0.9880 - val_dice_coef: 0.3541
Epoch 3/20
119/120 [============================>.] - ETA: 0s - loss: 0.0280 - accuracy: 0.9915 - dice_coef:
0.4312
Epoch 00003: val_dice_coef improved from 0.35414 to 0.37220, saving model to /content/drive/My Dri
ve/model_save/weights-03-0.3722.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0280 - accuracy: 0.9915 - dice
_coef: 0.4321 - val_loss: 0.0566 - val_accuracy: 0.9880 - val_dice_coef: 0.3722
Epoch 4/20
119/120 [============================>.] - ETA: 0s - loss: 0.0253 - accuracy: 0.9921 - dice_coef:
0.4801
Epoch 00004: val_dice_coef improved from 0.37220 to 0.38459, saving model to /content/drive/My Dri
ve/model_save/weights-04-0.3846.hdf5
120/120 [==============================] - 28s 237ms/step - loss: 0.0253 - accuracy: 0.9921 - dice
_coef: 0.4809 - val_loss: 0.0596 - val_accuracy: 0.9875 - val_dice_coef: 0.3846
Epoch 5/20
120/120 [==============================] - ETA: 0s - loss: 0.0228 - accuracy: 0.9927 - dice_coef:
0.5280
Epoch 00005: val_dice_coef improved from 0.38459 to 0.40308, saving model to /content/drive/My Dri
ve/model_save/weights-05-0.4031.hdf5
120/120 [==============================] - 28s 234ms/step - loss: 0.0228 - accuracy: 0.9927 - dice
_coef: 0.5280 - val_loss: 0.0602 - val_accuracy: 0.9870 - val_dice_coef: 0.4031
Epoch 6/20
120/120 [==============================] - ETA: 0s - loss: 0.0211 - accuracy: 0.9931 - dice_coef:
0.5614
Epoch 00006: val_dice_coef did not improve from 0.40308
120/120 [==============================] - 26s 213ms/step - loss: 0.0211 - accuracy: 0.9931 - dice
_coef: 0.5614 - val_loss: 0.0636 - val_accuracy: 0.9869 - val_dice_coef: 0.3847
Epoch 7/20
119/120 [============================>.] - ETA: 0s - loss: 0.0194 - accuracy: 0.9935 - dice_coef:
0.5912
Epoch 00007: val_dice_coef improved from 0.40308 to 0.43649, saving model to /content/drive/My Dri
ve/model_save/weights-07-0.4365.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0194 - accuracy: 0.9935 - dice
_coef: 0.5918 - val_loss: 0.0626 - val_accuracy: 0.9857 - val_dice_coef: 0.4365
Epoch 8/20
119/120 [============================>.] - ETA: 0s - loss: 0.0184 - accuracy: 0.9937 - dice_coef:
0.6082
Epoch 00008: val_dice_coef improved from 0.43649 to 0.43867, saving model to /content/drive/My Dri
ve/model_save/weights-08-0.4387.hdf5
120/120 [==============================] - 28s 234ms/step - loss: 0.0184 - accuracy: 0.9937 - dice
_coef: 0.6087 - val_loss: 0.0624 - val_accuracy: 0.9852 - val_dice_coef: 0.4387
Epoch 9/20
120/120 [==============================] - ETA: 0s - loss: 0.0172 - accuracy: 0.9940 - dice_coef:
0.6326
Epoch 00009: val_dice_coef did not improve from 0.43867
120/120 [==============================] - 25s 212ms/step - loss: 0.0172 - accuracy: 0.9940 - dice
_coef: 0.6326 - val_loss: 0.0724 - val_accuracy: 0.9871 - val_dice_coef: 0.3594
Epoch 10/20
120/120 [==============================] - ETA: 0s - loss: 0.0166 - accuracy: 0.9941 - dice_coef:
0.6447
Epoch 00010: val_dice_coef did not improve from 0.43867
120/120 [==============================] - 25s 212ms/step - loss: 0.0166 - accuracy: 0.9941 - dice
_coef: 0.6447 - val_loss: 0.0708 - val_accuracy: 0.9875 - val_dice_coef: 0.3912
Epoch 11/20
119/120 [============================>.] - ETA: 0s - loss: 0.0158 - accuracy: 0.9943 - dice_coef:
0.6564
Epoch 00011: val_dice_coef improved from 0.43867 to 0.44731, saving model to /content/drive/My Dri
ve/model_save/weights-11-0.4473.hdf5
120/120 [==============================] - 28s 233ms/step - loss: 0.0158 - accuracy: 0.9943 - dice
_coef: 0.6574 - val_loss: 0.0687 - val_accuracy: 0.9876 - val_dice_coef: 0.4473
Epoch 12/20
119/120 [============================>.] - ETA: 0s - loss: 0.0151 - accuracy: 0.9944 - dice_coef:
0.6692
Epoch 00012: val_dice_coef improved from 0.44731 to 0.46556, saving model to /content/drive/My Dri
ve/model_save/weights-12-0.4656.hdf5
120/120 [==============================] - 28s 232ms/step - loss: 0.0151 - accuracy: 0.9944 - dice
_coef: 0.6701 - val_loss: 0.0690 - val_accuracy: 0.9869 - val_dice_coef: 0.4656
Epoch 13/20
119/120 [============================>.] - ETA: 0s - loss: 0.0139 - accuracy: 0.9948 - dice_coef:
0.6910
Epoch 00013: val_dice_coef did not improve from 0.46556
```

```
Epoch 00013: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 212ms/step - loss: 0.0139 - accuracy: 0.9948 - dice
_coef: 0.6919 - val_loss: 0.0689 - val_accuracy: 0.9874 - val_dice_coef: 0.4589
Epoch 14/20
120/120 [==============================] - ETA: 0s - loss: 0.0125 - accuracy: 0.9953 - dice_coef:
0.7208
Epoch 00014: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 212ms/step - loss: 0.0125 - accuracy: 0.9953 - dice
_coef: 0.7208 - val_loss: 0.0789 - val_accuracy: 0.9880 - val_dice_coef: 0.3930
Epoch 15/20
119/120 [============================>.] - ETA: 0s - loss: 0.0114 - accuracy: 0.9957 - dice_coef:
0.7417
Epoch 00015: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 211ms/step - loss: 0.0114 - accuracy: 0.9957 - dice
_coef: 0.7424 - val_loss: 0.0873 - val_accuracy: 0.9877 - val_dice_coef: 0.3549
Epoch 16/20
120/120 [==============================] - ETA: 0s - loss: 0.0109 - accuracy: 0.9958 - dice_coef:
0.7532
Epoch 00016: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 212ms/step - loss: 0.0109 - accuracy: 0.9958 - dice
_coef: 0.7532 - val_loss: 0.0878 - val_accuracy: 0.9876 - val_dice_coef: 0.3483
Epoch 17/20
119/120 [============================>.] - ETA: 0s - loss: 0.0109 - accuracy: 0.9958 - dice_coef:
0.7541
Epoch 00017: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 211ms/step - loss: 0.0109 - accuracy: 0.9958 - dice
_coef: 0.7545 - val_loss: 0.0931 - val_accuracy: 0.9880 - val_dice_coef: 0.3350
Epoch 18/20
119/120 [============================>.] - ETA: 0s - loss: 0.0110 - accuracy: 0.9957 - dice_coef:
0.7520
Epoch 00018: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 211ms/step - loss: 0.0110 - accuracy: 0.9957 - dice
_coef: 0.7523 - val_loss: 0.0788 - val_accuracy: 0.9869 - val_dice_coef: 0.4562
Epoch 19/20
119/120 [============================>.] - ETA: 0s - loss: 0.0110 - accuracy: 0.9957 - dice_coef:
0.7520
Epoch 00019: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 211ms/step - loss: 0.0110 - accuracy: 0.9957 - dice
_coef: 0.7527 - val_loss: 0.0819 - val_accuracy: 0.9872 - val_dice_coef: 0.4415
Epoch 20/20
120/120 [==============================] - ETA: 0s - loss: 0.0103 - accuracy: 0.9959 - dice_coef:
0.7676
Epoch 00020: val_dice_coef did not improve from 0.46556
120/120 [==============================] - 25s 212ms/step - loss: 0.0103 - accuracy: 0.9959 - dice
_coef: 0.7676 - val_loss: 0.0898 - val_accuracy: 0.9882 - val_dice_coef: 0.4069
```

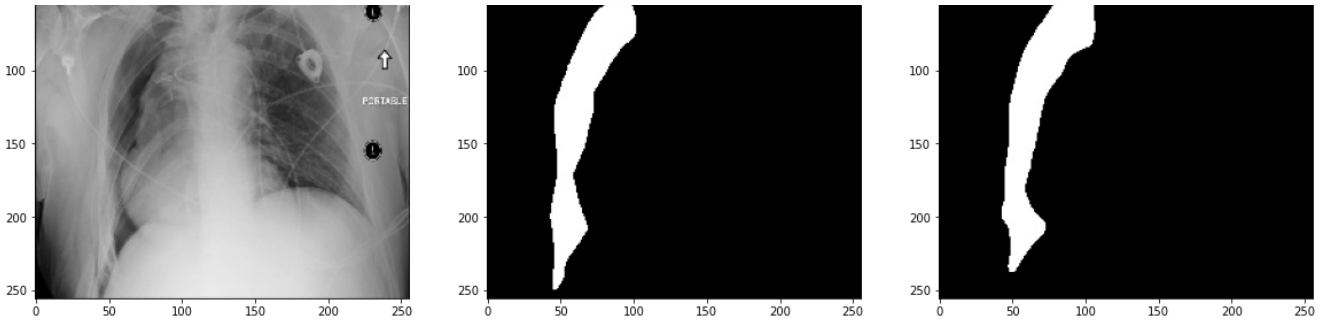
Out[ ]:

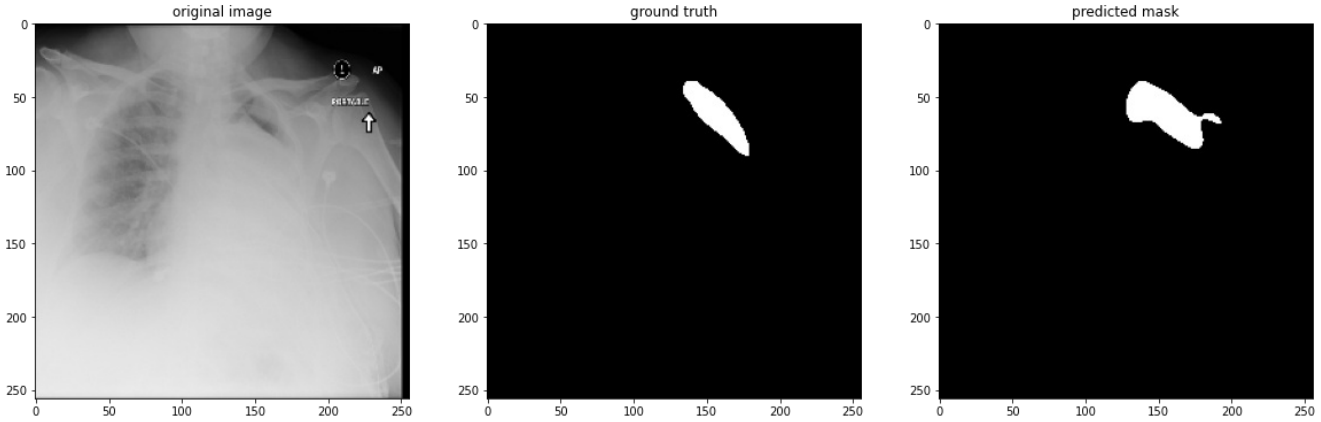
```
<tensorflow.python.keras.callbacks.History at 0x7f9117f7d4a8>
```

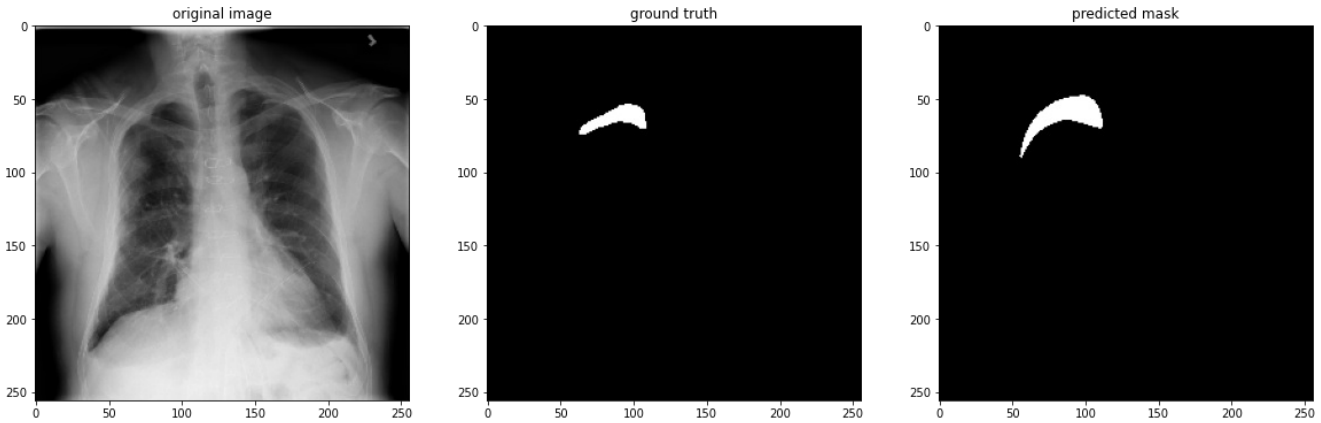
Random visualization of images

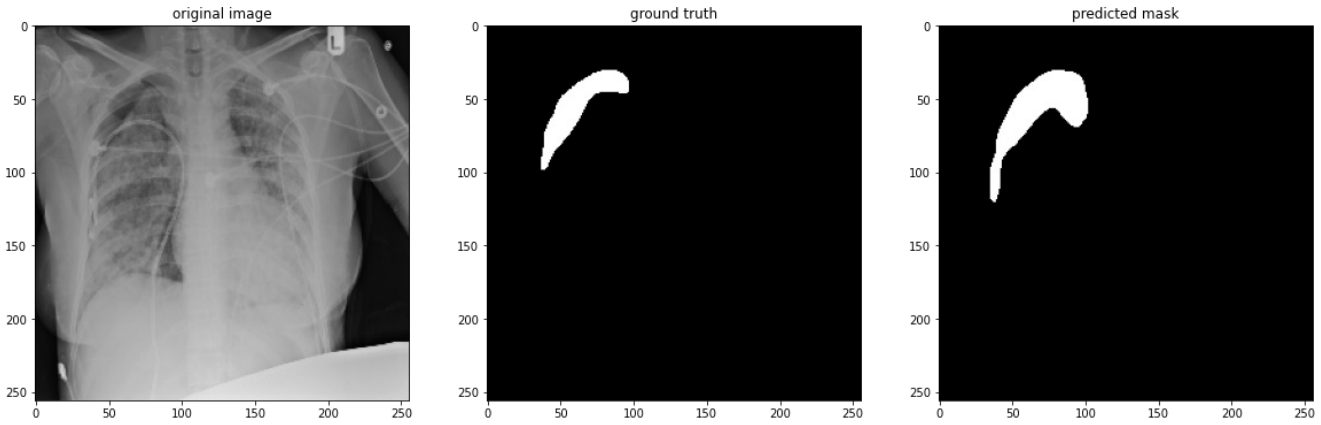
In [ ]:

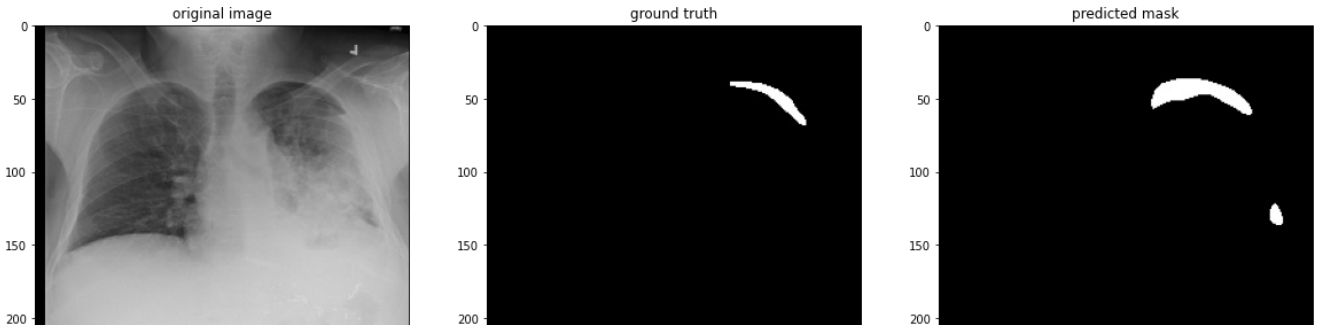
```
unet_chexnet_model.load_weights('/content/drive/My Drive/model_save/weights-12-0.4656.hdf5')
for i,j in test_dataset.take(5):
  a=unet_chexnet_model.predict(i)
  preds_val_t = (a[0]>0.5).astype(np.uint8)
  plt.figure(figsize=(20,6))
  plt.subplot(131)
  plt.title("original image")
  plt.imshow(np.squeeze(i[0]),cmap='gray')
  plt.subplot(132)
  plt.title("ground truth")
  plt.imshow(np.squeeze(j[0]),cmap='gray')
  plt.subplot(133)
  plt.title("predicted mask")
  plt.imshow(np.squeeze(preds_val_t).astype(np.uint8),cmap='gray')
  plt.show()
```

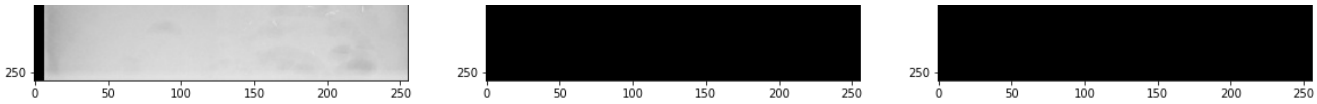



original image
ground truth
predicted mask


original image
ground truth
predicted mask


original image
ground truth
predicted mask


original image
ground truth
predicted mask



- This model definetely performs well than all the previous models.
- Though it is not perfect
- It is decent enough to narrow down the location of the affected area for the doctor to look into.

HRNET

In [ ]:

```
#https://github.com/niecongchong/HRNet-keras-semantic-segmentation/blob/master/train.ipynb
import keras.backend as K
import tensorflow as tf
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input, Conv2D, BatchNormalization, Activation
from tensorflow.keras.layers import UpSampling2D, add, concatenate


def conv3x3(x, out_filters, strides=(1, 1)):
    x = Conv2D(out_filters, 3, padding='same', strides=strides, use_bias=False, kernel_initializer=
'he_normal')(x)
    return x


def basic_Block(input, out_filters, strides=(1, 1), with_conv_shortcut=False):
    x = conv3x3(input, out_filters, strides)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = conv3x3(x, out_filters)
    x = BatchNormalization(axis=3)(x)

    if with_conv_shortcut:
        residual = Conv2D(out_filters, 1, strides=strides, use_bias=False, kernel_initializer='he_n
ormal')(input)
        residual = BatchNormalization(axis=3)(residual)
        x = add([x, residual])
    else:
        x = add([x, input])

    x = Activation('relu')(x)
    return x


def bottleneck_Block(input, out_filters, strides=(1, 1), with_conv_shortcut=False):
    expansion = 4
    de_filters = int(out_filters / expansion)

    x = Conv2D(de_filters, 1, use_bias=False, kernel_initializer='he_normal')(input)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = Conv2D(de_filters, 3, strides=strides, padding='same', use_bias=False, kernel_initializer='
he_normal')(x)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = Conv2D(out_filters, 1, use_bias=False, kernel_initializer='he_normal')(x)
    x = BatchNormalization(axis=3)(x)

    if with_conv_shortcut:
        residual = Conv2D(out_filters, 1, strides=strides, use_bias=False, kernel_initializer='he_n
ormal')(input)
        residual = BatchNormalization(axis=3)(residual)
        x = add([x, residual])
    else:
        x = add([x, input])

    x = Activation('relu')(x)
    return x
```

```
def stem_net(input):
    x = Conv2D(64, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(input)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = bottleneck_Block(x, 256, with_conv_shortcut=True)
    x = bottleneck_Block(x, 256, with_conv_shortcut=False)
    x = bottleneck_Block(x, 256, with_conv_shortcut=False)
    x = bottleneck_Block(x, 256, with_conv_shortcut=False)

    return x


def transition_layer1(x, out_filters_list=[32, 64]):
    x0 = Conv2D(out_filters_list[0], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x)
    x0 = BatchNormalization(axis=3)(x0)
    x0 = Activation('relu')(x0)

    x1 = Conv2D(out_filters_list[1], 3, strides=(2, 2),
                padding='same', use_bias=False, kernel_initializer='he_normal')(x)
    x1 = BatchNormalization(axis=3)(x1)
    x1 = Activation('relu')(x1)

    return [x0, x1]


def make_branch1_0(x, out_filters=32):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch1_1(x, out_filters=64):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def fuse_layer1(x):
    x0_0 = x[0]
    x0_1 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[1])
    x0_1 = BatchNormalization(axis=3)(x0_1)
    x0_1 = UpSampling2D(size=(2, 2))(x0_1)
    x0 = add([x0_0, x0_1])

    x1_0 = Conv2D(64, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[0])
    x1_0 = BatchNormalization(axis=3)(x1_0)
    x1_1 = x[1]
    x1 = add([x1_0, x1_1])
    return [x0, x1]


def transition_layer2(x, out_filters_list=[32, 64, 128]):
    x0 = Conv2D(out_filters_list[0], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[0])
    x0 = BatchNormalization(axis=3)(x0)
    x0 = Activation('relu')(x0)

    x1 = Conv2D(out_filters_list[1], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[1])
    x1 = BatchNormalization(axis=3)(x1)
    x1 = Activation('relu')(x1)

    x2 = Conv2D(out_filters_list[2], 3, strides=(2, 2),
                padding='same', use_bias=False, kernel_initializer='he_normal')(x[1])
    x2 = BatchNormalization(axis=3)(x2)
    x2 = Activation('relu')(x2)
```

```
    return [x0, x1, x2]


def make_branch2_0(x, out_filters=32):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch2_1(x, out_filters=64):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch2_2(x, out_filters=128):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def fuse_layer2(x):
    x0_0 = x[0]
    x0_1 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[1])
    x0_1 = BatchNormalization(axis=3)(x0_1)
    x0_1 = UpSampling2D(size=(2, 2))(x0_1)
    x0_2 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[2])
    x0_2 = BatchNormalization(axis=3)(x0_2)
    x0_2 = UpSampling2D(size=(4, 4))(x0_2)
    x0 = add([x0_0, x0_1, x0_2])

    x1_0 = Conv2D(64, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[0])
    x1_0 = BatchNormalization(axis=3)(x1_0)
    x1_1 = x[1]
    x1_2 = Conv2D(64, 1, use_bias=False, kernel_initializer='he_normal')(x[2])
    x1_2 = BatchNormalization(axis=3)(x1_2)
    x1_2 = UpSampling2D(size=(2, 2))(x1_2)
    x1 = add([x1_0, x1_1, x1_2])

    x2_0 = Conv2D(32, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[0])
    x2_0 = BatchNormalization(axis=3)(x2_0)
    x2_0 = Activation('relu')(x2_0)
    x2_0 = Conv2D(128, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x2_0)
    x2_0 = BatchNormalization(axis=3)(x2_0)
    x2_1 = Conv2D(128, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[1])
    x2_1 = BatchNormalization(axis=3)(x2_1)
    x2_2 = x[2]
    x2 = add([x2_0, x2_1, x2_2])
    return [x0, x1, x2]


def transition_layer3(x, out_filters_list=[32, 64, 128, 256]):
    x0 = Conv2D(out_filters_list[0], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[0])
    x0 = BatchNormalization(axis=3)(x0)
    x0 = Activation('relu')(x0)

    x1 = Conv2D(out_filters_list[1], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[1])
    x1 = BatchNormalization(axis=3)(x1)
    x1 = Activation('relu')(x1)

    x2 = Conv2D(out_filters_list[2], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[2])
    x2 = BatchNormalization(axis=3)(x2)
    x2 = Activation('relu')(x2)
```

```
    x3 = Conv2D(out_filters_list[3], 3, strides=(2, 2),
                padding='same', use_bias=False, kernel_initializer='he_normal')(x[2])
    x3 = BatchNormalization(axis=3)(x3)
    x3 = Activation('relu')(x3)

    return [x0, x1, x2, x3]


def make_branch3_0(x, out_filters=32):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch3_1(x, out_filters=64):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch3_2(x, out_filters=128):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch3_3(x, out_filters=256):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def fuse_layer3(x):
    x0_0 = x[0]
    x0_1 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[1])
    x0_1 = BatchNormalization(axis=3)(x0_1)
    x0_1 = UpSampling2D(size=(2, 2))(x0_1)
    x0_2 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[2])
    x0_2 = BatchNormalization(axis=3)(x0_2)
    x0_2 = UpSampling2D(size=(4, 4))(x0_2)
    x0_3 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[3])
    x0_3 = BatchNormalization(axis=3)(x0_3)
    x0_3 = UpSampling2D(size=(8, 8))(x0_3)
    x0 = concatenate([x0_0, x0_1, x0_2, x0_3], axis=-1)
    return x0


def final_layer(x, classes=1):
    x = UpSampling2D(size=(2, 2))(x)
    x = Conv2D(classes, 1, use_bias=False, kernel_initializer='he_normal')(x)
    x = BatchNormalization(axis=3)(x)
    x = Activation('sigmoid', name='Classification')(x)
    return x


def seg_hrnet(batch_size, height, width, channel, classes):
    inputs = Input((256,256,3))

    x = stem_net(inputs)

    x = transition_layer1(x)
    x0 = make_branch1_0(x[0])
    x1 = make_branch1_1(x[1])
    x = fuse_layer1([x0, x1])

    x = transition_layer2(x)
    x0 = make_branch2_0(x[0])
    x1 = make_branch2_1(x[1])
    x2 = make_branch2_2(x[2])
```

```
    x = fuse_layer2([x0, x1, x2])

    x = transition_layer3(x)
    x0 = make_branch3_0(x[0])
    x1 = make_branch3_1(x[1])
    x2 = make_branch3_2(x[2])
    x3 = make_branch3_3(x[3])
    x = fuse_layer3([x0, x1, x2, x3])

    out = final_layer(x, classes=classes)

    model = Model(inputs=inputs, outputs=out)

    return model
```

In [ ]:

```
model=seg_hrnet(16,256,256,3,1)
```

In [ ]:

```
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy',dice_coef])
```

In [ ]:

```
tf.keras.backend.clear_session()
# Tensorbaord
logdir = os.path.join("/content/drive/My Drive/logs","HRNET_no_augmentation")
tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)
%tensorboard --logdir='/content/drive/My Drive/logs/HRNET_no_augmentation/'
model.fit(train_dataset,epochs=50,batch_size=16,validation_data=test_dataset,callbacks=[tensorboard
_callback,checkpoint])
```

```
Epoch 1/50
  2/120 [..............................] - ETA: 1:06 - loss: 0.7756 - accuracy: 0.3281 -
dice_coef: 0.0307WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the
batch time (batch time: 0.2093s vs `on_train_batch_end` time: 0.9112s). Check your callbacks.
120/120 [==============================] - ETA: 0s - loss: 0.6738 - accuracy: 0.7121 - dice_coef:
0.0281
Epoch 00001: val_dice_coef improved from -inf to 0.02597, saving model to /content/drive/My
Drive/model_save/weights-01-0.0260.hdf5
120/120 [==============================] - 58s 483ms/step - loss: 0.6738 - accuracy: 0.7121 - dice
_coef: 0.0281 - val_loss: 2.1391 - val_accuracy: 0.1316 - val_dice_coef: 0.0260
Epoch 2/50
120/120 [==============================] - ETA: 0s - loss: 0.6137 - accuracy: 0.9439 - dice_coef:
0.0305
Epoch 00002: val_dice_coef improved from 0.02597 to 0.02628, saving model to /content/drive/My Dri
ve/model_save/weights-02-0.0263.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.6137 - accuracy: 0.9439 - dice
_coef: 0.0305 - val_loss: 0.6309 - val_accuracy: 0.9266 - val_dice_coef: 0.0263
Epoch 3/50
120/120 [==============================] - ETA: 0s - loss: 0.5639 - accuracy: 0.9667 - dice_coef:
0.0315
Epoch 00003: val_dice_coef improved from 0.02628 to 0.03057, saving model to /content/drive/My Dri
ve/model_save/weights-03-0.0306.hdf5
120/120 [==============================] - 56s 466ms/step - loss: 0.5639 - accuracy: 0.9667 - dice
_coef: 0.0315 - val_loss: 0.5505 - val_accuracy: 0.9685 - val_dice_coef: 0.0306
Epoch 4/50
120/120 [==============================] - ETA: 0s - loss: 0.5178 - accuracy: 0.9738 - dice_coef:
0.0334
Epoch 00004: val_dice_coef improved from 0.03057 to 0.03092, saving model to /content/drive/My Dri
ve/model_save/weights-04-0.0309.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.5178 - accuracy: 0.9738 - dice
_coef: 0.0334 - val_loss: 0.4963 - val_accuracy: 0.9818 - val_dice_coef: 0.0309
Epoch 5/50
120/120 [==============================] - ETA: 0s - loss: 0.4774 - accuracy: 0.9776 - dice_coef:
0.0348
Epoch 00005: val_dice_coef improved from 0.03092 to 0.03723, saving model to /content/drive/My Dri
ve/model_save/weights-05-0.0372.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.4774 - accuracy: 0.9776 - dice
_coef: 0.0348 - val_loss: 0.4742 - val_accuracy: 0.9667 - val_dice_coef: 0.0372
Epoch 6/50
120/120 [==============================] - ETA: 0s - loss: 0.4405 - accuracy: 0.9803 - dice_coef:
```

```
0.0361
Epoch 00006: val_dice_coef did not improve from 0.03723
120/120 [==============================] - 54s 453ms/step - loss: 0.4405 - accuracy: 0.9803 - dice
_coef: 0.0361 - val_loss: 0.4232 - val_accuracy: 0.9854 - val_dice_coef: 0.0310
Epoch 7/50
120/120 [==============================] - ETA: 0s - loss: 0.4078 - accuracy: 0.9822 - dice_coef:
0.0370
Epoch 00007: val_dice_coef improved from 0.03723 to 0.03735, saving model to /content/drive/My Dri
ve/model_save/weights-07-0.0373.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.4078 - accuracy: 0.9822 - dice
_coef: 0.0370 - val_loss: 0.3666 - val_accuracy: 0.9835 - val_dice_coef: 0.0373
Epoch 8/50
120/120 [==============================] - ETA: 0s - loss: 0.3777 - accuracy: 0.9833 - dice_coef:
0.0382
Epoch 00008: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 452ms/step - loss: 0.3777 - accuracy: 0.9833 - dice
_coef: 0.0382 - val_loss: 0.3802 - val_accuracy: 0.9795 - val_dice_coef: 0.0286
Epoch 9/50
120/120 [==============================] - ETA: 0s - loss: 0.3506 - accuracy: 0.9844 - dice_coef:
0.0396
Epoch 00009: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 452ms/step - loss: 0.3506 - accuracy: 0.9844 - dice
_coef: 0.0396 - val_loss: 0.3328 - val_accuracy: 0.9854 - val_dice_coef: 0.0352
Epoch 10/50
120/120 [==============================] - ETA: 0s - loss: 0.3252 - accuracy: 0.9848 - dice_coef:
0.0421
Epoch 00010: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 453ms/step - loss: 0.3252 - accuracy: 0.9848 - dice
_coef: 0.0421 - val_loss: 0.3386 - val_accuracy: 0.9845 - val_dice_coef: 0.0280
Epoch 11/50
120/120 [==============================] - ETA: 0s - loss: 0.3025 - accuracy: 0.9856 - dice_coef:
0.0440
Epoch 00011: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 453ms/step - loss: 0.3025 - accuracy: 0.9856 - dice
_coef: 0.0440 - val_loss: 0.3053 - val_accuracy: 0.9824 - val_dice_coef: 0.0278
Epoch 12/50
120/120 [==============================] - ETA: 0s - loss: 0.2819 - accuracy: 0.9860 - dice_coef:
0.0464
Epoch 00012: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 452ms/step - loss: 0.2819 - accuracy: 0.9860 - dice
_coef: 0.0464 - val_loss: 0.2810 - val_accuracy: 0.9864 - val_dice_coef: 0.0322
Epoch 13/50
120/120 [==============================] - ETA: 0s - loss: 0.2738 - accuracy: 0.9841 - dice_coef:
0.0372
Epoch 00013: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 453ms/step - loss: 0.2738 - accuracy: 0.9841 - dice
_coef: 0.0372 - val_loss: 0.1865 - val_accuracy: 0.9827 - val_dice_coef: 0.0304
Epoch 14/50
120/120 [==============================] - ETA: 0s - loss: 0.2511 - accuracy: 0.9857 - dice_coef:
0.0395
Epoch 00014: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 452ms/step - loss: 0.2511 - accuracy: 0.9857 - dice
_coef: 0.0395 - val_loss: 0.2396 - val_accuracy: 0.9864 - val_dice_coef: 0.0359
Epoch 15/50
120/120 [==============================] - ETA: 0s - loss: 0.2336 - accuracy: 0.9859 - dice_coef:
0.0452
Epoch 00015: val_dice_coef did not improve from 0.03735
120/120 [==============================] - 54s 452ms/step - loss: 0.2336 - accuracy: 0.9859 - dice
_coef: 0.0452 - val_loss: 0.2205 - val_accuracy: 0.9864 - val_dice_coef: 0.0351
Epoch 16/50
120/120 [==============================] - ETA: 0s - loss: 0.2184 - accuracy: 0.9861 - dice_coef:
0.0504
Epoch 00016: val_dice_coef improved from 0.03735 to 0.04630, saving model to /content/drive/My Dri
ve/model_save/weights-16-0.0463.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.2184 - accuracy: 0.9861 - dice
_coef: 0.0504 - val_loss: 0.2175 - val_accuracy: 0.9852 - val_dice_coef: 0.0463
Epoch 17/50
120/120 [==============================] - ETA: 0s - loss: 0.2044 - accuracy: 0.9867 - dice_coef:
0.0543
Epoch 00017: val_dice_coef improved from 0.04630 to 0.05281, saving model to /content/drive/My Dri
ve/model_save/weights-17-0.0528.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.2044 - accuracy: 0.9867 - dice
_coef: 0.0543 - val_loss: 0.2111 - val_accuracy: 0.9827 - val_dice_coef: 0.0528
Epoch 18/50
120/120 [==============================] - ETA: 0s - loss: 0.1918 - accuracy: 0.9872 - dice_coef:
0.0576
Epoch 00018: val_dice_coef improved from 0.05281 to 0.05610, saving model to /content/drive/My Dri
```

```
ve/model_save/weights-18-0.0561.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.1918 - accuracy: 0.9872 - dice
_coef: 0.0576 - val_loss: 0.2112 - val_accuracy: 0.9800 - val_dice_coef: 0.0561
Epoch 19/50
120/120 [==============================] - ETA: 0s - loss: 0.1803 - accuracy: 0.9877 - dice_coef:
0.0627
Epoch 00019: val_dice_coef did not improve from 0.05610
120/120 [==============================] - 54s 452ms/step - loss: 0.1803 - accuracy: 0.9877 - dice
_coef: 0.0627 - val_loss: 0.1974 - val_accuracy: 0.9830 - val_dice_coef: 0.0504
Epoch 20/50
120/120 [==============================] - ETA: 0s - loss: 0.1696 - accuracy: 0.9881 - dice_coef:
0.0681
Epoch 00020: val_dice_coef improved from 0.05610 to 0.05706, saving model to /content/drive/My Dri
ve/model_save/weights-20-0.0571.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.1696 - accuracy: 0.9881 - dice
_coef: 0.0681 - val_loss: 0.1871 - val_accuracy: 0.9781 - val_dice_coef: 0.0571
Epoch 21/50
120/120 [==============================] - ETA: 0s - loss: 0.1600 - accuracy: 0.9884 - dice_coef:
0.0734
Epoch 00021: val_dice_coef did not improve from 0.05706
120/120 [==============================] - 54s 453ms/step - loss: 0.1600 - accuracy: 0.9884 - dice
_coef: 0.0734 - val_loss: 0.1702 - val_accuracy: 0.9818 - val_dice_coef: 0.0494
Epoch 22/50
120/120 [==============================] - ETA: 0s - loss: 0.1513 - accuracy: 0.9884 - dice_coef:
0.0775
Epoch 00022: val_dice_coef improved from 0.05706 to 0.06164, saving model to /content/drive/My Dri
ve/model_save/weights-22-0.0616.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.1513 - accuracy: 0.9884 - dice
_coef: 0.0775 - val_loss: 0.1536 - val_accuracy: 0.9860 - val_dice_coef: 0.0616
Epoch 23/50
120/120 [==============================] - ETA: 0s - loss: 0.1424 - accuracy: 0.9890 - dice_coef:
0.0858
Epoch 00023: val_dice_coef improved from 0.06164 to 0.06851, saving model to /content/drive/My Dri
ve/model_save/weights-23-0.0685.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.1424 - accuracy: 0.9890 - dice
_coef: 0.0858 - val_loss: 0.1463 - val_accuracy: 0.9847 - val_dice_coef: 0.0685
Epoch 24/50
120/120 [==============================] - ETA: 0s - loss: 0.1346 - accuracy: 0.9894 - dice_coef:
0.0922
Epoch 00024: val_dice_coef did not improve from 0.06851
120/120 [==============================] - 54s 453ms/step - loss: 0.1346 - accuracy: 0.9894 - dice
_coef: 0.0922 - val_loss: 0.1440 - val_accuracy: 0.9857 - val_dice_coef: 0.0371
Epoch 25/50
120/120 [==============================] - ETA: 0s - loss: 0.1270 - accuracy: 0.9898 - dice_coef:
0.1007
Epoch 00025: val_dice_coef improved from 0.06851 to 0.06874, saving model to /content/drive/My Dri
ve/model_save/weights-25-0.0687.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.1270 - accuracy: 0.9898 - dice
_coef: 0.1007 - val_loss: 0.1360 - val_accuracy: 0.9846 - val_dice_coef: 0.0687
Epoch 26/50
120/120 [==============================] - ETA: 0s - loss: 0.1197 - accuracy: 0.9904 - dice_coef:
0.1108
Epoch 00026: val_dice_coef did not improve from 0.06874
120/120 [==============================] - 54s 453ms/step - loss: 0.1197 - accuracy: 0.9904 - dice
_coef: 0.1108 - val_loss: 0.1264 - val_accuracy: 0.9863 - val_dice_coef: 0.0614
Epoch 27/50
120/120 [==============================] - ETA: 0s - loss: 0.1131 - accuracy: 0.9907 - dice_coef:
0.1201
Epoch 00027: val_dice_coef did not improve from 0.06874
120/120 [==============================] - 54s 453ms/step - loss: 0.1131 - accuracy: 0.9907 - dice
_coef: 0.1201 - val_loss: 0.1225 - val_accuracy: 0.9858 - val_dice_coef: 0.0613
Epoch 28/50
120/120 [==============================] - ETA: 0s - loss: 0.1072 - accuracy: 0.9909 - dice_coef:
0.1286
Epoch 00028: val_dice_coef did not improve from 0.06874
120/120 [==============================] - 54s 452ms/step - loss: 0.1072 - accuracy: 0.9909 - dice
_coef: 0.1286 - val_loss: 0.1149 - val_accuracy: 0.9863 - val_dice_coef: 0.0640
Epoch 29/50
120/120 [==============================] - ETA: 0s - loss: 0.1015 - accuracy: 0.9912 - dice_coef:
0.1378
Epoch 00029: val_dice_coef improved from 0.06874 to 0.07955, saving model to /content/drive/My Dri
ve/model_save/weights-29-0.0796.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.1015 - accuracy: 0.9912 - dice
_coef: 0.1378 - val_loss: 0.1171 - val_accuracy: 0.9849 - val_dice_coef: 0.0796
Epoch 30/50
120/120 [==============================] - ETA: 0s - loss: 0.0960 - accuracy: 0.9916 - dice_coef:
0.1479
```

```
Epoch 00030: val_dice_coef did not improve from 0.07955
120/120 [==============================] - 54s 453ms/step - loss: 0.0960 - accuracy: 0.9916 - dice
_coef: 0.1479 - val_loss: 0.1042 - val_accuracy: 0.9861 - val_dice_coef: 0.0725
Epoch 31/50
120/120 [==============================] - ETA: 0s - loss: 0.0910 - accuracy: 0.9920 - dice_coef:
0.1577
Epoch 00031: val_dice_coef improved from 0.07955 to 0.09143, saving model to /content/drive/My Dri
ve/model_save/weights-31-0.0914.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0910 - accuracy: 0.9920 - dice
_coef: 0.1577 - val_loss: 0.1000 - val_accuracy: 0.9865 - val_dice_coef: 0.0914
Epoch 32/50
120/120 [==============================] - ETA: 0s - loss: 0.0865 - accuracy: 0.9921 - dice_coef:
0.1669
Epoch 00032: val_dice_coef did not improve from 0.09143
120/120 [==============================] - 54s 453ms/step - loss: 0.0865 - accuracy: 0.9921 - dice
_coef: 0.1669 - val_loss: 0.0995 - val_accuracy: 0.9866 - val_dice_coef: 0.0688
Epoch 33/50
120/120 [==============================] - ETA: 0s - loss: 0.0818 - accuracy: 0.9925 - dice_coef:
0.1790
Epoch 00033: val_dice_coef did not improve from 0.09143
120/120 [==============================] - 54s 453ms/step - loss: 0.0818 - accuracy: 0.9925 - dice
_coef: 0.1790 - val_loss: 0.0949 - val_accuracy: 0.9868 - val_dice_coef: 0.0639
Epoch 34/50
120/120 [==============================] - ETA: 0s - loss: 0.0774 - accuracy: 0.9929 - dice_coef:
0.1911
Epoch 00034: val_dice_coef did not improve from 0.09143
120/120 [==============================] - 54s 453ms/step - loss: 0.0774 - accuracy: 0.9929 - dice
_coef: 0.1911 - val_loss: 0.0902 - val_accuracy: 0.9871 - val_dice_coef: 0.0763
Epoch 35/50
120/120 [==============================] - ETA: 0s - loss: 0.0735 - accuracy: 0.9931 - dice_coef:
0.2026
Epoch 00035: val_dice_coef improved from 0.09143 to 0.09824, saving model to /content/drive/My Dri
ve/model_save/weights-35-0.0982.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.0735 - accuracy: 0.9931 - dice
_coef: 0.2026 - val_loss: 0.0899 - val_accuracy: 0.9867 - val_dice_coef: 0.0982
Epoch 36/50
120/120 [==============================] - ETA: 0s - loss: 0.0696 - accuracy: 0.9935 - dice_coef:
0.2147
Epoch 00036: val_dice_coef did not improve from 0.09824
120/120 [==============================] - 54s 452ms/step - loss: 0.0696 - accuracy: 0.9935 - dice
_coef: 0.2147 - val_loss: 0.0866 - val_accuracy: 0.9870 - val_dice_coef: 0.0954
Epoch 37/50
120/120 [==============================] - ETA: 0s - loss: 0.0659 - accuracy: 0.9937 - dice_coef:
0.2278
Epoch 00037: val_dice_coef improved from 0.09824 to 0.10181, saving model to /content/drive/My Dri
ve/model_save/weights-37-0.1018.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0659 - accuracy: 0.9937 - dice
_coef: 0.2278 - val_loss: 0.0833 - val_accuracy: 0.9868 - val_dice_coef: 0.1018
Epoch 38/50
120/120 [==============================] - ETA: 0s - loss: 0.0624 - accuracy: 0.9940 - dice_coef:
0.2409
Epoch 00038: val_dice_coef improved from 0.10181 to 0.10857, saving model to /content/drive/My Dri
ve/model_save/weights-38-0.1086.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0624 - accuracy: 0.9940 - dice
_coef: 0.2409 - val_loss: 0.0804 - val_accuracy: 0.9869 - val_dice_coef: 0.1086
Epoch 39/50
120/120 [==============================] - ETA: 0s - loss: 0.0595 - accuracy: 0.9941 - dice_coef:
0.2525
Epoch 00039: val_dice_coef improved from 0.10857 to 0.11207, saving model to /content/drive/My Dri
ve/model_save/weights-39-0.1121.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0595 - accuracy: 0.9941 - dice
_coef: 0.2525 - val_loss: 0.0788 - val_accuracy: 0.9872 - val_dice_coef: 0.1121
Epoch 40/50
120/120 [==============================] - ETA: 0s - loss: 0.0565 - accuracy: 0.9944 - dice_coef:
0.2649
Epoch 00040: val_dice_coef did not improve from 0.11207
120/120 [==============================] - 54s 452ms/step - loss: 0.0565 - accuracy: 0.9944 - dice
_coef: 0.2649 - val_loss: 0.0778 - val_accuracy: 0.9872 - val_dice_coef: 0.0913
Epoch 41/50
120/120 [==============================] - ETA: 0s - loss: 0.0539 - accuracy: 0.9945 - dice_coef:
0.2761
Epoch 00041: val_dice_coef did not improve from 0.11207
120/120 [==============================] - 54s 452ms/step - loss: 0.0539 - accuracy: 0.9945 - dice
_coef: 0.2761 - val_loss: 0.0763 - val_accuracy: 0.9871 - val_dice_coef: 0.0931
Epoch 42/50
120/120 [==============================] - ETA: 0s - loss: 0.0512 - accuracy: 0.9947 - dice_coef:
0.2893
```

```
Epoch 00042: val_dice_coef did not improve from 0.11207
120/120 [==============================] - 54s 452ms/step - loss: 0.0512 - accuracy: 0.9947 - dice
_coef: 0.2893 - val_loss: 0.0727 - val_accuracy: 0.9873 - val_dice_coef: 0.1085
Epoch 43/50
120/120 [==============================] - ETA: 0s - loss: 0.0487 - accuracy: 0.9949 - dice_coef:
0.3023
Epoch 00043: val_dice_coef improved from 0.11207 to 0.13490, saving model to /content/drive/My Dri
ve/model_save/weights-43-0.1349.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0487 - accuracy: 0.9949 - dice
_coef: 0.3023 - val_loss: 0.0727 - val_accuracy: 0.9866 - val_dice_coef: 0.1349
Epoch 44/50
120/120 [==============================] - ETA: 0s - loss: 0.0465 - accuracy: 0.9950 - dice_coef:
0.3142
Epoch 00044: val_dice_coef improved from 0.13490 to 0.14207, saving model to /content/drive/My Dri
ve/model_save/weights-44-0.1421.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.0465 - accuracy: 0.9950 - dice
_coef: 0.3142 - val_loss: 0.0699 - val_accuracy: 0.9868 - val_dice_coef: 0.1421
Epoch 45/50
120/120 [==============================] - ETA: 0s - loss: 0.0441 - accuracy: 0.9952 - dice_coef:
0.3280
Epoch 00045: val_dice_coef improved from 0.14207 to 0.14715, saving model to /content/drive/My Dri
ve/model_save/weights-45-0.1471.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0441 - accuracy: 0.9952 - dice
_coef: 0.3280 - val_loss: 0.0651 - val_accuracy: 0.9871 - val_dice_coef: 0.1471
Epoch 46/50
120/120 [==============================] - ETA: 0s - loss: 0.0420 - accuracy: 0.9954 - dice_coef:
0.3421
Epoch 00046: val_dice_coef improved from 0.14715 to 0.15823, saving model to /content/drive/My Dri
ve/model_save/weights-46-0.1582.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0420 - accuracy: 0.9954 - dice
_coef: 0.3421 - val_loss: 0.0659 - val_accuracy: 0.9871 - val_dice_coef: 0.1582
Epoch 47/50
120/120 [==============================] - ETA: 0s - loss: 0.0402 - accuracy: 0.9955 - dice_coef:
0.3536
Epoch 00047: val_dice_coef did not improve from 0.15823
120/120 [==============================] - 54s 453ms/step - loss: 0.0402 - accuracy: 0.9955 - dice
_coef: 0.3536 - val_loss: 0.0636 - val_accuracy: 0.9874 - val_dice_coef: 0.1495
Epoch 48/50
120/120 [==============================] - ETA: 0s - loss: 0.0383 - accuracy: 0.9956 - dice_coef:
0.3678
Epoch 00048: val_dice_coef did not improve from 0.15823
120/120 [==============================] - 54s 453ms/step - loss: 0.0383 - accuracy: 0.9956 - dice
_coef: 0.3678 - val_loss: 0.0632 - val_accuracy: 0.9872 - val_dice_coef: 0.1262
Epoch 49/50
120/120 [==============================] - ETA: 0s - loss: 0.0366 - accuracy: 0.9957 - dice_coef:
0.3797
Epoch 00049: val_dice_coef improved from 0.15823 to 0.16302, saving model to /content/drive/My Dri
ve/model_save/weights-49-0.1630.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.0366 - accuracy: 0.9957 - dice
_coef: 0.3797 - val_loss: 0.0620 - val_accuracy: 0.9871 - val_dice_coef: 0.1630
Epoch 50/50
120/120 [==============================] - ETA: 0s - loss: 0.0348 - accuracy: 0.9959 - dice_coef:
0.3938
Epoch 00050: val_dice_coef did not improve from 0.16302
120/120 [==============================] - 54s 453ms/step - loss: 0.0348 - accuracy: 0.9959 - dice
_coef: 0.3938 - val_loss: 0.0621 - val_accuracy: 0.9870 - val_dice_coef: 0.1482
```

Out[ ]:

```
<tensorflow.python.keras.callbacks.History at 0x7f43469a0160>
```

HRNET-WITH DATA AUGMENTATION

In [ ]:

```
#https://github.com/niecongchong/HRNet-keras-semantic-segmentation/blob/master/train.ipynb
import keras.backend as K
import tensorflow as tf
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input, Conv2D, BatchNormalization, Activation
from tensorflow.keras.layers import UpSampling2D, add, concatenate


def conv3x3(x, out_filters, strides=(1, 1)):
```

```
    x = Conv2D(out_filters, 3, padding='same', strides=strides, use_bias=False, kernel_initializer=
'he_normal')(x)
    return x


def basic_Block(input, out_filters, strides=(1, 1), with_conv_shortcut=False):
    x = conv3x3(input, out_filters, strides)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = conv3x3(x, out_filters)
    x = BatchNormalization(axis=3)(x)

    if with_conv_shortcut:
        residual = Conv2D(out_filters, 1, strides=strides, use_bias=False, kernel_initializer='he_n
ormal')(input)
        residual = BatchNormalization(axis=3)(residual)
        x = add([x, residual])
    else:
        x = add([x, input])

    x = Activation('relu')(x)
    return x


def bottleneck_Block(input, out_filters, strides=(1, 1), with_conv_shortcut=False):
    expansion = 4
    de_filters = int(out_filters / expansion)

    x = Conv2D(de_filters, 1, use_bias=False, kernel_initializer='he_normal')(input)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = Conv2D(de_filters, 3, strides=strides, padding='same', use_bias=False, kernel_initializer='
he_normal')(x)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = Conv2D(out_filters, 1, use_bias=False, kernel_initializer='he_normal')(x)
    x = BatchNormalization(axis=3)(x)

    if with_conv_shortcut:
        residual = Conv2D(out_filters, 1, strides=strides, use_bias=False, kernel_initializer='he_n
ormal')(input)
        residual = BatchNormalization(axis=3)(residual)
        x = add([x, residual])
    else:
        x = add([x, input])

    x = Activation('relu')(x)
    return x


def stem_net(input):
    x = Conv2D(64, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(input)
    x = BatchNormalization(axis=3)(x)
    x = Activation('relu')(x)

    x = bottleneck_Block(x, 256, with_conv_shortcut=True)
    x = bottleneck_Block(x, 256, with_conv_shortcut=False)
    x = bottleneck_Block(x, 256, with_conv_shortcut=False)
    x = bottleneck_Block(x, 256, with_conv_shortcut=False)

    return x


def transition_layer1(x, out_filters_list=[32, 64]):
    x0 = Conv2D(out_filters_list[0], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x)
    x0 = BatchNormalization(axis=3)(x0)
    x0 = Activation('relu')(x0)

    x1 = Conv2D(out_filters_list[1], 3, strides=(2, 2),
                padding='same', use_bias=False, kernel_initializer='he_normal')(x)
    x1 = BatchNormalization(axis=3)(x1)
    x1 = Activation('relu')(x1)
```

```
    return [x0, x1]


def make_branch1_0(x, out_filters=32):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch1_1(x, out_filters=64):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def fuse_layer1(x):
    x0_0 = x[0]
    x0_1 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[1])
    x0_1 = BatchNormalization(axis=3)(x0_1)
    x0_1 = UpSampling2D(size=(2, 2))(x0_1)
    x0 = add([x0_0, x0_1])

    x1_0 = Conv2D(64, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[0])
    x1_0 = BatchNormalization(axis=3)(x1_0)
    x1_1 = x[1]
    x1 = add([x1_0, x1_1])
    return [x0, x1]


def transition_layer2(x, out_filters_list=[32, 64, 128]):
    x0 = Conv2D(out_filters_list[0], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[0])
    x0 = BatchNormalization(axis=3)(x0)
    x0 = Activation('relu')(x0)

    x1 = Conv2D(out_filters_list[1], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[1])
    x1 = BatchNormalization(axis=3)(x1)
    x1 = Activation('relu')(x1)

    x2 = Conv2D(out_filters_list[2], 3, strides=(2, 2),
                padding='same', use_bias=False, kernel_initializer='he_normal')(x[1])
    x2 = BatchNormalization(axis=3)(x2)
    x2 = Activation('relu')(x2)

    return [x0, x1, x2]


def make_branch2_0(x, out_filters=32):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch2_1(x, out_filters=64):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch2_2(x, out_filters=128):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x
```

```
def fuse_layer2(x):
    x0_0 = x[0]
    x0_1 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[1])
    x0_1 = BatchNormalization(axis=3)(x0_1)
    x0_1 = UpSampling2D(size=(2, 2))(x0_1)
    x0_2 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[2])
    x0_2 = BatchNormalization(axis=3)(x0_2)
    x0_2 = UpSampling2D(size=(4, 4))(x0_2)
    x0 = add([x0_0, x0_1, x0_2])

    x1_0 = Conv2D(64, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[0])
    x1_0 = BatchNormalization(axis=3)(x1_0)
    x1_1 = x[1]
    x1_2 = Conv2D(64, 1, use_bias=False, kernel_initializer='he_normal')(x[2])
    x1_2 = BatchNormalization(axis=3)(x1_2)
    x1_2 = UpSampling2D(size=(2, 2))(x1_2)
    x1 = add([x1_0, x1_1, x1_2])

    x2_0 = Conv2D(32, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[0])
    x2_0 = BatchNormalization(axis=3)(x2_0)
    x2_0 = Activation('relu')(x2_0)
    x2_0 = Conv2D(128, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x2_0)
    x2_0 = BatchNormalization(axis=3)(x2_0)
    x2_1 = Conv2D(128, 3, strides=(2, 2), padding='same', use_bias=False,
kernel_initializer='he_normal')(x[1])
    x2_1 = BatchNormalization(axis=3)(x2_1)
    x2_2 = x[2]
    x2 = add([x2_0, x2_1, x2_2])
    return [x0, x1, x2]


def transition_layer3(x, out_filters_list=[32, 64, 128, 256]):
    x0 = Conv2D(out_filters_list[0], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[0])
    x0 = BatchNormalization(axis=3)(x0)
    x0 = Activation('relu')(x0)

    x1 = Conv2D(out_filters_list[1], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[1])
    x1 = BatchNormalization(axis=3)(x1)
    x1 = Activation('relu')(x1)

    x2 = Conv2D(out_filters_list[2], 3, padding='same', use_bias=False, kernel_initializer='he_norm
al')(x[2])
    x2 = BatchNormalization(axis=3)(x2)
    x2 = Activation('relu')(x2)

    x3 = Conv2D(out_filters_list[3], 3, strides=(2, 2),
                padding='same', use_bias=False, kernel_initializer='he_normal')(x[2])
    x3 = BatchNormalization(axis=3)(x3)
    x3 = Activation('relu')(x3)

    return [x0, x1, x2, x3]


def make_branch3_0(x, out_filters=32):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch3_1(x, out_filters=64):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch3_2(x, out_filters=128):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
```

```
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def make_branch3_3(x, out_filters=256):
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    x = basic_Block(x, out_filters, with_conv_shortcut=False)
    return x


def fuse_layer3(x):
    x0_0 = x[0]
    x0_1 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[1])
    x0_1 = BatchNormalization(axis=3)(x0_1)
    x0_1 = UpSampling2D(size=(2, 2))(x0_1)
    x0_2 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[2])
    x0_2 = BatchNormalization(axis=3)(x0_2)
    x0_2 = UpSampling2D(size=(4, 4))(x0_2)
    x0_3 = Conv2D(32, 1, use_bias=False, kernel_initializer='he_normal')(x[3])
    x0_3 = BatchNormalization(axis=3)(x0_3)
    x0_3 = UpSampling2D(size=(8, 8))(x0_3)
    x0 = concatenate([x0_0, x0_1, x0_2, x0_3], axis=-1)
    return x0


def final_layer(x, classes=1):
    x = UpSampling2D(size=(2, 2))(x)
    x = Conv2D(classes, 1, use_bias=False, kernel_initializer='he_normal')(x)
    x = BatchNormalization(axis=3)(x)
    x = Activation('sigmoid', name='Classification')(x)
    return x


def seg_hrnet(batch_size, height, width, channel, classes):
    inputs = Input((256,256,3))

    x = stem_net(inputs)

    x = transition_layer1(x)
    x0 = make_branch1_0(x[0])
    x1 = make_branch1_1(x[1])
    x = fuse_layer1([x0, x1])

    x = transition_layer2(x)
    x0 = make_branch2_0(x[0])
    x1 = make_branch2_1(x[1])
    x2 = make_branch2_2(x[2])
    x = fuse_layer2([x0, x1, x2])

    x = transition_layer3(x)
    x0 = make_branch3_0(x[0])
    x1 = make_branch3_1(x[1])
    x2 = make_branch3_2(x[2])
    x3 = make_branch3_3(x[3])
    x = fuse_layer3([x0, x1, x2, x3])

    out = final_layer(x, classes=classes)

    model = Model(inputs=inputs, outputs=out)

    return model
model=seg_hrnet(16,256,256,3,1)
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy',dice_coef])
```

In [ ]:

```
model.summary()
```

```
Model: "functional_1"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
```

```
==================================================================================================
input_1 (InputLayer)            [(None, 256, 256, 3) 0
__________________________________________________________________________________________________
conv2d (Conv2D)                 (None, 128, 128, 64) 1728        input_1[0][0]
__________________________________________________________________________________________________
batch_normalization (BatchNorma (None, 128, 128, 64) 256         conv2d[0][0]
__________________________________________________________________________________________________
activation (Activation)         (None, 128, 128, 64) 0           batch_normalization[0][0]
__________________________________________________________________________________________________
conv2d_1 (Conv2D)               (None, 128, 128, 64) 4096        activation[0][0]
__________________________________________________________________________________________________
batch_normalization_1 (BatchNor (None, 128, 128, 64) 256         conv2d_1[0][0]
__________________________________________________________________________________________________
activation_1 (Activation)       (None, 128, 128, 64) 0           batch_normalization_1[0][0]
__________________________________________________________________________________________________
conv2d_2 (Conv2D)               (None, 128, 128, 64) 36864       activation_1[0][0]
__________________________________________________________________________________________________
batch_normalization_2 (BatchNor (None, 128, 128, 64) 256         conv2d_2[0][0]
__________________________________________________________________________________________________
activation_2 (Activation)       (None, 128, 128, 64) 0           batch_normalization_2[0][0]
__________________________________________________________________________________________________
conv2d_3 (Conv2D)               (None, 128, 128, 256 16384       activation_2[0][0]
__________________________________________________________________________________________________
conv2d_4 (Conv2D)               (None, 128, 128, 256 16384       activation[0][0]
__________________________________________________________________________________________________
batch_normalization_3 (BatchNor (None, 128, 128, 256 1024        conv2d_3[0][0]
__________________________________________________________________________________________________
batch_normalization_4 (BatchNor (None, 128, 128, 256 1024        conv2d_4[0][0]
__________________________________________________________________________________________________
add (Add)                       (None, 128, 128, 256 0           batch_normalization_3[0][0]
                                                                 batch_normalization_4[0][0]
__________________________________________________________________________________________________
activation_3 (Activation)       (None, 128, 128, 256 0           add[0][0]
__________________________________________________________________________________________________
conv2d_5 (Conv2D)               (None, 128, 128, 64) 16384       activation_3[0][0]
__________________________________________________________________________________________________
batch_normalization_5 (BatchNor (None, 128, 128, 64) 256         conv2d_5[0][0]
__________________________________________________________________________________________________
activation_4 (Activation)       (None, 128, 128, 64) 0           batch_normalization_5[0][0]
__________________________________________________________________________________________________
conv2d_6 (Conv2D)               (None, 128, 128, 64) 36864       activation_4[0][0]
__________________________________________________________________________________________________
batch_normalization_6 (BatchNor (None, 128, 128, 64) 256         conv2d_6[0][0]
__________________________________________________________________________________________________
activation_5 (Activation)       (None, 128, 128, 64) 0           batch_normalization_6[0][0]
__________________________________________________________________________________________________
conv2d_7 (Conv2D)               (None, 128, 128, 256 16384       activation_5[0][0]
__________________________________________________________________________________________________
batch_normalization_7 (BatchNor (None, 128, 128, 256 1024        conv2d_7[0][0]
__________________________________________________________________________________________________
add_1 (Add)                     (None, 128, 128, 256 0           batch_normalization_7[0][0]
                                                                 activation_3[0][0]
__________________________________________________________________________________________________
activation_6 (Activation)       (None, 128, 128, 256 0           add_1[0][0]
__________________________________________________________________________________________________
conv2d_8 (Conv2D)               (None, 128, 128, 64) 16384       activation_6[0][0]
__________________________________________________________________________________________________
batch_normalization_8 (BatchNor (None, 128, 128, 64) 256         conv2d_8[0][0]
__________________________________________________________________________________________________
activation_7 (Activation)       (None, 128, 128, 64) 0           batch_normalization_8[0][0]
__________________________________________________________________________________________________
conv2d_9 (Conv2D)               (None, 128, 128, 64) 36864       activation_7[0][0]
__________________________________________________________________________________________________
batch_normalization_9 (BatchNor (None, 128, 128, 64) 256         conv2d_9[0][0]
__________________________________________________________________________________________________
activation_8 (Activation)       (None, 128, 128, 64) 0           batch_normalization_9[0][0]
__________________________________________________________________________________________________
conv2d_10 (Conv2D)              (None, 128, 128, 256 16384       activation_8[0][0]
__________________________________________________________________________________________________
batch_normalization_10 (BatchNo (None, 128, 128, 256 1024        conv2d_10[0][0]
__________________________________________________________________________________________________
add_2 (Add)                     (None, 128, 128, 256 0           batch_normalization_10[0][0]
                                                                 activation_6[0][0]
__________________________________________________________________________________________________
activation_9 (Activation)       (None, 128, 128, 256 0           add_2[0][0]
__________________________________________________________________________________________________
conv2d_11 (Conv2D)              (None, 128, 128, 64) 16384       activation_9[0][0]
```

batch_normalization_11 (BatchNo	(None, 128, 128, 64)	256	conv2d_11[0][0]
activation_10 (Activation)	(None, 128, 128, 64)	0	batch_normalization_11[0][0]
conv2d_12 (Conv2D)	(None, 128, 128, 64)	36864	activation_10[0][0]
batch_normalization_12 (BatchNo	(None, 128, 128, 64)	256	conv2d_12[0][0]
activation_11 (Activation)	(None, 128, 128, 64)	0	batch_normalization_12[0][0]
conv2d_13 (Conv2D)	(None, 128, 128, 256	16384	activation_11[0][0]
batch_normalization_13 (BatchNo	(None, 128, 128, 256	1024	conv2d_13[0][0]
add_3 (Add)	(None, 128, 128, 256	0	batch_normalization_13[0][0] activation_9[0][0]
activation_12 (Activation)	(None, 128, 128, 256	0	add_3[0][0]
conv2d_15 (Conv2D)	(None, 64, 64, 64)	147456	activation_12[0][0]
batch_normalization_15 (BatchNo	(None, 64, 64, 64)	256	conv2d_15[0][0]
activation_14 (Activation)	(None, 64, 64, 64)	0	batch_normalization_15[0][0]
conv2d_14 (Conv2D)	(None, 128, 128, 32)	73728	activation_12[0][0]
conv2d_24 (Conv2D)	(None, 64, 64, 64)	36864	activation_14[0][0]
batch_normalization_14 (BatchNo	(None, 128, 128, 32)	128	conv2d_14[0][0]
batch_normalization_24 (BatchNo	(None, 64, 64, 64)	256	conv2d_24[0][0]
activation_13 (Activation)	(None, 128, 128, 32)	0	batch_normalization_14[0][0]
activation_23 (Activation)	(None, 64, 64, 64)	0	batch_normalization_24[0][0]
conv2d_16 (Conv2D)	(None, 128, 128, 32)	9216	activation_13[0][0]
conv2d_25 (Conv2D)	(None, 64, 64, 64)	36864	activation_23[0][0]
batch_normalization_16 (BatchNo	(None, 128, 128, 32)	128	conv2d_16[0][0]
batch_normalization_25 (BatchNo	(None, 64, 64, 64)	256	conv2d_25[0][0]
activation_15 (Activation)	(None, 128, 128, 32)	0	batch_normalization_16[0][0]
add_8 (Add)	(None, 64, 64, 64)	0	batch_normalization_25[0][0] activation_14[0][0]
conv2d_17 (Conv2D)	(None, 128, 128, 32)	9216	activation_15[0][0]
activation_24 (Activation)	(None, 64, 64, 64)	0	add_8[0][0]
batch_normalization_17 (BatchNo	(None, 128, 128, 32)	128	conv2d_17[0][0]
conv2d_26 (Conv2D)	(None, 64, 64, 64)	36864	activation_24[0][0]
add_4 (Add)	(None, 128, 128, 32)	0	batch_normalization_17[0][0] activation_13[0][0]
batch_normalization_26 (BatchNo	(None, 64, 64, 64)	256	conv2d_26[0][0]
activation_16 (Activation)	(None, 128, 128, 32)	0	add_4[0][0]
activation_25 (Activation)	(None, 64, 64, 64)	0	batch_normalization_26[0][0]
conv2d_18 (Conv2D)	(None, 128, 128, 32)	9216	activation_16[0][0]
conv2d_27 (Conv2D)	(None, 64, 64, 64)	36864	activation_25[0][0]
batch_normalization_18 (BatchNo	(None, 128, 128, 32)	128	conv2d_18[0][0]
batch_normalization_27 (BatchNo	(None, 64, 64, 64)	256	conv2d_27[0][0]
activation_17 (Activation)	(None, 128, 128, 32)	0	batch_normalization_18[0][0]

add_9 (Add)	(None, 64, 64, 64)	0	batch_normalization_27[0][0] activation_24[0][0]
conv2d_19 (Conv2D)	(None, 128, 128, 32)	9216	activation_17[0][0]
activation_26 (Activation)	(None, 64, 64, 64)	0	add_9[0][0]
batch_normalization_19 (BatchNo	(None, 128, 128, 32)	128	conv2d_19[0][0]
conv2d_28 (Conv2D)	(None, 64, 64, 64)	36864	activation_26[0][0]
add_5 (Add)	(None, 128, 128, 32)	0	batch_normalization_19[0][0] activation_16[0][0]
batch_normalization_28 (BatchNo	(None, 64, 64, 64)	256	conv2d_28[0][0]
activation_18 (Activation)	(None, 128, 128, 32)	0	add_5[0][0]
activation_27 (Activation)	(None, 64, 64, 64)	0	batch_normalization_28[0][0]
conv2d_20 (Conv2D)	(None, 128, 128, 32)	9216	activation_18[0][0]
conv2d_29 (Conv2D)	(None, 64, 64, 64)	36864	activation_27[0][0]
batch_normalization_20 (BatchNo	(None, 128, 128, 32)	128	conv2d_20[0][0]
batch_normalization_29 (BatchNo	(None, 64, 64, 64)	256	conv2d_29[0][0]
activation_19 (Activation)	(None, 128, 128, 32)	0	batch_normalization_20[0][0]
add_10 (Add)	(None, 64, 64, 64)	0	batch_normalization_29[0][0] activation_26[0][0]
conv2d_21 (Conv2D)	(None, 128, 128, 32)	9216	activation_19[0][0]
activation_28 (Activation)	(None, 64, 64, 64)	0	add_10[0][0]
batch_normalization_21 (BatchNo	(None, 128, 128, 32)	128	conv2d_21[0][0]
conv2d_30 (Conv2D)	(None, 64, 64, 64)	36864	activation_28[0][0]
add_6 (Add)	(None, 128, 128, 32)	0	batch_normalization_21[0][0] activation_18[0][0]
batch_normalization_30 (BatchNo	(None, 64, 64, 64)	256	conv2d_30[0][0]
activation_20 (Activation)	(None, 128, 128, 32)	0	add_6[0][0]
activation_29 (Activation)	(None, 64, 64, 64)	0	batch_normalization_30[0][0]
conv2d_22 (Conv2D)	(None, 128, 128, 32)	9216	activation_20[0][0]
conv2d_31 (Conv2D)	(None, 64, 64, 64)	36864	activation_29[0][0]
batch_normalization_22 (BatchNo	(None, 128, 128, 32)	128	conv2d_22[0][0]
batch_normalization_31 (BatchNo	(None, 64, 64, 64)	256	conv2d_31[0][0]
activation_21 (Activation)	(None, 128, 128, 32)	0	batch_normalization_22[0][0]
add_11 (Add)	(None, 64, 64, 64)	0	batch_normalization_31[0][0] activation_28[0][0]
conv2d_23 (Conv2D)	(None, 128, 128, 32)	9216	activation_21[0][0]
activation_30 (Activation)	(None, 64, 64, 64)	0	add_11[0][0]
batch_normalization_23 (BatchNo	(None, 128, 128, 32)	128	conv2d_23[0][0]
conv2d_32 (Conv2D)	(None, 64, 64, 32)	2048	activation_30[0][0]
add_7 (Add)	(None, 128, 128, 32)	0	batch_normalization_23[0][0] activation_20[0][0]
batch_normalization_32 (BatchNo	(None, 64, 64, 32)	128	conv2d_32[0][0]

activation_22 (Activation)	(None, 128, 128, 32)	0	add_7[0][0]
up_sampling2d (UpSampling2D)	(None, 128, 128, 32)	0	batch_normalization_32[0][0]
add_12 (Add)	(None, 128, 128, 32)	0	activation_22[0][0] up_sampling2d[0][0]
conv2d_33 (Conv2D)	(None, 64, 64, 64)	18432	activation_22[0][0]
conv2d_34 (Conv2D)	(None, 128, 128, 32)	9216	add_12[0][0]
batch_normalization_33 (BatchNo	(None, 64, 64, 64)	256	conv2d_33[0][0]
batch_normalization_34 (BatchNo	(None, 128, 128, 32)	128	conv2d_34[0][0]
add_13 (Add)	(None, 64, 64, 64)	0	batch_normalization_33[0][0] activation_30[0][0]
activation_31 (Activation)	(None, 128, 128, 32)	0	batch_normalization_34[0][0]
conv2d_36 (Conv2D)	(None, 32, 32, 128)	73728	add_13[0][0]
conv2d_37 (Conv2D)	(None, 128, 128, 32)	9216	activation_31[0][0]
conv2d_35 (Conv2D)	(None, 64, 64, 64)	36864	add_13[0][0]
batch_normalization_36 (BatchNo	(None, 32, 32, 128)	512	conv2d_36[0][0]
batch_normalization_37 (BatchNo	(None, 128, 128, 32)	128	conv2d_37[0][0]
batch_normalization_35 (BatchNo	(None, 64, 64, 64)	256	conv2d_35[0][0]
activation_33 (Activation)	(None, 32, 32, 128)	0	batch_normalization_36[0][0]
activation_34 (Activation)	(None, 128, 128, 32)	0	batch_normalization_37[0][0]
activation_32 (Activation)	(None, 64, 64, 64)	0	batch_normalization_35[0][0]
conv2d_53 (Conv2D)	(None, 32, 32, 128)	147456	activation_33[0][0]
conv2d_38 (Conv2D)	(None, 128, 128, 32)	9216	activation_34[0][0]
conv2d_45 (Conv2D)	(None, 64, 64, 64)	36864	activation_32[0][0]
batch_normalization_53 (BatchNo	(None, 32, 32, 128)	512	conv2d_53[0][0]
batch_normalization_38 (BatchNo	(None, 128, 128, 32)	128	conv2d_38[0][0]
batch_normalization_45 (BatchNo	(None, 64, 64, 64)	256	conv2d_45[0][0]
activation_50 (Activation)	(None, 32, 32, 128)	0	batch_normalization_53[0][0]
add_14 (Add)	(None, 128, 128, 32)	0	batch_normalization_38[0][0] activation_31[0][0]
activation_42 (Activation)	(None, 64, 64, 64)	0	batch_normalization_45[0][0]
conv2d_54 (Conv2D)	(None, 32, 32, 128)	147456	activation_50[0][0]
activation_35 (Activation)	(None, 128, 128, 32)	0	add_14[0][0]
conv2d_46 (Conv2D)	(None, 64, 64, 64)	36864	activation_42[0][0]
batch_normalization_54 (BatchNo	(None, 32, 32, 128)	512	conv2d_54[0][0]
conv2d_39 (Conv2D)	(None, 128, 128, 32)	9216	activation_35[0][0]
batch_normalization_46 (BatchNo	(None, 64, 64, 64)	256	conv2d_46[0][0]
add_22 (Add)	(None, 32, 32, 128)	0	batch_normalization_54[0][0] activation_33[0][0]
batch_normalization_39 (BatchNo	(None, 128, 128, 32)	128	conv2d_39[0][0]
add_18 (Add)	(None, 64, 64, 64)	0	batch_normalization_46[0][0] activation_32[0][0]

activation_51 (Activation)	(None, 32, 32, 128)	0	add_22[0][0]
activation_36 (Activation)	(None, 128, 128, 32)	0	batch_normalization_39[0][0]
activation_43 (Activation)	(None, 64, 64, 64)	0	add_18[0][0]
conv2d_55 (Conv2D)	(None, 32, 32, 128)	147456	activation_51[0][0]
conv2d_40 (Conv2D)	(None, 128, 128, 32)	9216	activation_36[0][0]
conv2d_47 (Conv2D)	(None, 64, 64, 64)	36864	activation_43[0][0]
batch_normalization_55 (BatchNo	(None, 32, 32, 128)	512	conv2d_55[0][0]
batch_normalization_40 (BatchNo	(None, 128, 128, 32)	128	conv2d_40[0][0]
batch_normalization_47 (BatchNo	(None, 64, 64, 64)	256	conv2d_47[0][0]
activation_52 (Activation)	(None, 32, 32, 128)	0	batch_normalization_55[0][0]
add_15 (Add)	(None, 128, 128, 32)	0	batch_normalization_40[0][0] activation_35[0][0]
activation_44 (Activation)	(None, 64, 64, 64)	0	batch_normalization_47[0][0]
conv2d_56 (Conv2D)	(None, 32, 32, 128)	147456	activation_52[0][0]
activation_37 (Activation)	(None, 128, 128, 32)	0	add_15[0][0]
conv2d_48 (Conv2D)	(None, 64, 64, 64)	36864	activation_44[0][0]
batch_normalization_56 (BatchNo	(None, 32, 32, 128)	512	conv2d_56[0][0]
conv2d_41 (Conv2D)	(None, 128, 128, 32)	9216	activation_37[0][0]
batch_normalization_48 (BatchNo	(None, 64, 64, 64)	256	conv2d_48[0][0]
add_23 (Add)	(None, 32, 32, 128)	0	batch_normalization_56[0][0] activation_51[0][0]
batch_normalization_41 (BatchNo	(None, 128, 128, 32)	128	conv2d_41[0][0]
add_19 (Add)	(None, 64, 64, 64)	0	batch_normalization_48[0][0] activation_43[0][0]
activation_53 (Activation)	(None, 32, 32, 128)	0	add_23[0][0]
activation_38 (Activation)	(None, 128, 128, 32)	0	batch_normalization_41[0][0]
activation_45 (Activation)	(None, 64, 64, 64)	0	add_19[0][0]
conv2d_57 (Conv2D)	(None, 32, 32, 128)	147456	activation_53[0][0]
conv2d_42 (Conv2D)	(None, 128, 128, 32)	9216	activation_38[0][0]
conv2d_49 (Conv2D)	(None, 64, 64, 64)	36864	activation_45[0][0]
batch_normalization_57 (BatchNo	(None, 32, 32, 128)	512	conv2d_57[0][0]
batch_normalization_42 (BatchNo	(None, 128, 128, 32)	128	conv2d_42[0][0]
batch_normalization_49 (BatchNo	(None, 64, 64, 64)	256	conv2d_49[0][0]
activation_54 (Activation)	(None, 32, 32, 128)	0	batch_normalization_57[0][0]
add_16 (Add)	(None, 128, 128, 32)	0	batch_normalization_42[0][0] activation_37[0][0]
activation_46 (Activation)	(None, 64, 64, 64)	0	batch_normalization_49[0][0]
conv2d_58 (Conv2D)	(None, 32, 32, 128)	147456	activation_54[0][0]
activation_39 (Activation)	(None, 128, 128, 32)	0	add_16[0][0]
conv2d_50 (Conv2D)	(None, 64, 64, 64)	36864	activation_46[0][0]
batch_normalization_58 (BatchNo	(None, 32, 32, 128)	512	conv2d_58[0][0]

conv2d_43 (Conv2D)	(None, 128, 128, 32)	9216	activation_39[0][0]
batch_normalization_50 (BatchNo	(None, 64, 64, 64)	256	conv2d_50[0][0]
add_24 (Add)	(None, 32, 32, 128)	0	batch_normalization_58[0][0] activation_53[0][0]
batch_normalization_43 (BatchNo	(None, 128, 128, 32)	128	conv2d_43[0][0]
add_20 (Add)	(None, 64, 64, 64)	0	batch_normalization_50[0][0] activation_45[0][0]
activation_55 (Activation)	(None, 32, 32, 128)	0	add_24[0][0]
activation_40 (Activation)	(None, 128, 128, 32)	0	batch_normalization_43[0][0]
activation_47 (Activation)	(None, 64, 64, 64)	0	add_20[0][0]
conv2d_59 (Conv2D)	(None, 32, 32, 128)	147456	activation_55[0][0]
conv2d_44 (Conv2D)	(None, 128, 128, 32)	9216	activation_40[0][0]
conv2d_51 (Conv2D)	(None, 64, 64, 64)	36864	activation_47[0][0]
batch_normalization_59 (BatchNo	(None, 32, 32, 128)	512	conv2d_59[0][0]
batch_normalization_44 (BatchNo	(None, 128, 128, 32)	128	conv2d_44[0][0]
batch_normalization_51 (BatchNo	(None, 64, 64, 64)	256	conv2d_51[0][0]
activation_56 (Activation)	(None, 32, 32, 128)	0	batch_normalization_59[0][0]
add_17 (Add)	(None, 128, 128, 32)	0	batch_normalization_44[0][0] activation_39[0][0]
activation_48 (Activation)	(None, 64, 64, 64)	0	batch_normalization_51[0][0]
conv2d_60 (Conv2D)	(None, 32, 32, 128)	147456	activation_56[0][0]
activation_41 (Activation)	(None, 128, 128, 32)	0	add_17[0][0]
conv2d_52 (Conv2D)	(None, 64, 64, 64)	36864	activation_48[0][0]
batch_normalization_60 (BatchNo	(None, 32, 32, 128)	512	conv2d_60[0][0]
batch_normalization_52 (BatchNo	(None, 64, 64, 64)	256	conv2d_52[0][0]
add_25 (Add)	(None, 32, 32, 128)	0	batch_normalization_60[0][0] activation_55[0][0]
conv2d_65 (Conv2D)	(None, 64, 64, 32)	9216	activation_41[0][0]
add_21 (Add)	(None, 64, 64, 64)	0	batch_normalization_52[0][0] activation_47[0][0]
activation_57 (Activation)	(None, 32, 32, 128)	0	add_25[0][0]
batch_normalization_65 (BatchNo	(None, 64, 64, 32)	128	conv2d_65[0][0]
activation_49 (Activation)	(None, 64, 64, 64)	0	add_21[0][0]
conv2d_64 (Conv2D)	(None, 32, 32, 64)	8192	activation_57[0][0]
activation_58 (Activation)	(None, 64, 64, 32)	0	batch_normalization_65[0][0]
conv2d_63 (Conv2D)	(None, 64, 64, 64)	18432	activation_41[0][0]
batch_normalization_64 (BatchNo	(None, 32, 32, 64)	256	conv2d_64[0][0]
conv2d_66 (Conv2D)	(None, 32, 32, 128)	36864	activation_58[0][0]
conv2d_67 (Conv2D)	(None, 32, 32, 128)	73728	activation_49[0][0]
batch_normalization_63 (BatchNo	(None, 64, 64, 64)	256	conv2d_63[0][0]
up_sampling2d_3 (UpSampling2D)	(None, 64, 64, 64)	0	batch_normalization_64[0][0]

up_sampling2d_3 (UpSampling2D)	(None, 64, 64, 64)	0	batch_normalization_63[0][0]
batch_normalization_66 (BatchNo	(None, 32, 32, 128)	512	conv2d_66[0][0]
batch_normalization_67 (BatchNo	(None, 32, 32, 128)	512	conv2d_67[0][0]
conv2d_61 (Conv2D)	(None, 64, 64, 32)	2048	activation_49[0][0]
conv2d_62 (Conv2D)	(None, 32, 32, 32)	4096	activation_57[0][0]
add_27 (Add)	(None, 64, 64, 64)	0	batch_normalization_63[0][0] activation_49[0][0] up_sampling2d_3[0][0]
add_28 (Add)	(None, 32, 32, 128)	0	batch_normalization_66[0][0] batch_normalization_67[0][0] activation_57[0][0]
batch_normalization_61 (BatchNo	(None, 64, 64, 32)	128	conv2d_61[0][0]
batch_normalization_62 (BatchNo	(None, 32, 32, 32)	128	conv2d_62[0][0]
conv2d_69 (Conv2D)	(None, 64, 64, 64)	36864	add_27[0][0]
conv2d_70 (Conv2D)	(None, 32, 32, 128)	147456	add_28[0][0]
conv2d_71 (Conv2D)	(None, 16, 16, 256)	294912	add_28[0][0]
up_sampling2d_1 (UpSampling2D)	(None, 128, 128, 32)	0	batch_normalization_61[0][0]
up_sampling2d_2 (UpSampling2D)	(None, 128, 128, 32)	0	batch_normalization_62[0][0]
batch_normalization_69 (BatchNo	(None, 64, 64, 64)	256	conv2d_69[0][0]
batch_normalization_70 (BatchNo	(None, 32, 32, 128)	512	conv2d_70[0][0]
batch_normalization_71 (BatchNo	(None, 16, 16, 256)	1024	conv2d_71[0][0]
add_26 (Add)	(None, 128, 128, 32)	0	activation_41[0][0] up_sampling2d_1[0][0] up_sampling2d_2[0][0]
activation_60 (Activation)	(None, 64, 64, 64)	0	batch_normalization_69[0][0]
activation_61 (Activation)	(None, 32, 32, 128)	0	batch_normalization_70[0][0]
activation_62 (Activation)	(None, 16, 16, 256)	0	batch_normalization_71[0][0]
conv2d_68 (Conv2D)	(None, 128, 128, 32)	9216	add_26[0][0]
conv2d_80 (Conv2D)	(None, 64, 64, 64)	36864	activation_60[0][0]
conv2d_88 (Conv2D)	(None, 32, 32, 128)	147456	activation_61[0][0]
conv2d_96 (Conv2D)	(None, 16, 16, 256)	589824	activation_62[0][0]
batch_normalization_68 (BatchNo	(None, 128, 128, 32)	128	conv2d_68[0][0]
batch_normalization_80 (BatchNo	(None, 64, 64, 64)	256	conv2d_80[0][0]
batch_normalization_88 (BatchNo	(None, 32, 32, 128)	512	conv2d_88[0][0]
batch_normalization_96 (BatchNo	(None, 16, 16, 256)	1024	conv2d_96[0][0]
activation_59 (Activation)	(None, 128, 128, 32)	0	batch_normalization_68[0][0]
activation_71 (Activation)	(None, 64, 64, 64)	0	batch_normalization_80[0][0]
activation_79 (Activation)	(None, 32, 32, 128)	0	batch_normalization_88[0][0]
activation_87 (Activation)	(None, 16, 16, 256)	0	batch_normalization_96[0][0]
conv2d_72 (Conv2D)	(None, 128, 128, 32)	9216	activation_59[0][0]
conv2d_81 (Conv2D)	(None, 64, 64, 64)	36864	activation_71[0][0]
conv2d_89 (Conv2D)	(None, 32, 32, 128)	147456	activation_79[0][0]

conv2d_97 (Conv2D)	(None, 16, 16, 256)	589824	activation_87[0][0]
batch_normalization_72 (BatchNo	(None, 128, 128, 32)	128	conv2d_72[0][0]
batch_normalization_81 (BatchNo	(None, 64, 64, 64)	256	conv2d_81[0][0]
batch_normalization_89 (BatchNo	(None, 32, 32, 128)	512	conv2d_89[0][0]
batch_normalization_97 (BatchNo	(None, 16, 16, 256)	1024	conv2d_97[0][0]
activation_63 (Activation)	(None, 128, 128, 32)	0	batch_normalization_72[0][0]
add_33 (Add)	(None, 64, 64, 64)	0	batch_normalization_81[0][0] activation_60[0][0]
add_37 (Add)	(None, 32, 32, 128)	0	batch_normalization_89[0][0] activation_61[0][0]
add_41 (Add)	(None, 16, 16, 256)	0	batch_normalization_97[0][0] activation_62[0][0]
conv2d_73 (Conv2D)	(None, 128, 128, 32)	9216	activation_63[0][0]
activation_72 (Activation)	(None, 64, 64, 64)	0	add_33[0][0]
activation_80 (Activation)	(None, 32, 32, 128)	0	add_37[0][0]
activation_88 (Activation)	(None, 16, 16, 256)	0	add_41[0][0]
batch_normalization_73 (BatchNo	(None, 128, 128, 32)	128	conv2d_73[0][0]
conv2d_82 (Conv2D)	(None, 64, 64, 64)	36864	activation_72[0][0]
conv2d_90 (Conv2D)	(None, 32, 32, 128)	147456	activation_80[0][0]
conv2d_98 (Conv2D)	(None, 16, 16, 256)	589824	activation_88[0][0]
add_29 (Add)	(None, 128, 128, 32)	0	batch_normalization_73[0][0] activation_59[0][0]
batch_normalization_82 (BatchNo	(None, 64, 64, 64)	256	conv2d_82[0][0]
batch_normalization_90 (BatchNo	(None, 32, 32, 128)	512	conv2d_90[0][0]
batch_normalization_98 (BatchNo	(None, 16, 16, 256)	1024	conv2d_98[0][0]
activation_64 (Activation)	(None, 128, 128, 32)	0	add_29[0][0]
activation_73 (Activation)	(None, 64, 64, 64)	0	batch_normalization_82[0][0]
activation_81 (Activation)	(None, 32, 32, 128)	0	batch_normalization_90[0][0]
activation_89 (Activation)	(None, 16, 16, 256)	0	batch_normalization_98[0][0]
conv2d_74 (Conv2D)	(None, 128, 128, 32)	9216	activation_64[0][0]
conv2d_83 (Conv2D)	(None, 64, 64, 64)	36864	activation_73[0][0]
conv2d_91 (Conv2D)	(None, 32, 32, 128)	147456	activation_81[0][0]
conv2d_99 (Conv2D)	(None, 16, 16, 256)	589824	activation_89[0][0]
batch_normalization_74 (BatchNo	(None, 128, 128, 32)	128	conv2d_74[0][0]
batch_normalization_83 (BatchNo	(None, 64, 64, 64)	256	conv2d_83[0][0]
batch_normalization_91 (BatchNo	(None, 32, 32, 128)	512	conv2d_91[0][0]
batch_normalization_99 (BatchNo	(None, 16, 16, 256)	1024	conv2d_99[0][0]
activation_65 (Activation)	(None, 128, 128, 32)	0	batch_normalization_74[0][0]
add_34 (Add)	(None, 64, 64, 64)	0	batch_normalization_83[0][0] activation_72[0][0]
add_38 (Add)	(None, 32, 32, 128)	0	batch_normalization_91[0][0] activation_80[0][0]

			activation_80[0][0]
add_42 (Add)	(None, 16, 16, 256)	0	batch_normalization_99[0][0] activation_88[0][0]
conv2d_75 (Conv2D)	(None, 128, 128, 32)	9216	activation_65[0][0]
activation_74 (Activation)	(None, 64, 64, 64)	0	add_34[0][0]
activation_82 (Activation)	(None, 32, 32, 128)	0	add_38[0][0]
activation_90 (Activation)	(None, 16, 16, 256)	0	add_42[0][0]
batch_normalization_75 (BatchNo	(None, 128, 128, 32)	128	conv2d_75[0][0]
conv2d_84 (Conv2D)	(None, 64, 64, 64)	36864	activation_74[0][0]
conv2d_92 (Conv2D)	(None, 32, 32, 128)	147456	activation_82[0][0]
conv2d_100 (Conv2D)	(None, 16, 16, 256)	589824	activation_90[0][0]
add_30 (Add)	(None, 128, 128, 32)	0	batch_normalization_75[0][0] activation_64[0][0]
batch_normalization_84 (BatchNo	(None, 64, 64, 64)	256	conv2d_84[0][0]
batch_normalization_92 (BatchNo	(None, 32, 32, 128)	512	conv2d_92[0][0]
batch_normalization_100 (BatchN	(None, 16, 16, 256)	1024	conv2d_100[0][0]
activation_66 (Activation)	(None, 128, 128, 32)	0	add_30[0][0]
activation_75 (Activation)	(None, 64, 64, 64)	0	batch_normalization_84[0][0]
activation_83 (Activation)	(None, 32, 32, 128)	0	batch_normalization_92[0][0]
activation_91 (Activation)	(None, 16, 16, 256)	0	batch_normalization_100[0][0]
conv2d_76 (Conv2D)	(None, 128, 128, 32)	9216	activation_66[0][0]
conv2d_85 (Conv2D)	(None, 64, 64, 64)	36864	activation_75[0][0]
conv2d_93 (Conv2D)	(None, 32, 32, 128)	147456	activation_83[0][0]
conv2d_101 (Conv2D)	(None, 16, 16, 256)	589824	activation_91[0][0]
batch_normalization_76 (BatchNo	(None, 128, 128, 32)	128	conv2d_76[0][0]
batch_normalization_85 (BatchNo	(None, 64, 64, 64)	256	conv2d_85[0][0]
batch_normalization_93 (BatchNo	(None, 32, 32, 128)	512	conv2d_93[0][0]
batch_normalization_101 (BatchN	(None, 16, 16, 256)	1024	conv2d_101[0][0]
activation_67 (Activation)	(None, 128, 128, 32)	0	batch_normalization_76[0][0]
add_35 (Add)	(None, 64, 64, 64)	0	batch_normalization_85[0][0] activation_74[0][0]
add_39 (Add)	(None, 32, 32, 128)	0	batch_normalization_93[0][0] activation_82[0][0]
add_43 (Add)	(None, 16, 16, 256)	0	batch_normalization_101[0][0] activation_90[0][0]
conv2d_77 (Conv2D)	(None, 128, 128, 32)	9216	activation_67[0][0]
activation_76 (Activation)	(None, 64, 64, 64)	0	add_35[0][0]
activation_84 (Activation)	(None, 32, 32, 128)	0	add_39[0][0]
activation_92 (Activation)	(None, 16, 16, 256)	0	add_43[0][0]
batch_normalization_77 (BatchNo	(None, 128, 128, 32)	128	conv2d_77[0][0]
conv2d_86 (Conv2D)	(None, 64, 64, 64)	36864	activation_76[0][0]
conv2d_94 (Conv2D)	(None, 32, 32, 128)	147456	activation_84[0][0]

conv2d_94 (Conv2D)	(None, 32, 32, 128)	147456	activation_84[0][0]
conv2d_102 (Conv2D)	(None, 16, 16, 256)	589824	activation_92[0][0]
add_31 (Add)	(None, 128, 128, 32)	0	batch_normalization_77[0][0] activation_66[0][0]
batch_normalization_86 (BatchNo	(None, 64, 64, 64)	256	conv2d_86[0][0]
batch_normalization_94 (BatchNo	(None, 32, 32, 128)	512	conv2d_94[0][0]
batch_normalization_102 (BatchN	(None, 16, 16, 256)	1024	conv2d_102[0][0]
activation_68 (Activation)	(None, 128, 128, 32)	0	add_31[0][0]
activation_77 (Activation)	(None, 64, 64, 64)	0	batch_normalization_86[0][0]
activation_85 (Activation)	(None, 32, 32, 128)	0	batch_normalization_94[0][0]
activation_93 (Activation)	(None, 16, 16, 256)	0	batch_normalization_102[0][0]
conv2d_78 (Conv2D)	(None, 128, 128, 32)	9216	activation_68[0][0]
conv2d_87 (Conv2D)	(None, 64, 64, 64)	36864	activation_77[0][0]
conv2d_95 (Conv2D)	(None, 32, 32, 128)	147456	activation_85[0][0]
conv2d_103 (Conv2D)	(None, 16, 16, 256)	589824	activation_93[0][0]
batch_normalization_78 (BatchNo	(None, 128, 128, 32)	128	conv2d_78[0][0]
batch_normalization_87 (BatchNo	(None, 64, 64, 64)	256	conv2d_87[0][0]
batch_normalization_95 (BatchNo	(None, 32, 32, 128)	512	conv2d_95[0][0]
batch_normalization_103 (BatchN	(None, 16, 16, 256)	1024	conv2d_103[0][0]
activation_69 (Activation)	(None, 128, 128, 32)	0	batch_normalization_78[0][0]
add_36 (Add)	(None, 64, 64, 64)	0	batch_normalization_87[0][0] activation_76[0][0]
add_40 (Add)	(None, 32, 32, 128)	0	batch_normalization_95[0][0] activation_84[0][0]
add_44 (Add)	(None, 16, 16, 256)	0	batch_normalization_103[0][0] activation_92[0][0]
conv2d_79 (Conv2D)	(None, 128, 128, 32)	9216	activation_69[0][0]
activation_78 (Activation)	(None, 64, 64, 64)	0	add_36[0][0]
activation_86 (Activation)	(None, 32, 32, 128)	0	add_40[0][0]
activation_94 (Activation)	(None, 16, 16, 256)	0	add_44[0][0]
batch_normalization_79 (BatchNo	(None, 128, 128, 32)	128	conv2d_79[0][0]
conv2d_104 (Conv2D)	(None, 64, 64, 32)	2048	activation_78[0][0]
conv2d_105 (Conv2D)	(None, 32, 32, 32)	4096	activation_86[0][0]
conv2d_106 (Conv2D)	(None, 16, 16, 32)	8192	activation_94[0][0]
add_32 (Add)	(None, 128, 128, 32)	0	batch_normalization_79[0][0] activation_68[0][0]
batch_normalization_104 (BatchN	(None, 64, 64, 32)	128	conv2d_104[0][0]
batch_normalization_105 (BatchN	(None, 32, 32, 32)	128	conv2d_105[0][0]
batch_normalization_106 (BatchN	(None, 16, 16, 32)	128	conv2d_106[0][0]
activation_70 (Activation)	(None, 128, 128, 32)	0	add_32[0][0]
up_sampling2d_4 (UpSampling2D)	(None, 128, 128, 32)	0	batch_normalization_104[0][0]
up_sampling2d_5 (UpSampling2D)	(None, 128, 128, 32)	0	batch_normalization_105[0][0]

```
up_sampling2d_5 (UpSampling2D)  (None, 128, 128, 32) 0           batch_normalization_105[0][0]
__________________________________________________________________________________________________
up_sampling2d_6 (UpSampling2D)  (None, 128, 128, 32) 0           batch_normalization_106[0][0]
__________________________________________________________________________________________________
concatenate (Concatenate)       (None, 128, 128, 128 0           activation_70[0][0]
                                                                 up_sampling2d_4[0][0]
                                                                 up_sampling2d_5[0][0]
                                                                 up_sampling2d_6[0][0]
__________________________________________________________________________________________________
up_sampling2d_7 (UpSampling2D)  (None, 256, 256, 128 0           concatenate[0][0]
__________________________________________________________________________________________________
conv2d_107 (Conv2D)             (None, 256, 256, 1)  128         up_sampling2d_7[0][0]
__________________________________________________________________________________________________
batch_normalization_107 (BatchN (None, 256, 256, 1)  4           conv2d_107[0][0]
__________________________________________________________________________________________________
Classification (Activation)     (None, 256, 256, 1)  0           batch_normalization_107[0][0]
==================================================================================================
Total params: 9,524,036
Trainable params: 9,504,578
Non-trainable params: 19,458
__________________________________________________________________________________________________
```

In [ ]:

```
train_ds=train_ds.map(augment, num_parallel_calls=AUTOTUNE)
train_ds = train_ds.map(set_shapes, num_parallel_calls=AUTOTUNE)
val_ds = val_ds.map(set_shapes, num_parallel_calls=AUTOTUNE)
```

In [ ]:

```
train_dataset = train_ds.batch(16).cache().prefetch(1920)
test_dataset=val_ds.batch(16).cache().prefetch(1920)
```

In [ ]:

```
tf.keras.backend.clear_session()
# Tensorbaord
logdir = os.path.join("/content/drive/My Drive/logs","HRNET_with_augmentation")
tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)
%tensorboard --logdir='/content/drive/My Drive/logs/HRNET_with_augmentation/'
model.fit(train_dataset,epochs=50,batch_size=16,validation_data=test_dataset,callbacks=[tensorboard
_callback,checkpoint])
```

```
Epoch 1/50
  2/120 [..............................] - ETA: 2:23 - loss: 0.7811 - accuracy: 0.5817 -
dice_coef: 0.0300WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the
batch time (batch time: 0.2700s vs `on_train_batch_end` time: 2.0661s). Check your callbacks.
120/120 [==============================] - ETA: 0s - loss: 0.6737 - accuracy: 0.8596 - dice_coef:
0.0270
Epoch 00001: val_dice_coef improved from -inf to 0.02749, saving model to /content/drive/My
Drive/model_save/weights-01-0.0275.hdf5
120/120 [==============================] - 71s 596ms/step - loss: 0.6737 - accuracy: 0.8596 - dice
_coef: 0.0270 - val_loss: 0.6761 - val_accuracy: 0.7330 - val_dice_coef: 0.0275
Epoch 2/50
120/120 [==============================] - ETA: 0s - loss: 0.6148 - accuracy: 0.9796 - dice_coef:
0.0265
Epoch 00002: val_dice_coef did not improve from 0.02749
120/120 [==============================] - 54s 452ms/step - loss: 0.6148 - accuracy: 0.9796 - dice
_coef: 0.0265 - val_loss: 0.5851 - val_accuracy: 0.9862 - val_dice_coef: 0.0272
Epoch 3/50
120/120 [==============================] - ETA: 0s - loss: 0.5665 - accuracy: 0.9818 - dice_coef:
0.0267
Epoch 00003: val_dice_coef did not improve from 0.02749
120/120 [==============================] - 54s 452ms/step - loss: 0.5665 - accuracy: 0.9818 - dice
_coef: 0.0267 - val_loss: 0.5465 - val_accuracy: 0.9636 - val_dice_coef: 0.0269
Epoch 4/50
120/120 [==============================] - ETA: 0s - loss: 0.5208 - accuracy: 0.9817 - dice_coef:
0.0278
Epoch 00004: val_dice_coef did not improve from 0.02749
120/120 [==============================] - 54s 452ms/step - loss: 0.5208 - accuracy: 0.9817 - dice
_coef: 0.0278 - val_loss: 0.5125 - val_accuracy: 0.9779 - val_dice_coef: 0.0269
Epoch 5/50
120/120 [==============================] - ETA: 0s - loss: 0.4815 - accuracy: 0.9843 - dice_coef:
```

```
0.0273
Epoch 00005: val_dice_coef did not improve from 0.02749
120/120 [==============================] - 54s 452ms/step - loss: 0.4815 - accuracy: 0.9843 - dice
_coef: 0.0273 - val_loss: 0.4598 - val_accuracy: 0.9862 - val_dice_coef: 0.0271
Epoch 6/50
120/120 [==============================] - ETA: 0s - loss: 0.4432 - accuracy: 0.9840 - dice_coef:
0.0294
Epoch 00006: val_dice_coef improved from 0.02749 to 0.02867, saving model to /content/drive/My Dri
ve/model_save/weights-06-0.0287.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.4432 - accuracy: 0.9840 - dice
_coef: 0.0294 - val_loss: 0.4295 - val_accuracy: 0.9857 - val_dice_coef: 0.0287
Epoch 7/50
120/120 [==============================] - ETA: 0s - loss: 0.4126 - accuracy: 0.9848 - dice_coef:
0.0284
Epoch 00007: val_dice_coef did not improve from 0.02867
120/120 [==============================] - 54s 452ms/step - loss: 0.4126 - accuracy: 0.9848 - dice
_coef: 0.0284 - val_loss: 0.6127 - val_accuracy: 0.7955 - val_dice_coef: 0.0243
Epoch 8/50
120/120 [==============================] - ETA: 0s - loss: 0.3823 - accuracy: 0.9850 - dice_coef:
0.0284
Epoch 00008: val_dice_coef did not improve from 0.02867
120/120 [==============================] - 54s 452ms/step - loss: 0.3823 - accuracy: 0.9850 - dice
_coef: 0.0284 - val_loss: 0.3702 - val_accuracy: 0.9861 - val_dice_coef: 0.0279
Epoch 9/50
120/120 [==============================] - ETA: 0s - loss: 0.3536 - accuracy: 0.9850 - dice_coef:
0.0309
Epoch 00009: val_dice_coef improved from 0.02867 to 0.03038, saving model to /content/drive/My Dri
ve/model_save/weights-09-0.0304.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.3536 - accuracy: 0.9850 - dice
_coef: 0.0309 - val_loss: 0.3324 - val_accuracy: 0.9862 - val_dice_coef: 0.0304
Epoch 10/50
120/120 [==============================] - ETA: 0s - loss: 0.3286 - accuracy: 0.9852 - dice_coef:
0.0327
Epoch 00010: val_dice_coef improved from 0.03038 to 0.03209, saving model to /content/drive/My Dri
ve/model_save/weights-10-0.0321.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.3286 - accuracy: 0.9852 - dice
_coef: 0.0327 - val_loss: 0.3081 - val_accuracy: 0.9862 - val_dice_coef: 0.0321
Epoch 11/50
120/120 [==============================] - ETA: 0s - loss: 0.3063 - accuracy: 0.9856 - dice_coef:
0.0331
Epoch 00011: val_dice_coef improved from 0.03209 to 0.03733, saving model to /content/drive/My Dri
ve/model_save/weights-11-0.0373.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.3063 - accuracy: 0.9856 - dice
_coef: 0.0331 - val_loss: 0.3038 - val_accuracy: 0.9838 - val_dice_coef: 0.0373
Epoch 12/50
120/120 [==============================] - ETA: 0s - loss: 0.2850 - accuracy: 0.9855 - dice_coef:
0.0360
Epoch 00012: val_dice_coef did not improve from 0.03733
120/120 [==============================] - 54s 452ms/step - loss: 0.2850 - accuracy: 0.9855 - dice
_coef: 0.0360 - val_loss: 0.2727 - val_accuracy: 0.9856 - val_dice_coef: 0.0362
Epoch 13/50
120/120 [==============================] - ETA: 0s - loss: 0.2660 - accuracy: 0.9858 - dice_coef:
0.0380
Epoch 00013: val_dice_coef improved from 0.03733 to 0.03926, saving model to /content/drive/My Dri
ve/model_save/weights-13-0.0393.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.2660 - accuracy: 0.9858 - dice
_coef: 0.0380 - val_loss: 0.2614 - val_accuracy: 0.9846 - val_dice_coef: 0.0393
Epoch 14/50
120/120 [==============================] - ETA: 0s - loss: 0.2489 - accuracy: 0.9859 - dice_coef:
0.0401
Epoch 00014: val_dice_coef improved from 0.03926 to 0.04200, saving model to /content/drive/My Dri
ve/model_save/weights-14-0.0420.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.2489 - accuracy: 0.9859 - dice
_coef: 0.0401 - val_loss: 0.2445 - val_accuracy: 0.9850 - val_dice_coef: 0.0420
Epoch 15/50
120/120 [==============================] - ETA: 0s - loss: 0.2330 - accuracy: 0.9861 - dice_coef:
0.0432
Epoch 00015: val_dice_coef did not improve from 0.04200
120/120 [==============================] - 54s 452ms/step - loss: 0.2330 - accuracy: 0.9861 - dice
_coef: 0.0432 - val_loss: 0.2263 - val_accuracy: 0.9859 - val_dice_coef: 0.0397
Epoch 16/50
120/120 [==============================] - ETA: 0s - loss: 0.2185 - accuracy: 0.9863 - dice_coef:
0.0462
Epoch 00016: val_dice_coef improved from 0.04200 to 0.04683, saving model to /content/drive/My Dri
ve/model_save/weights-16-0.0468.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.2185 - accuracy: 0.9863 - dice
_coef: 0.0462 - val_loss: 0.2198 - val_accuracy: 0.9844 - val_dice_coef: 0.0468
```

```
Epoch 17/50
120/120 [==============================] - ETA: 0s - loss: 0.2050 - accuracy: 0.9863 - dice_coef:
0.0503
Epoch 00017: val_dice_coef did not improve from 0.04683
120/120 [==============================] - 54s 452ms/step - loss: 0.2050 - accuracy: 0.9863 - dice
_coef: 0.0503 - val_loss: 0.2015 - val_accuracy: 0.9861 - val_dice_coef: 0.0409
Epoch 18/50
120/120 [==============================] - ETA: 0s - loss: 0.1926 - accuracy: 0.9870 - dice_coef:
0.0517
Epoch 00018: val_dice_coef did not improve from 0.04683
120/120 [==============================] - 54s 451ms/step - loss: 0.1926 - accuracy: 0.9870 - dice
_coef: 0.0517 - val_loss: 0.1915 - val_accuracy: 0.9860 - val_dice_coef: 0.0443
Epoch 19/50
120/120 [==============================] - ETA: 0s - loss: 0.1814 - accuracy: 0.9873 - dice_coef:
0.0553
Epoch 00019: val_dice_coef improved from 0.04683 to 0.04831, saving model to /content/drive/My Dri
ve/model_save/weights-19-0.0483.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.1814 - accuracy: 0.9873 - dice
_coef: 0.0553 - val_loss: 0.1760 - val_accuracy: 0.9854 - val_dice_coef: 0.0483
Epoch 20/50
120/120 [==============================] - ETA: 0s - loss: 0.1709 - accuracy: 0.9876 - dice_coef:
0.0599
Epoch 00020: val_dice_coef improved from 0.04831 to 0.05278, saving model to /content/drive/My Dri
ve/model_save/weights-20-0.0528.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.1709 - accuracy: 0.9876 - dice
_coef: 0.0599 - val_loss: 0.1714 - val_accuracy: 0.9842 - val_dice_coef: 0.0528
Epoch 21/50
120/120 [==============================] - ETA: 0s - loss: 0.1611 - accuracy: 0.9879 - dice_coef:
0.0652
Epoch 00021: val_dice_coef improved from 0.05278 to 0.05617, saving model to /content/drive/My Dri
ve/model_save/weights-21-0.0562.hdf5
120/120 [==============================] - 56s 464ms/step - loss: 0.1611 - accuracy: 0.9879 - dice
_coef: 0.0652 - val_loss: 0.1595 - val_accuracy: 0.9856 - val_dice_coef: 0.0562
Epoch 22/50
120/120 [==============================] - ETA: 0s - loss: 0.1520 - accuracy: 0.9883 - dice_coef:
0.0711
Epoch 00022: val_dice_coef improved from 0.05617 to 0.06523, saving model to /content/drive/My Dri
ve/model_save/weights-22-0.0652.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.1520 - accuracy: 0.9883 - dice
_coef: 0.0711 - val_loss: 0.1567 - val_accuracy: 0.9842 - val_dice_coef: 0.0652
Epoch 23/50
120/120 [==============================] - ETA: 0s - loss: 0.1434 - accuracy: 0.9886 - dice_coef:
0.0781
Epoch 00023: val_dice_coef improved from 0.06523 to 0.07264, saving model to /content/drive/My Dri
ve/model_save/weights-23-0.0726.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.1434 - accuracy: 0.9886 - dice
_coef: 0.0781 - val_loss: 0.1506 - val_accuracy: 0.9827 - val_dice_coef: 0.0726
Epoch 24/50
120/120 [==============================] - ETA: 0s - loss: 0.1357 - accuracy: 0.9888 - dice_coef:
0.0841
Epoch 00024: val_dice_coef improved from 0.07264 to 0.07329, saving model to /content/drive/My Dri
ve/model_save/weights-24-0.0733.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.1357 - accuracy: 0.9888 - dice
_coef: 0.0841 - val_loss: 0.1429 - val_accuracy: 0.9834 - val_dice_coef: 0.0733
Epoch 25/50
120/120 [==============================] - ETA: 0s - loss: 0.1295 - accuracy: 0.9886 - dice_coef:
0.0850
Epoch 00025: val_dice_coef did not improve from 0.07329
120/120 [==============================] - 54s 451ms/step - loss: 0.1295 - accuracy: 0.9886 - dice
_coef: 0.0850 - val_loss: 0.1332 - val_accuracy: 0.9857 - val_dice_coef: 0.0707
Epoch 26/50
120/120 [==============================] - ETA: 0s - loss: 0.1215 - accuracy: 0.9895 - dice_coef:
0.0975
Epoch 00026: val_dice_coef improved from 0.07329 to 0.07976, saving model to /content/drive/My Dri
ve/model_save/weights-26-0.0798.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.1215 - accuracy: 0.9895 - dice
_coef: 0.0975 - val_loss: 0.1286 - val_accuracy: 0.9853 - val_dice_coef: 0.0798
Epoch 27/50
120/120 [==============================] - ETA: 0s - loss: 0.1155 - accuracy: 0.9897 - dice_coef:
0.1044
Epoch 00027: val_dice_coef did not improve from 0.07976
120/120 [==============================] - 54s 452ms/step - loss: 0.1155 - accuracy: 0.9897 - dice
_coef: 0.1044 - val_loss: 0.1222 - val_accuracy: 0.9857 - val_dice_coef: 0.0730
Epoch 28/50
120/120 [==============================] - ETA: 0s - loss: 0.1091 - accuracy: 0.9901 - dice_coef:
0.1142
Epoch 00028: val_dice_coef did not improve from 0.07976
```

```
120/120 [==============================] - 54s 452ms/step - loss: 0.1091 - accuracy: 0.9901 - dice
_coef: 0.1142 - val_loss: 0.1155 - val_accuracy: 0.9855 - val_dice_coef: 0.0738
Epoch 29/50
120/120 [==============================] - ETA: 0s - loss: 0.1034 - accuracy: 0.9904 - dice_coef:
0.1234
Epoch 00029: val_dice_coef improved from 0.07976 to 0.08627, saving model to /content/drive/My Dri
ve/model_save/weights-29-0.0863.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.1034 - accuracy: 0.9904 - dice
_coef: 0.1234 - val_loss: 0.1111 - val_accuracy: 0.9845 - val_dice_coef: 0.0863
Epoch 30/50
120/120 [==============================] - ETA: 0s - loss: 0.0980 - accuracy: 0.9907 - dice_coef:
0.1335
Epoch 00030: val_dice_coef did not improve from 0.08627
120/120 [==============================] - 54s 451ms/step - loss: 0.0980 - accuracy: 0.9907 - dice
_coef: 0.1335 - val_loss: 0.1020 - val_accuracy: 0.9864 - val_dice_coef: 0.0676
Epoch 31/50
120/120 [==============================] - ETA: 0s - loss: 0.0929 - accuracy: 0.9911 - dice_coef:
0.1431
Epoch 00031: val_dice_coef did not improve from 0.08627
120/120 [==============================] - 54s 451ms/step - loss: 0.0929 - accuracy: 0.9911 - dice
_coef: 0.1431 - val_loss: 0.1013 - val_accuracy: 0.9863 - val_dice_coef: 0.0840
Epoch 32/50
120/120 [==============================] - ETA: 0s - loss: 0.0880 - accuracy: 0.9915 - dice_coef:
0.1546
Epoch 00032: val_dice_coef did not improve from 0.08627
120/120 [==============================] - 54s 452ms/step - loss: 0.0880 - accuracy: 0.9915 - dice
_coef: 0.1546 - val_loss: 0.0986 - val_accuracy: 0.9864 - val_dice_coef: 0.0829
Epoch 33/50
120/120 [==============================] - ETA: 0s - loss: 0.0833 - accuracy: 0.9919 - dice_coef:
0.1666
Epoch 00033: val_dice_coef improved from 0.08627 to 0.08766, saving model to /content/drive/My Dri
ve/model_save/weights-33-0.0877.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.0833 - accuracy: 0.9919 - dice
_coef: 0.1666 - val_loss: 0.0951 - val_accuracy: 0.9862 - val_dice_coef: 0.0877
Epoch 34/50
120/120 [==============================] - ETA: 0s - loss: 0.0789 - accuracy: 0.9923 - dice_coef:
0.1790
Epoch 00034: val_dice_coef improved from 0.08766 to 0.10062, saving model to /content/drive/My Dri
ve/model_save/weights-34-0.1006.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.0789 - accuracy: 0.9923 - dice
_coef: 0.1790 - val_loss: 0.0913 - val_accuracy: 0.9861 - val_dice_coef: 0.1006
Epoch 35/50
120/120 [==============================] - ETA: 0s - loss: 0.0750 - accuracy: 0.9924 - dice_coef:
0.1893
Epoch 00035: val_dice_coef improved from 0.10062 to 0.10607, saving model to /content/drive/My Dri
ve/model_save/weights-35-0.1061.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0750 - accuracy: 0.9924 - dice
_coef: 0.1893 - val_loss: 0.0910 - val_accuracy: 0.9858 - val_dice_coef: 0.1061
Epoch 36/50
120/120 [==============================] - ETA: 0s - loss: 0.0711 - accuracy: 0.9928 - dice_coef:
0.2018
Epoch 00036: val_dice_coef did not improve from 0.10607
120/120 [==============================] - 54s 451ms/step - loss: 0.0711 - accuracy: 0.9928 - dice
_coef: 0.2018 - val_loss: 0.0843 - val_accuracy: 0.9869 - val_dice_coef: 0.0866
Epoch 37/50
120/120 [==============================] - ETA: 0s - loss: 0.0675 - accuracy: 0.9930 - dice_coef:
0.2141
Epoch 00037: val_dice_coef improved from 0.10607 to 0.11489, saving model to /content/drive/My Dri
ve/model_save/weights-37-0.1149.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.0675 - accuracy: 0.9930 - dice
_coef: 0.2141 - val_loss: 0.0835 - val_accuracy: 0.9858 - val_dice_coef: 0.1149
Epoch 38/50
120/120 [==============================] - ETA: 0s - loss: 0.0640 - accuracy: 0.9933 - dice_coef:
0.2270
Epoch 00038: val_dice_coef did not improve from 0.11489
120/120 [==============================] - 54s 452ms/step - loss: 0.0640 - accuracy: 0.9933 - dice
_coef: 0.2270 - val_loss: 0.0800 - val_accuracy: 0.9863 - val_dice_coef: 0.1143
Epoch 39/50
120/120 [==============================] - ETA: 0s - loss: 0.0605 - accuracy: 0.9937 - dice_coef:
0.2419
Epoch 00039: val_dice_coef improved from 0.11489 to 0.11784, saving model to /content/drive/My Dri
ve/model_save/weights-39-0.1178.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.0605 - accuracy: 0.9937 - dice
_coef: 0.2419 - val_loss: 0.0804 - val_accuracy: 0.9860 - val_dice_coef: 0.1178
Epoch 40/50
120/120 [==============================] - ETA: 0s - loss: 0.0575 - accuracy: 0.9940 - dice_coef:
0.2542
```

```
Epoch 00040: val_dice_coef did not improve from 0.11784
120/120 [==============================] - 54s 451ms/step - loss: 0.0575 - accuracy: 0.9940 - dice
_coef: 0.2542 - val_loss: 0.0767 - val_accuracy: 0.9859 - val_dice_coef: 0.1104
Epoch 41/50
120/120 [==============================] - ETA: 0s - loss: 0.0549 - accuracy: 0.9941 - dice_coef:
0.2668
Epoch 00041: val_dice_coef improved from 0.11784 to 0.13707, saving model to /content/drive/My Dri
ve/model_save/weights-41-0.1371.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0549 - accuracy: 0.9941 - dice
_coef: 0.2668 - val_loss: 0.0772 - val_accuracy: 0.9857 - val_dice_coef: 0.1371
Epoch 42/50
120/120 [==============================] - ETA: 0s - loss: 0.0523 - accuracy: 0.9942 - dice_coef:
0.2777
Epoch 00042: val_dice_coef improved from 0.13707 to 0.13992, saving model to /content/drive/My Dri
ve/model_save/weights-42-0.1399.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.0523 - accuracy: 0.9942 - dice
_coef: 0.2777 - val_loss: 0.0746 - val_accuracy: 0.9857 - val_dice_coef: 0.1399
Epoch 43/50
120/120 [==============================] - ETA: 0s - loss: 0.0497 - accuracy: 0.9945 - dice_coef:
0.2918
Epoch 00043: val_dice_coef did not improve from 0.13992
120/120 [==============================] - 54s 451ms/step - loss: 0.0497 - accuracy: 0.9945 - dice
_coef: 0.2918 - val_loss: 0.0724 - val_accuracy: 0.9861 - val_dice_coef: 0.1393
Epoch 44/50
120/120 [==============================] - ETA: 0s - loss: 0.0475 - accuracy: 0.9946 - dice_coef:
0.3039
Epoch 00044: val_dice_coef improved from 0.13992 to 0.15410, saving model to /content/drive/My Dri
ve/model_save/weights-44-0.1541.hdf5
120/120 [==============================] - 55s 462ms/step - loss: 0.0475 - accuracy: 0.9946 - dice
_coef: 0.3039 - val_loss: 0.0727 - val_accuracy: 0.9854 - val_dice_coef: 0.1541
Epoch 45/50
120/120 [==============================] - ETA: 0s - loss: 0.0452 - accuracy: 0.9948 - dice_coef:
0.3166
Epoch 00045: val_dice_coef did not improve from 0.15410
120/120 [==============================] - 54s 451ms/step - loss: 0.0452 - accuracy: 0.9948 - dice
_coef: 0.3166 - val_loss: 0.0679 - val_accuracy: 0.9864 - val_dice_coef: 0.1402
Epoch 46/50
120/120 [==============================] - ETA: 0s - loss: 0.0433 - accuracy: 0.9949 - dice_coef:
0.3285
Epoch 00046: val_dice_coef did not improve from 0.15410
120/120 [==============================] - 54s 451ms/step - loss: 0.0433 - accuracy: 0.9949 - dice
_coef: 0.3285 - val_loss: 0.0692 - val_accuracy: 0.9858 - val_dice_coef: 0.1468
Epoch 47/50
120/120 [==============================] - ETA: 0s - loss: 0.0415 - accuracy: 0.9949 - dice_coef:
0.3404
Epoch 00047: val_dice_coef did not improve from 0.15410
120/120 [==============================] - 54s 452ms/step - loss: 0.0415 - accuracy: 0.9949 - dice
_coef: 0.3404 - val_loss: 0.0680 - val_accuracy: 0.9860 - val_dice_coef: 0.1501
Epoch 48/50
120/120 [==============================] - ETA: 0s - loss: 0.0394 - accuracy: 0.9952 - dice_coef:
0.3547
Epoch 00048: val_dice_coef did not improve from 0.15410
120/120 [==============================] - 54s 452ms/step - loss: 0.0394 - accuracy: 0.9952 - dice
_coef: 0.3547 - val_loss: 0.0674 - val_accuracy: 0.9863 - val_dice_coef: 0.1393
Epoch 49/50
120/120 [==============================] - ETA: 0s - loss: 0.0375 - accuracy: 0.9954 - dice_coef:
0.3687
Epoch 00049: val_dice_coef improved from 0.15410 to 0.15678, saving model to /content/drive/My Dri
ve/model_save/weights-49-0.1568.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0375 - accuracy: 0.9954 - dice
_coef: 0.3687 - val_loss: 0.0644 - val_accuracy: 0.9867 - val_dice_coef: 0.1568
Epoch 50/50
120/120 [==============================] - ETA: 0s - loss: 0.0359 - accuracy: 0.9955 - dice_coef:
0.3820
Epoch 00050: val_dice_coef improved from 0.15678 to 0.16169, saving model to /content/drive/My Dri
ve/model_save/weights-50-0.1617.hdf5
120/120 [==============================] - 56s 463ms/step - loss: 0.0359 - accuracy: 0.9955 - dice
_coef: 0.3820 - val_loss: 0.0640 - val_accuracy: 0.9866 - val_dice_coef: 0.1617
```

Out[ ]:

```
<tensorflow.python.keras.callbacks.History at 0x7f433dd94f60>
```

Both the HRNET models with and without augmentation did not perform upto the mark. It is a new model hence there are no pretrained weights available for the keras library to use .

Error analysis

Let us take the best model obtained from all the above models and perform some analysis. The best model is the unet model with chexnet weights(with dropout layer and without data augmentation)

In [ ]:

```
model=tf.keras.models.load_model('/content/drive/My Drive/model_save/weights-12-0.4656.hdf5',
custom_objects={'dice_coef':dice_coef})
```

In [ ]:

```
model.evaluate(test_dataset)
```

```
30/30 [==============================] - 2s 54ms/step - loss: 0.0690 - accuracy: 0.9869 -
dice_coef: 0.4656
```

Out[ ]:

```
[0.06902240216732025, 0.9868783354759216, 0.4655648469924927]
```

In [ ]:

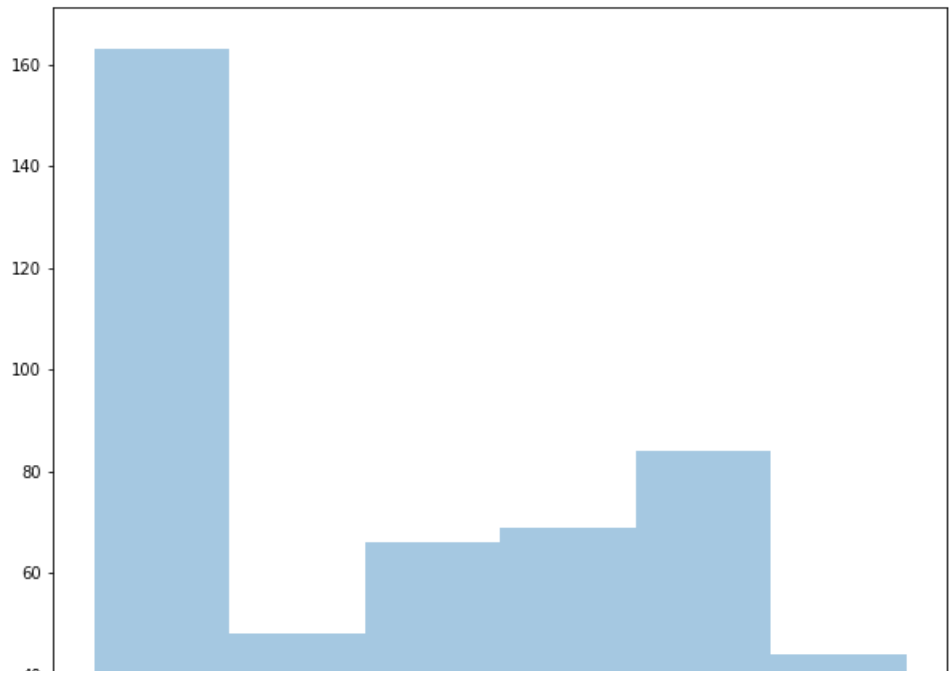
```
iou_scores=[]
for i,j in tqdm(val_ds):
  a=model.predict(tf.expand_dims(i,axis=0))
  a=(a >0.5).astype(np.uint8)
  j=tf.dtypes.cast(j, tf.float32)
  a=tf.dtypes.cast(a, tf.float32)

  b=dice_coef(j,a,smooth=0.1)
  iou_scores.append(b.numpy())
```

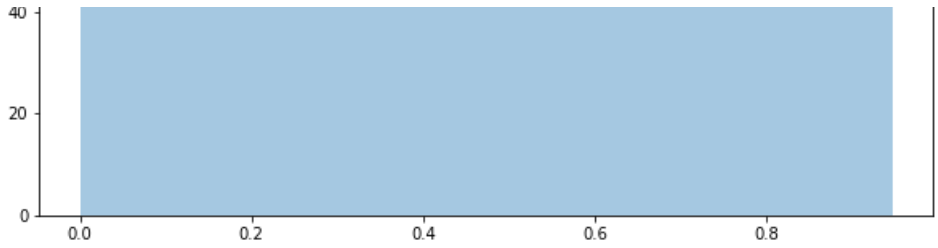
In [ ]:

```
import seaborn as sns
plt.figure(figsize=(10,10))
sns.distplot(iou_scores,kde=False)
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f910cb077b8>
```



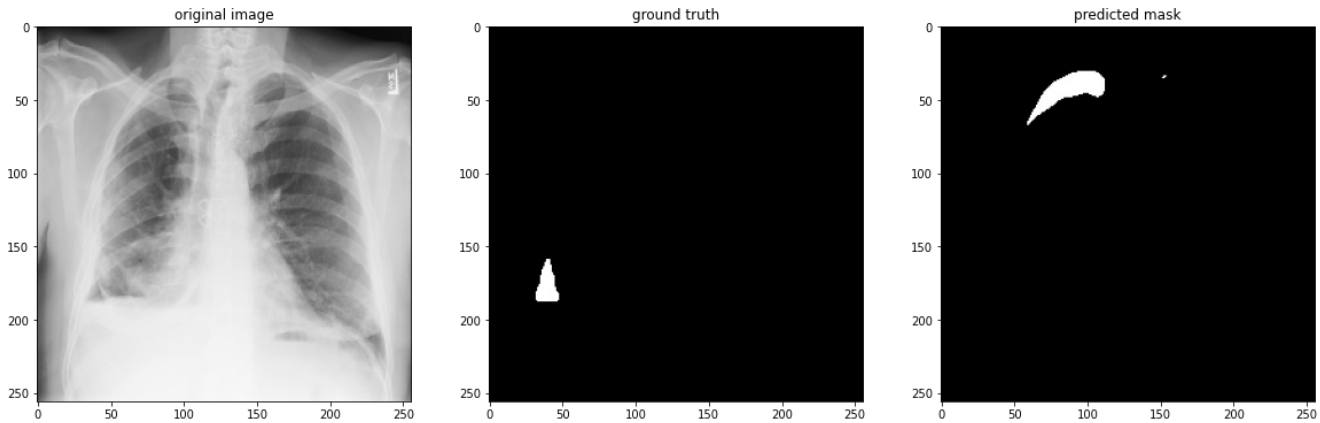


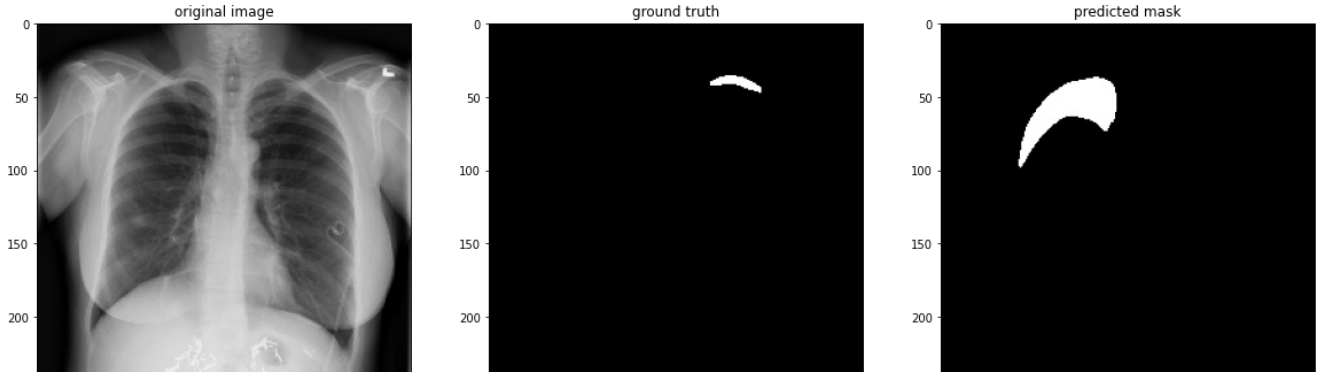
From the above histogram we can observe that there are good number of points with an iou score between 0.0 to 0.1 . But there are many points between 0.3-0.8 .

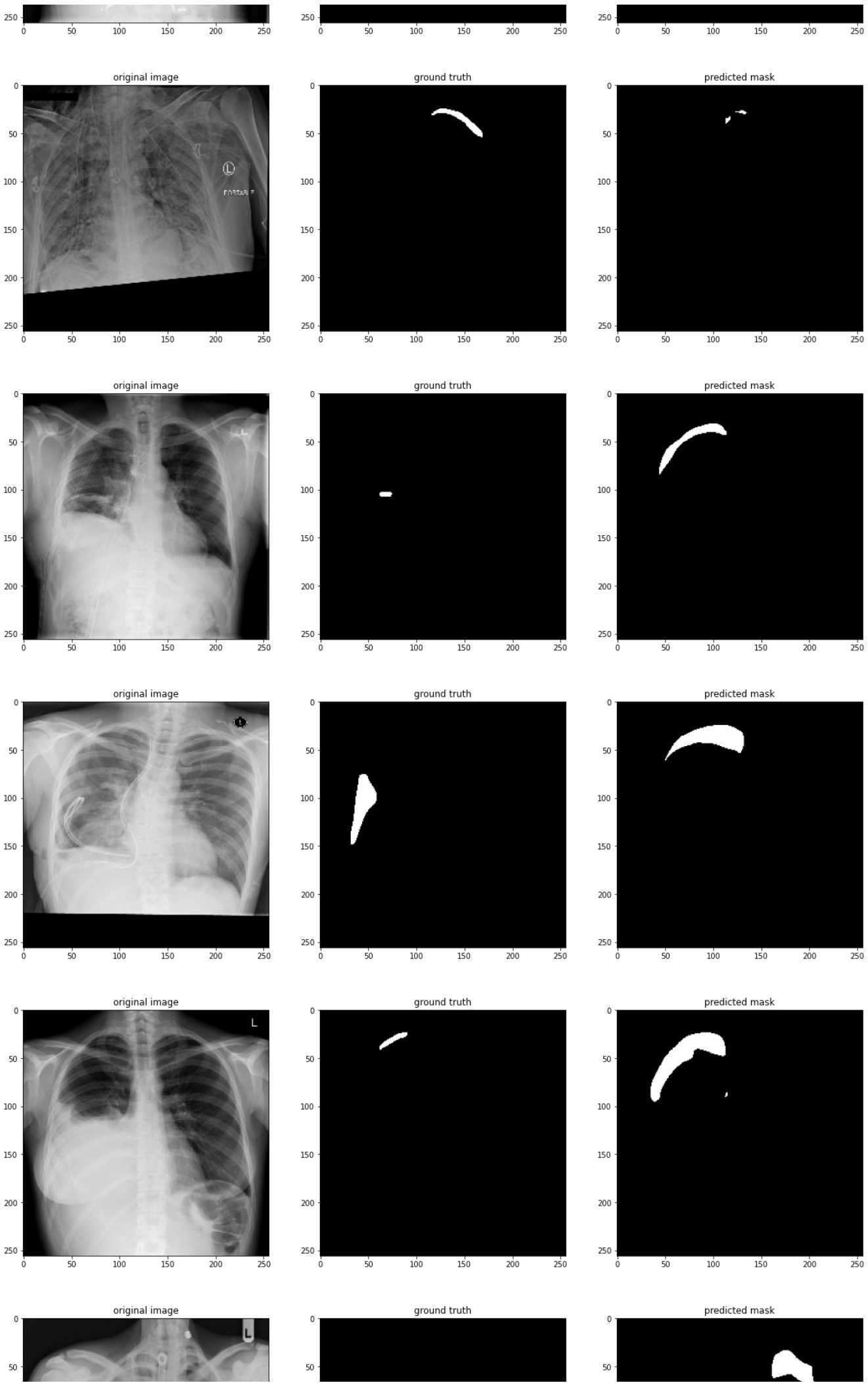
Let us manually observe few masks with an IOU score less than 0.5 and come to a conclusion and draw few observations from it.

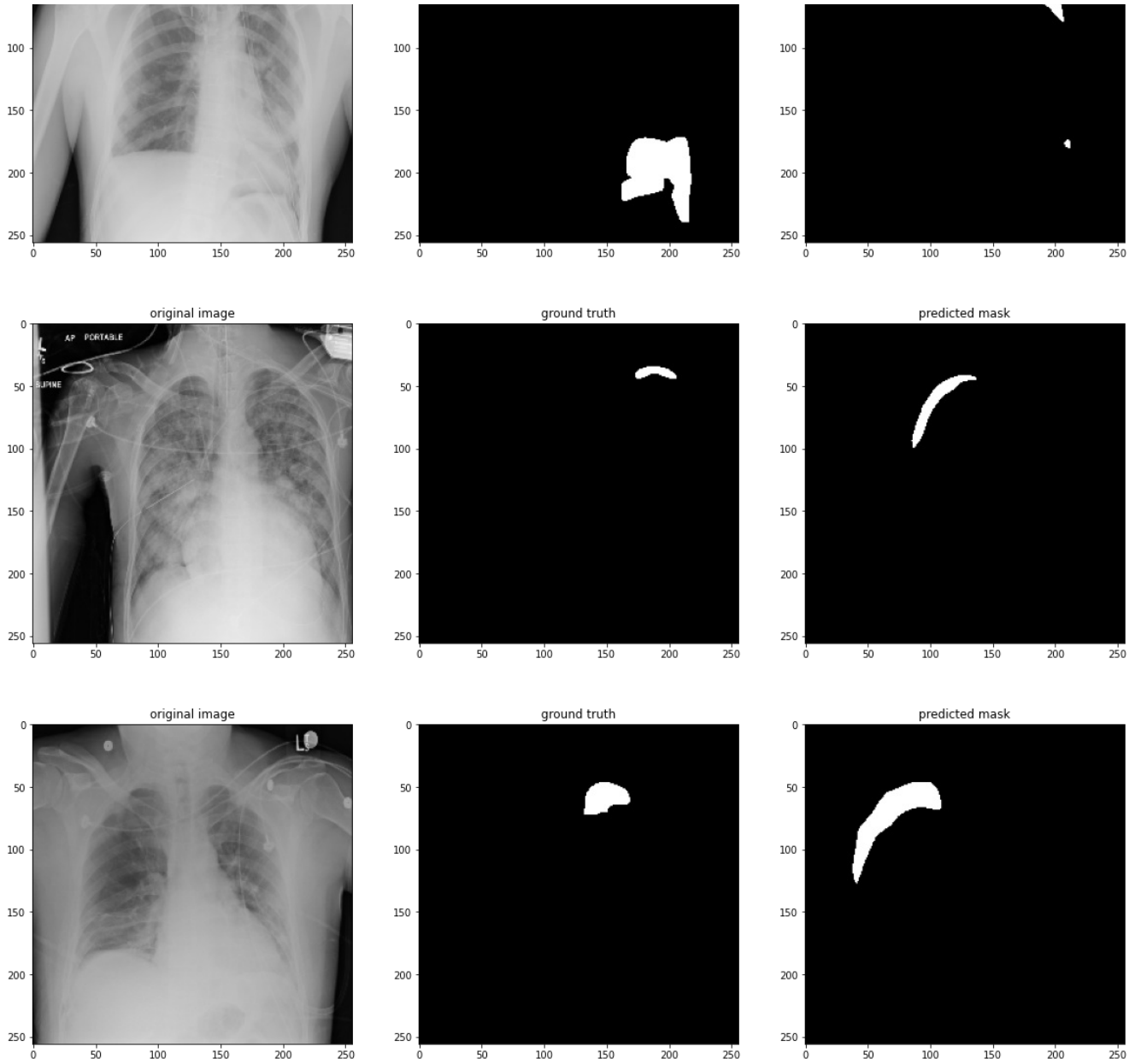
In [ ]:

```
count=0
for i,j in (val_ds):
  a=model.predict(tf.expand_dims(i,axis=0))
  a=(a >0.5).astype(np.uint8)
  j=tf.dtypes.cast(j, tf.float32)
  a=tf.dtypes.cast(a, tf.float32)
  b=dice_coef(j,a,smooth=0.1)
  if count>=10:
    break
  if b<0.2 and count<10:
    plt.figure(figsize=(20,6))
    plt.subplot(131)
    plt.title("original image")
    plt.imshow(np.squeeze(i),cmap='gray')
    plt.subplot(132)
    plt.title("ground truth")
    plt.imshow(np.squeeze(j),cmap='gray')
    plt.subplot(133)
    plt.title("predicted mask")
    plt.imshow(np.squeeze(a),cmap='gray')
    plt.show()
    count=count+1
```






original image
ground truth
predicted mask
original image
ground truth
predicted mask
original image
ground truth
predicted mask
original image
ground truth
predicted mask
original image
ground truth
predicted mask



In [ ]:

```
path=[] #saving path of the images with less than 0.5 iou score
for i,j in tqdm(val_ds):
  a=model.predict(tf.expand_dims(i,axis=0))
  a=(a >0.5).astype(np.uint8)
  j=tf.dtypes.cast(j, tf.float32)
  a=tf.dtypes.cast(a, tf.float32)
  b=dice_coef(j,a,smooth=0.1)
  if b<0.5:
    for k,l in enumerate(test_mask): #checking from the validation
      l=tf.dtypes.cast(l, tf.float32)
      if tf.math.equal(l,j).numpy().all():  #the validation mask matches the current mask from the
tf.datset then we shall take the masks corresponding image path
        path.append(test_path[k])
```

In [ ]:

```
train_df=[]
for i in tqdm(path):
  sample=dicom.dcmread(i) #reading each image
  train={}
```

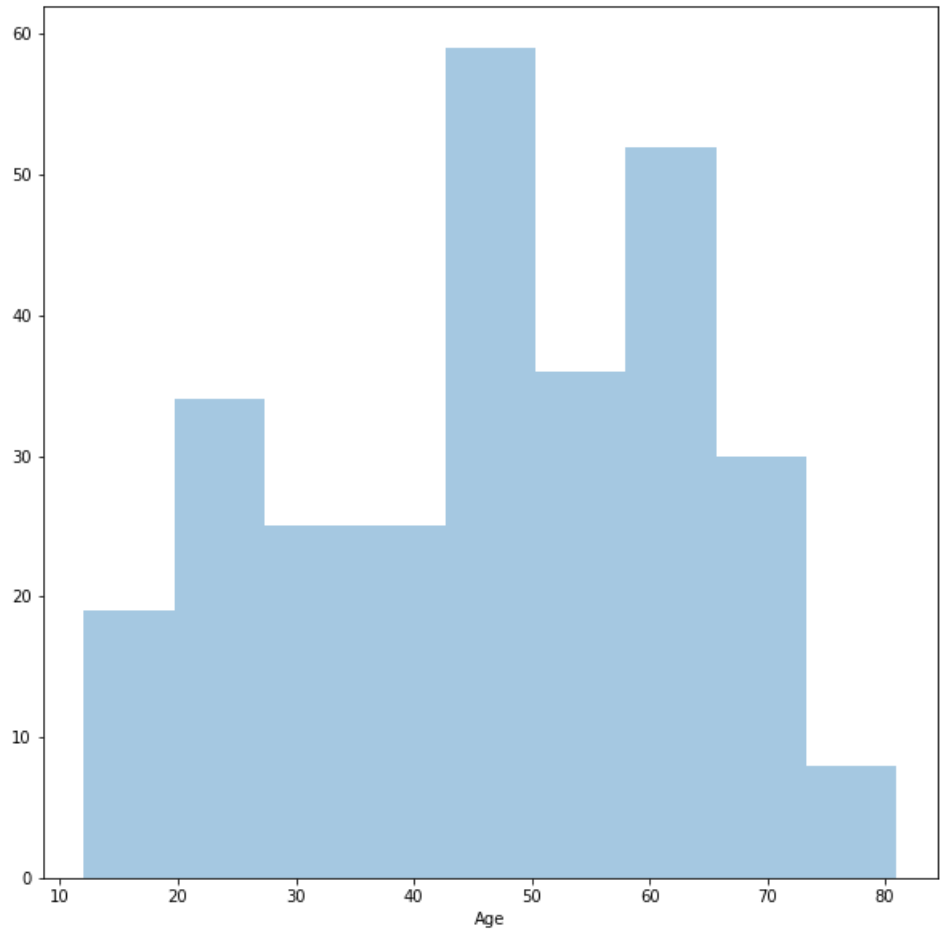
```
  try: #try and except to avoid throwing an error in case any file is missing
    encoded_pixels = dataset[dataset["ImageId"] == train["UID"]].values[0][1] #We are checking whea
ther each image(from the train) present has been mapped to the csv file given .
  except:
    pass
  train["Age"] = sample.PatientAge
  train["Sex"] = sample.PatientSex
  train["ViewPosition"] = sample.ViewPosition
  train_df.append(train)

patients_train = pd.DataFrame(train_df,columns=["UID", "EncodedPixels", "Age", "Sex","ViewPosition"
,"path"])
```

In [ ]:

```
plt.figure(figsize=(10,10))
sns.distplot(patients_train.Age,kde=False)
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f9111d476d8>
```



In [ ]:

```
patients_train.Sex.value_counts()
```

Out[ ]:

```
M    147
F    141
Name: Sex, dtype: int64
```

In [ ]:

```
patients_train.ViewPosition.value_counts()
```

Out[ ]:

```
PA    175
AP    113
Name: ViewPosition, dtype: int64
```

Observations:

- We can observe that the masks with an iou score less 0.5 might not have a proper overlap with the orginal mask but in most cases it does narrow down the location or affected region for the doctor to look into
- Few xray images are with have light coloured lungs with very bright background.
- We can say that even though the masks might be wrong it is decent as it does not totally point to a different region in most of the cases .

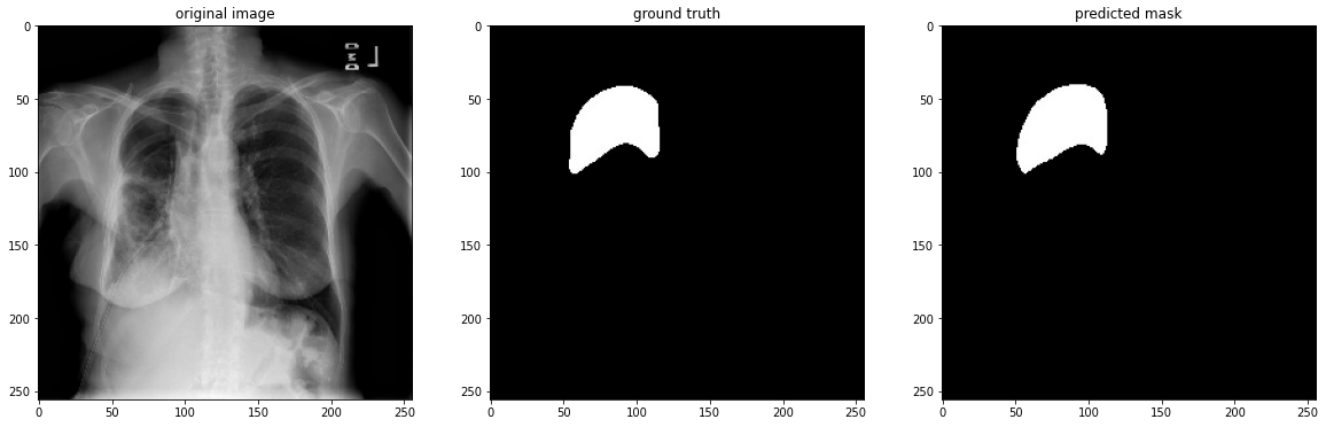
- We can observe that the model is not giving good results for the patients mostly between the age 45-50 and 60-65
- Though there are more male patients than female patients for which the model isnt doing its best . However , we cannot make a conclusion from it as the difference between the male and female points is not very significant

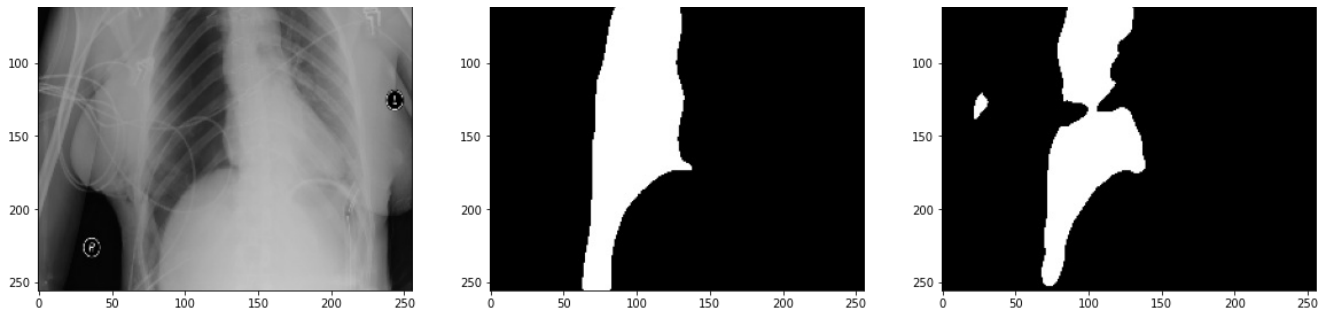
- There are many posteroanterior view xrays for which the model didnt work very well but we shouldnt take it as a conclusion as there are many AP view xray's as well

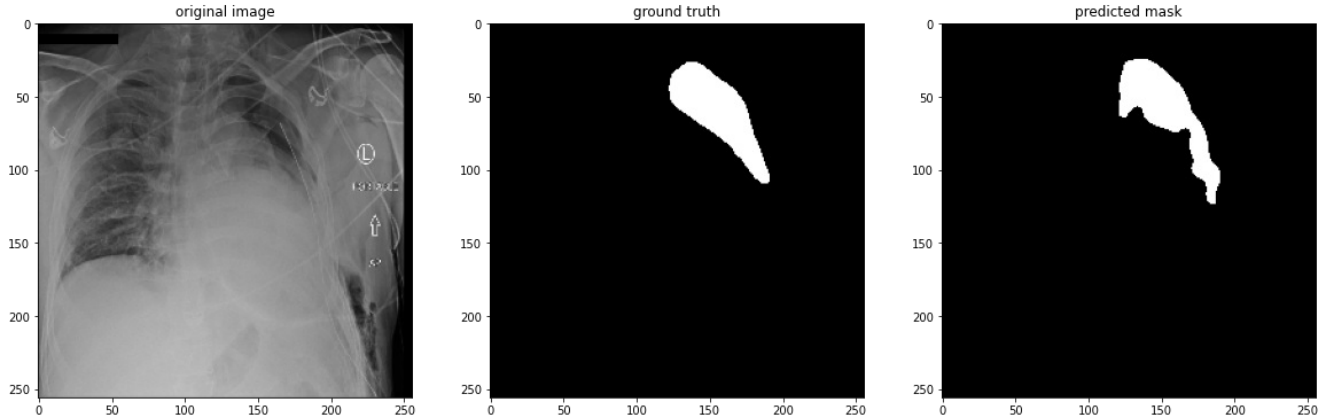
Observations from the images for which the model is performing well

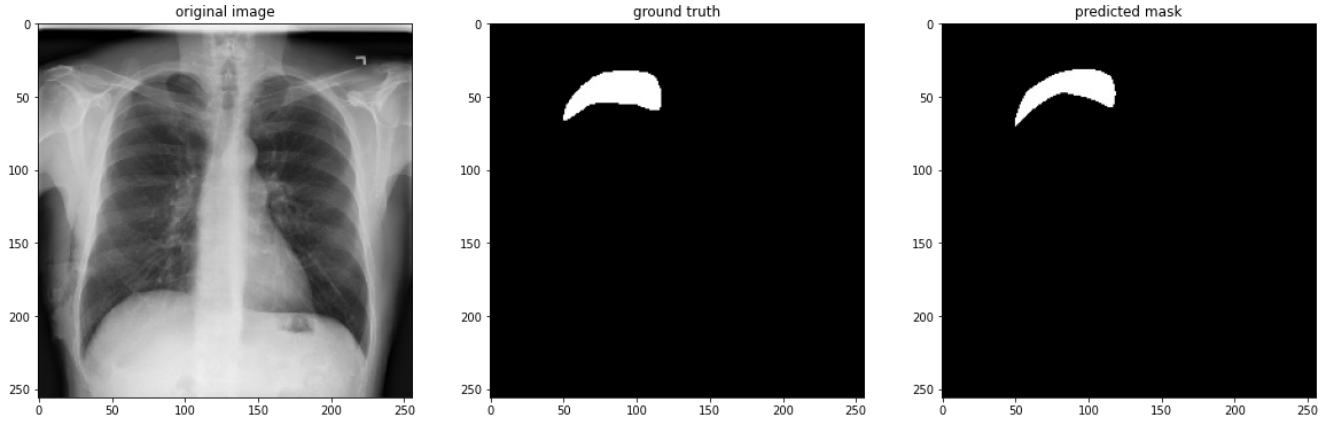
In [ ]:

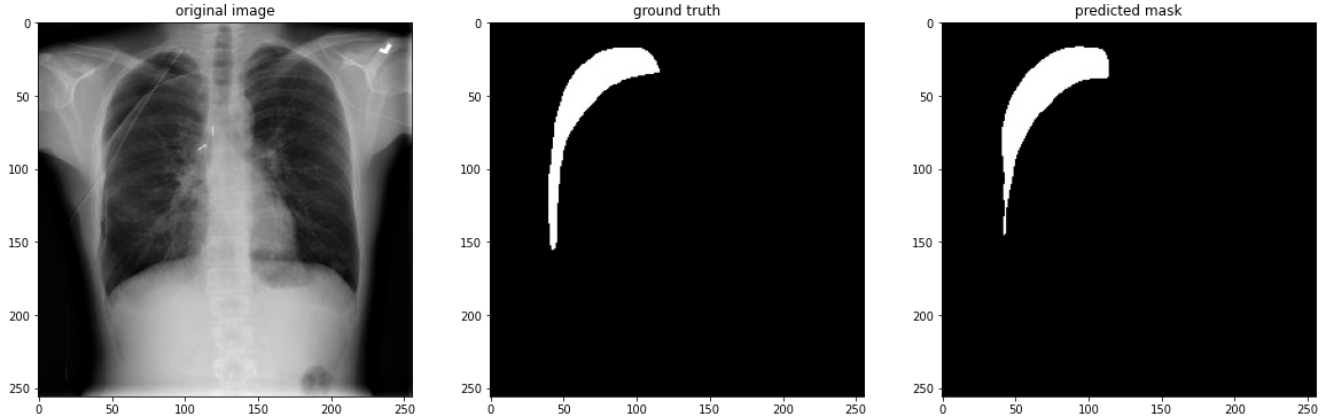
```
count=0
for i,j in (val_ds):
  a=model.predict(tf.expand_dims(i,axis=0))
  a=(a >0.5).astype(np.uint8)
  j=tf.dtypes.cast(j, tf.float32)
  a=tf.dtypes.cast(a, tf.float32)
  b=dice_coef(j,a,smooth=0.1)
  if count>=10:
    break
  if b>0.5 and count<10:
    plt.figure(figsize=(20,6))
    plt.subplot(131)
    plt.title("original image")
    plt.imshow(np.squeeze(i),cmap='gray')
    plt.subplot(132)
    plt.title("ground truth")
    plt.imshow(np.squeeze(j),cmap='gray')
    plt.subplot(133)
    plt.title("predicted mask")
    plt.imshow(np.squeeze(a),cmap='gray')
    plt.show()
    count=count+1
```

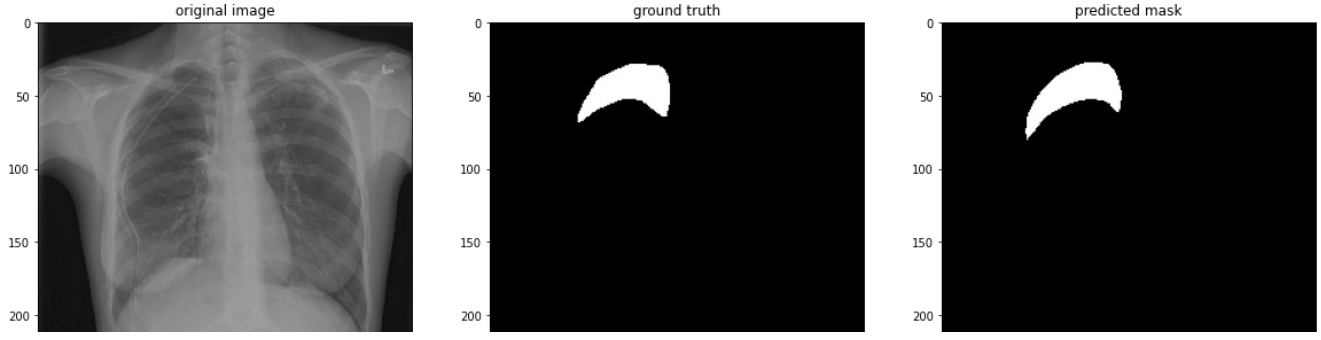


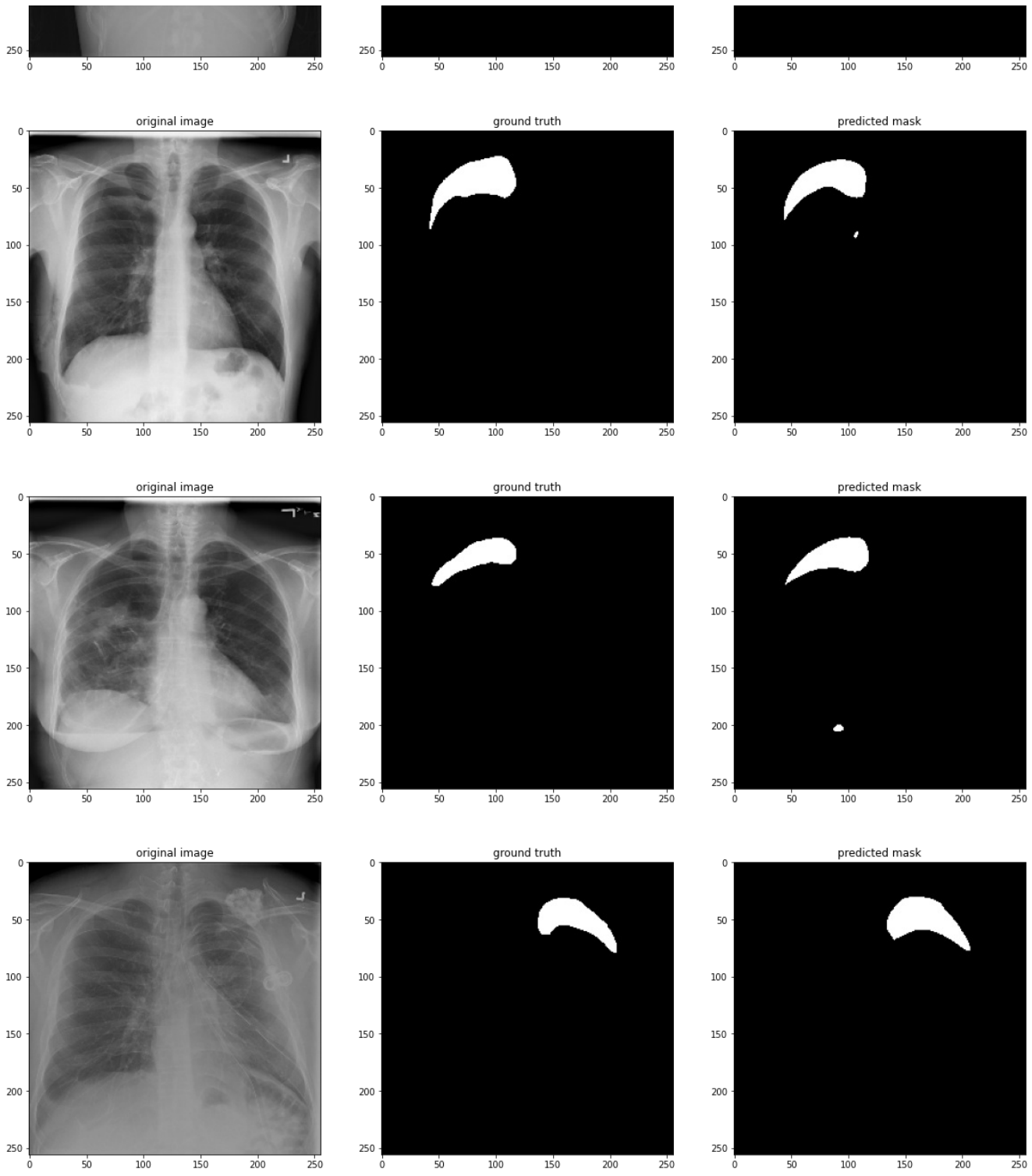



original image
ground truth
predicted mask


original image
ground truth
predicted mask


original image
ground truth
predicted mask


original image
ground truth
predicted mask



In [ ]:

```
path=[] #saving path of the images with greater than or equal to 0.2 iou score
for i,j in tqdm(val_ds):
  a=model.predict(tf.expand_dims(i,axis=0))
  a=(a >0.5).astype(np.uint8)
  j=tf.dtypes.cast(j, tf.float32)
  a=tf.dtypes.cast(a, tf.float32)
  b=dice_coef(j,a,smooth=0.1)
  if b>=0.5:
    for k,l in enumerate(test_mask): #checking from the validation
      l=tf.dtypes.cast(l, tf.float32)
      if tf.math.equal(l,j).numpy().all():  #the validation mask matches the current mask from the
tf.datset then we shall take the masks corresponding image path
        path.append(test_path[k])
```

In [ ]:

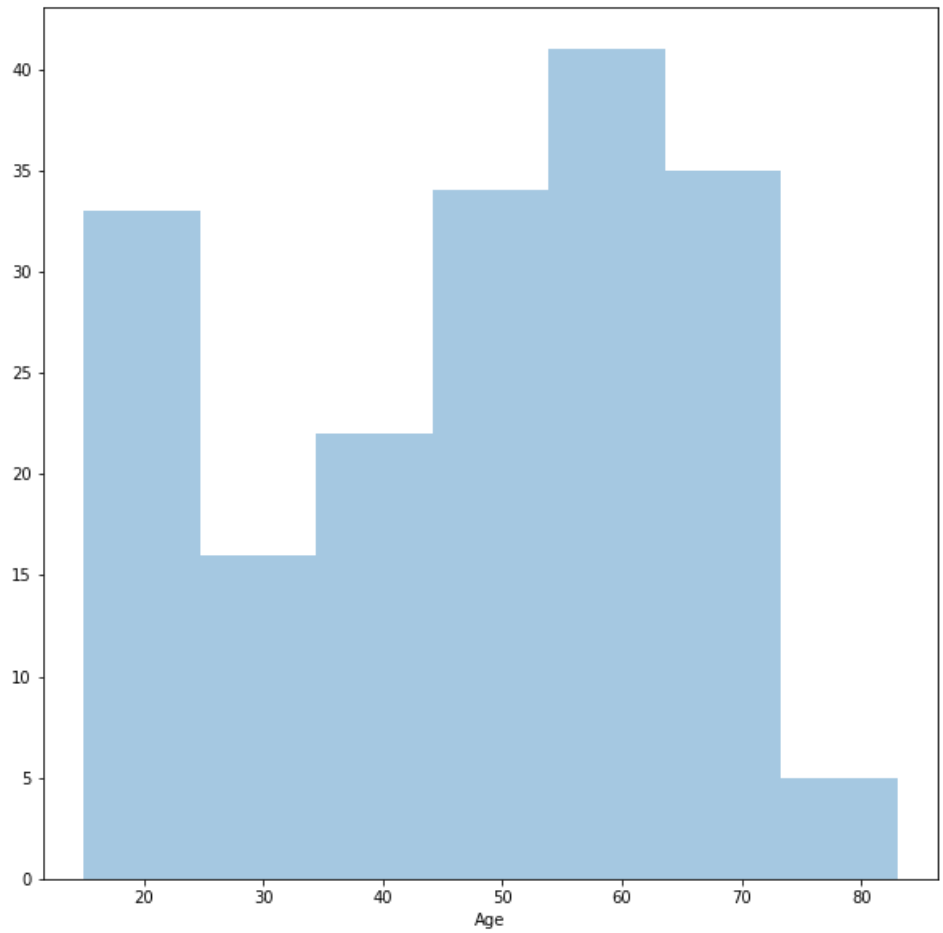
```
train_df=[]
for i in tqdm(path):
  sample=dicom.dcmread(i) #reading each image
  train={}
  try: #try and except to avoid throwing an error in case any file is missing
    encoded_pixels = dataset[dataset["ImageId"] == train["UID"]].values[0][1] #We are checking whea
ther each image(from the train) present has been mapped to the csv file given .
  except:
    pass
  train["Age"] = sample.PatientAge
  train["Sex"] = sample.PatientSex
  train["ViewPosition"] = sample.ViewPosition
  train_df.append(train)

patients_train = pd.DataFrame(train_df,columns=["UID", "EncodedPixels", "Age", "Sex","ViewPosition"
,"path"])
```

In [ ]:

```
plt.figure(figsize=(10,10))
sns.distplot(patients_train.Age,kde=False)
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f941a45f7b8>
```



In [ ]:

```
patients_train.Sex.value_counts()
```

Out[ ]:

```
M    99
F    87
Name: Sex, dtype: int64
```

In [ ]:

```
patients_train.ViewPosition.value_counts()
```

Out[ ]:

```
PA    127
AP     59
Name: ViewPosition, dtype: int64
```

Observations:

- We can observe that the model is giving good results for the patients mostly between the age 55-65 and decently for other age groups as well
- Though there are more male patients than male patients for which the model is doing its best . However , we cannot make a conclusion from it as the difference between the male and female points is not very significant
- There are many posteroanterior view xrays for which the model did work well

Inference time for the Best models from each architecture

In [78]:

```
img = tf.io.read_file(test_path[0]) #reading the image from the file path
img = decode_img(img)
img=tf.expand_dims(img,axis=0)
```

In [57]:

```
import time
best_models=['/content/drive/My Drive/model_save/weights-74-0.2562.hdf5','/content/drive/My
Drive/model_save/weights-09-0.4296.hdf5','/content/drive/My Drive/model_save/weights-20-
0.3750.hdf5','/content/drive/My Drive/model_save/weights-12-0.4656.hdf5','/content/drive/My Drive/
model_save/weights-49-0.1630.hdf5','/content/drive/My Drive/model_save/weights-50-0.1617.hdf5']
time_taken=[]
for i in tqdm(best_models):
  model=tf.keras.models.load_model(i,custom_objects={'dice_coef':dice_coef})
  start_time = time.time()
  model.predict(img)
  time_taken.append(time.time() - start_time)
```

```
WARNING:tensorflow:5 out of the last 5 calls to <function Model.make_predict_function.
<locals>.predict_function at 0x7f4853ff12f0> triggered tf.function retracing. Tracing is expensive
and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loo
p, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (
1), please define your @tf.function outside of the loop. For (2), @tf.function has
experimental_relax_shapes=True option that relaxes argument shapes that can avoid unnecessary retr
acing. For (3), please refer to
https://www.tensorflow.org/tutorials/customization/performance#python_or_tensor_args and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.
WARNING:tensorflow:6 out of the last 6 calls to <function Model.make_predict_function.
<locals>.predict_function at 0x7f484e542d08> triggered tf.function retracing. Tracing is expensive
and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loo
p, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (
1), please define your @tf.function outside of the loop. For (2), @tf.function has
experimental_relax_shapes=True option that relaxes argument shapes that can avoid unnecessary retr
acing. For (3), please refer to
https://www.tensorflow.org/tutorials/customization/performance#python_or_tensor_args and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.
```

In [76]:

```
model_names=['simple unet','Unet with densenet121 Backbone(chexnet weights and data augmentation)'
,'Unet with densenet121 Backbone(chexnet weights and without data augmentation)','Unet with densen
```

```
et121 Backbone(Dropout)(chexnet weights and data augmentation)','HRNET without data augmentation',
'HRNET with data augmentation']
for i in range(0,len(time_taken)):
  print("The time taken to predict a single data point by the {} model is {}
seconds".format(model_names[i],time_taken[i]))
```

```
The time taken to predict a single data point by the simple unet model is 0.42502760887145996
seconds
The time taken to predict a single data point by the Unet with densenet121 Backbone(chexnet
weights and data augmentation) model is 1.600532054901123 seconds
The time taken to predict a single data point by the Unet with densenet121 Backbone(chexnet
weights and without data augmentation) model is 1.6536757946014404 seconds
The time taken to predict a single data point by the Unet with densenet121 Backbone(Dropout)
(chexnet weights and data augmentation) model is 1.6086997985839844 seconds
The time taken to predict a single data point by the HRNET without data augmentation model is
1.4905080795288086 seconds
The time taken to predict a single data point by the HRNET with data augmentation model is
1.2823524475097656 seconds
```

Summary

In [77]:

```
from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ["Model name","Number of parameters","Train IOU Score","Test IOU Score",'Train
loss','Test loss','Inference time(in seconds)']
x.add_row([ "simple unet",'1,941,105','0.4523','0.0256','0.270','0.0603','0.42502760887145996'])
x.add_row([ "Unet with densenet121 Bckbone(chexnet weights and data augmentation) ",'12,144,977','
0.6401','0.4296','0.0159','0.0530','1.600532054901123'])
x.add_row([ "Unet with densenet121 Backbone(chexnet weights and without data augmentation)",'12,14
4,977','0.5401','0.3750','0.0159','0.0530','1.6536757946014404'])
x.add_row([ "Unet with densenet121 Backbone(Dropout)(chexnet weights and data augmentation)",'12,1
44,977','0.6701','0.4656','0.0151','0.0690','1.6086997985839844'])
x.add_row([ "HRNET without data augmentation",'9,524,036','0.3797','0.1630','0.0366','0.0620','1.49
05080795288086'])
x.add_row([ "HRNET with data augmentation",'9,524,036','0.3820','0.1617','0.0359','0.0640','1.28235
24475097656 '])
print(x)
```

```
+-----------------------------------------------------------------------------------+-----------------
-+----------------+---------------+------------+-----------+---------------------------+
|                                    Model name                                     | Number of
parameters | Train IOU Score | Test IOU Score | Train loss | Test loss | Inference time(in
seconds) |
+-----------------------------------------------------------------------------------+-----------------
-+----------------+---------------+------------+-----------+---------------------------+
|                                   simple unet                                     |      1,941,105
|      0.4523     |     0.0256     |   0.270    |   0.0603  |    0.42502760887145996     |
|     Unet with densenet121 Bckbone(chexnet weights and data augmentation)       |      12,144,977
|      0.6401     |     0.4296     |   0.0159   |   0.0530  |     1.600532054901123      |
| Unet with densenet121 Backbone(chexnet weights and without data augmentation)  |      12,144,977
|      0.5401     |     0.3750     |   0.0159   |   0.0530  |     1.6536757946014404     |
| Unet with densenet121 Backbone(Dropout)(chexnet weights and data augmentation) |      12,144,977
|      0.6701     |     0.4656     |   0.0151   |   0.0690  |     1.6086997985839844     |
|                          HRNET without data augmentation                        |      9,524,036
|      0.3797     |     0.1630     |   0.0366   |   0.0620  |     1.4905080795288086     |
|                             HRNET with data augmentation                        |      9,524,036
|      0.3820     |     0.1617     |   0.0359   |   0.0640  |    1.2823524475097656      |
+-----------------------------------------------------------------------------------+-----------------
-+----------------+---------------+------------+-----------+---------------------------+
```