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**Years of Work Experience: 2.6 years**

**Date: 24th Jan 2021**

```
In [ ]: import warnings
warnings.filterwarnings("ignore")
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
import os
import datetime as dt
from datetime import datetime
from tqdm import tqdm
from glob import glob
import pandas as pd
import shutil
import glob2
import cv2
```

```
In [ ]: from tensorflow.keras import models, layers
from tensorflow.keras.models import Model
# from tensorflow.keras.layers import BatchNormalization, Activation, Flatten
from tensorflow.keras.optimizers import Adam
# from tensorflow.keras.callbacks import ReduceLROnPlateau, ModelCheckpoint, EarlyStopping, LearningRateScheduler
from tensorflow.keras.callbacks import *
from tensorflow.keras.layers import *
from tensorflow.keras.models import Model
import datetime
from sklearn.model_selection import train_test_split
from keras.losses import binary_crossentropy
import keras.backend as K
```

**Download the dataset**

[https://www.kaggle.com/seesee/siim-train-test \(<https://www.kaggle.com/seesee/siim-train-test>\)](https://www.kaggle.com/seesee/siim-train-test)

```
In [ ]: # download the dataset
!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/89.0.4389.90 Safari/537.36" --header="Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9" --header="Accept-Language: en-US,en;q=0.9" --header="Referer: https://www.kaggle.com/" --header="Cookie: ext_name=ojsplmecpdpgccookcobabopnaifgihf" --header="Connection: keep-alive" "https://storage.googleapis.com/kaggle-data-sets/245622/651264/bundle/archive.zip?X-Goog-Algorithm=GOOG4-RSA-SHA256&X-Goog-Credential=gcp-kaggle-com%40kaggle-161607.iam.gserviceaccount.com%2F20210320%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-Date=20210320T061137Z&X-Goog-Expires=259199&X-Goog-SignedHeaders=host&X-Goog-Signature=814571cb0debb050458065c57642b402fea54b9215f6c76cb9a1c94212ec13cd48a2468cd4770dbc9444b3591956c35bed65e28053df029b39b8a07e8c6dceb8ac96f304523c0851cda2c6b3e89d8b60068b27c46858354fa9b3c47c74f2b5a02ac051abdecfc1da07608e9ccb22c9f5fe504c2e8e6b10a0dd725940f912bce08e84f33113c46216fc6170b073012685b335557c1c7b34ec70d24bb553885a97ecfe3488bab629d14de708f0dd5909cb1ef7ad7f400d79abafc55fa54059b953fef612079771070882ca8b2a9549a5b0324cc80420f74f10cdfcde099b9816bb9b5335af6a1733dd4f138a7762a2b802621e4e32583e22e85f4f1e83bf708e2ad" -c -O 'archive.zip'
```

```
--2021-03-20 06:12:04-- https://storage.googleapis.com/kaggle-data-sets/245622/651264/archive.zip?X-Goog-Algorithm=GOOG4-RSA-SHA256&X-Goog-Credential=gcp-kaggle-com%40kaggle-161607.iam.gserviceaccount.com%2F20210320%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-Date=20210320T061137Z&X-Goog-Expires=259199&X-Goog-SignedHeaders=host&X-Goog-Signature=814571cb0debb050458065c57642b402fea54b9215f6c76cb9a1c94212ec13cd48a2468cd4770dbc9444b3591956c35bed65e28053df029b39b8a07e8c6dceb8ac96f304523c0851cda2c6b3e89d8b6006b27c46858354fa9b3c47c74f2b5a02ac051abdecf1da07608e9ccb22c9f5fe504c2e8e6b10a0dd725940f912bc08e84f33113c46216fc6170b073012685b335557c1c7b34ec70d24bb553885a97ecfe3488bab629d14de708f0dd5909cb1ef7ad7f400d79abafc55fa54059b953fef612079771070882ca8b2a9549a5b0324cc80420f74f10cdfcde099b9816bb9b5335af6a1733dd4f138a7762a2b802621e4e32583e22e85f4f1e83bf708e2ad
Resolving storage.googleapis.com (storage.googleapis.com)... 74.125.195.128, 74.125.142.128, 2607:f8b0:400e:c07::80, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|74.125.195.128|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2059765561 (1.9G) [application/zip]
Saving to: 'archive.zip'

archive.zip      100%[=====] 1.92G 97.4MB/s    in 24s

2021-03-20 06:12:29 (81.4 MB/s) - 'archive.zip' saved [2059765561/2059765561]
```

```
In [ ]: # unzip the dataset  
!unzip -qq 'archive.zip'
```

## Load the google drive

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

Mounted at /content/drive

```
In [ ]: !pip install -q tensorflow-io  
        !pip install pydicom
```

```
|██████████| 25.3MB 130kB/s
Collecting pydicom
  Downloading https://files.pythonhosted.org/packages/f4/15/df16546bc59bfca390cf072d473fb2c8acd423163
6f64356593a63137e55/pydicom-2.1.2-py3-none-any.whl (1.9MB)
|██████████| 1.9MB 9.0MB/s
Installing collected packages: pydicom
Successfully installed pydicom-2.1.2
```

```
In [ ]: import pydicom as dicom  
        import tensorflow as tf  
        import tensorflow_io as tfio
```

```
In [ ]: # read the given train csv file
image_df = pd.read_csv('siim/train-rle.csv')
image_df.head()
```

Out[ ]:

	ImageId	EncodedPixels
0	1.2.276.0.7230010.3.1.4.8323329.6904.151787520...	-1
1	1.2.276.0.7230010.3.1.4.8323329.13666.15178752...	557374 2 1015 8 1009 14 1002 20 997 26 990 32 ...
2	1.2.276.0.7230010.3.1.4.8323329.11028.15178752...	-1
3	1.2.276.0.7230010.3.1.4.8323329.10366.15178752...	514175 10 1008 29 994 30 993 32 991 33 990 34 ...
4	1.2.276.0.7230010.3.1.4.8323329.10016.15178752...	592184 33 976 58 956 73 941 88 926 102 917 109...

```
In [ ]: # check the properties of the image dataframe
image_df.describe()
```

Out[ ]:

	ImageId	EncodedPixels
count	12954	12954
unique	12047	3577
top	1.2.276.0.7230010.3.1.4.8323329.1851.151787516...	-1
freq	10	9378

```
In [ ]: # drop the duplicate ImageIDs
image_df.drop_duplicates(subset = "ImageId", keep = 'first', inplace = True)
```

```
In [ ]: # remove extra space in EncodedPixels column
image_df.rename(columns = {'EncodedPixels':'EncodedPixels'}, inplace = True)

# add a column whether the image is with pneumothorax or without pneumothorax
image_df['is_pneumothorax'] = np.where(image_df['EncodedPixels']=='-1', 0, 1)

image_df = image_df.loc[image_df['is_pneumothorax'] == 1]
image_df.head()
```

Out[ ]:

	ImageId	EncodedPixels	is_pneumothorax
1	1.2.276.0.7230010.3.1.4.8323329.13666.15178752...	557374 2 1015 8 1009 14 1002 20 997 26 990 32 ...	1
3	1.2.276.0.7230010.3.1.4.8323329.10366.15178752...	514175 10 1008 29 994 30 993 32 991 33 990 34 ...	1
4	1.2.276.0.7230010.3.1.4.8323329.10016.15178752...	592184 33 976 58 956 73 941 88 926 102 917 109...	1
10	1.2.276.0.7230010.3.1.4.8323329.3514.151787517...	759441 11 1010 15 1007 18 1005 19 1005 20 1003...	1
13	1.2.276.0.7230010.3.1.4.8323329.14008.15178752...	119368 98 923 102 908 118 903 126 896 133 889 ...	1

## Move all the images in a single directory

```
In [ ]: # create a directory for dicom images
images_dicom = 'siim/images_dicom/'
if not os.path.isdir(images_dicom):
    os.makedirs(images_dicom)

# move all train dicom images from 'dicom-images-train' to 'images_dicom' in a single directory
existing_path = 'siim/dicom-images-train/'
dicom_list = glob2.glob(os.path.join(existing_path, '**/*.dcm'))
for filename in tqdm(dicom_list):
    shutil.move(str(filename), images_dicom)
```

100% |██████████| 12089/12089 [00:00<00:00, 22915.65it/s]

## Add the new image path to image\_df

```
In [ ]: # add full dicom path to image_df
image_df['dicom_path'] = images_dicom + image_df['ImageId']+'.dcm'
image_df.head()
```

Out[ ]:

	ImageId	EncodedPixels	is_pneumothorax	
1	1.2.276.0.7230010.3.1.4.8323329.13666.15178752...	557374 2 1015 8 1009 14 1002 20 997 26 990 32 ...	1	siim/images_dicom/1.2.276.0.
3	1.2.276.0.7230010.3.1.4.8323329.10366.15178752...	514175 10 1008 29 994 30 993 32 991 33 990 34 ...	1	siim/images_dicom/1.2.276.0.
4	1.2.276.0.7230010.3.1.4.8323329.10016.15178752...	592184 33 976 58 956 73 941 88 926 102 917 109...	1	siim/images_dicom/1.2.276.0.
10	1.2.276.0.7230010.3.1.4.8323329.3514.15178751...	759441 11 1010 15 1007 18 1005 19 1005 20 1003...	1	siim/images_dicom/1.2.276.0.
13	1.2.276.0.7230010.3.1.4.8323329.14008.15178752...	119368 98 923 102 908 118 903 126 896 133 889 ...	1	siim/images_dicom/1.2.276.0.

## Define a function to read and decode dicom image

```
In [ ]: # Define a function to read and decode dicom image
def decode_image(image_path, mask_path, size=256):
    # read the image from image_path
    image = tf.io.read_file(image_path)
    # convert the image into a 3D tensor
    image = tfio.image.decode_dicom_image(image, dtype=tf.uint8,color_dim=True,scale='preserve')
    # convert image datatype to float32
    image = tf.image.convert_image_dtype(image, tf.float32)
    # squeeze the image from shape (1,1024,1024,1) to (1024,1024,1)
    image =tf.squeeze(image,[0])
    # cons = tf.constant([1,1,3], tf.int32)
    # using tf.tile convert image shape (1024,1024,1) tp (1024,1024,3)
    # image=tf.tile(image,cons)
    image=tf.tile(image, tf.constant([1,1,3], tf.int32))
    # resize the image
    image=tf.image.resize(image,size=[size,size])

    mask = tf.io.read_file(mask_path)
    mask = tf.image.decode_png(mask, channels=1)
    mask = tf.image.resize(mask, [size, size])
    mask = tf.image.convert_image_dtype(mask, tf.float32)
    # mask = mask/255.0

    # return image and corresponding label
    return image, mask
```

## Define function to convert RLE to mask, provided by organizers

```
In [ ]: # Define function to convert RLE to mask, provided by organizers
def rle2mask(rle, width, height):
    mask= np.zeros(width* height)
    array = np.asarray([int(x) for x in rle.split()])
    starts = array[0::2]
    lengths = array[1::2]

    current_position = 0
    for index, start in enumerate(starts):
        current_position += start
        mask[current_position:current_position+lengths[index]] = 1
        current_position += lengths[index]

    return mask.reshape(width, height)
```

## Create Directories for mask png files

```
In [ ]: # Create Directories for mask png files
mask_png = 'siim/mask_png/'

if not os.path.isdir(mask_png):
    os.makedirs(mask_png)
```

## Define function to convert mask to png image

```
In [ ]: import cv2
# define function to convert mask to png image
def masks_to_png(data, outdir):
    for img_id, enc_pix in tqdm(data.values):
        mask_path = outdir + str(img_id) + '_mask.png'
        # print(mask_path)
        if enc_pix != "-1":
            image_bytes = rle2mask(enc_pix, 1024, 1024).T
            mask = cv2.resize(image_bytes, (256, 256))
            cv2.imwrite(mask_path, mask)
        else:
            mask = np.zeros((256, 256), dtype=np.uint8)
            cv2.imwrite(mask_path, mask)
masks_to_png(image_df[['ImageId', 'EncodedPixels']], mask_png)
```

100% |██████████| 2669/2669 [00:15<00:00, 167.79it/s]

```
In [ ]: # add full png path to image_df
image_df['mask_path'] = mask_png + image_df['ImageId'] + '_mask.png'
image_df.head()
```

Out[ ]:

	ImageId	EncodedPixels	is_pneumothorax	
1	1.2.276.0.7230010.3.1.4.8323329.13666.15178752...	557374 2 1015 8 1009 14 1002 20 997 26 990 32 ...	1	siim/images_dicom/1.2.276.0.
3	1.2.276.0.7230010.3.1.4.8323329.10366.15178752...	514175 10 1008 29 994 30 993 32 991 33 990 34 ...	1	siim/images_dicom/1.2.276.0.
4	1.2.276.0.7230010.3.1.4.8323329.10016.15178752...	592184 33 976 58 956 73 941 88 926 102 917 109...	1	siim/images_dicom/1.2.276.0.
10	1.2.276.0.7230010.3.1.4.8323329.3514.151787517...	759441 11 1010 15 1007 18 1005 19 1005 20 1003...	1	siim/images_dicom/1.2.276.0.
13	1.2.276.0.7230010.3.1.4.8323329.14008.15178752...	119368 98 923 102 908 118 903 126 896 133 889 ...	1	siim/images_dicom/1.2.276.0.

## Define a function to augment image

```
In [ ]: # Define a function to augment image
def augment_image(image, mask):
    a = np.random.uniform()
    if a<0.2:
        image = tf.image.random_flip_left_right(image)
        mask = tf.image.random_flip_left_right(mask)
    elif a<0.4:
        image = tf.image.random_flip_up_down(image)
        mask = tf.image.random_flip_up_down(mask)
    elif a<0.6:
        image = tf.image.random_brightness(image, 0.3)
    elif a<0.8:
        image = tf.image.random_contrast(image, lower=0.2, upper=0.3)
    else:
        image = tf.image.random_saturation(image, lower=2, upper=5)
    return image, mask
```

```
In [ ]: # Define a function to give proper shape to image and mask
def shape_image_mask(image, mask, size=256):
    image.set_shape((size, size, 3))
    mask.set_shape((size, size, 1))
    return image, mask
```

## Define train\_generator and val\_generator using tf.data

```
In [ ]: import tensorflow as tf
AUTOTUNE = tf.data.experimental.AUTOTUNE
def train_generator(image_path, mask_path):
    # creating a dataset from tensor slices
    dataset = tf.data.Dataset.from_tensor_slices((image_path, mask_path))
    # shuffle the dataset
    dataset = dataset.shuffle(len(image_path), seed=42)
    # decode image using decode_image function
    dataset = dataset.map(decode_image, num_parallel_calls=AUTOTUNE)
    # augment image using augment_image function
    dataset = dataset.map(augment_image, num_parallel_calls=AUTOTUNE)
    dataset = dataset.map(shape_image_mask, num_parallel_calls=AUTOTUNE)
    return dataset

def val_generator(image_path, mask_path):
    # creating a dataset from tensor slices
    dataset = tf.data.Dataset.from_tensor_slices((image_path, mask_path))
    # shuffle the dataset
    dataset = dataset.shuffle(len(image_path), seed=42)
    # decode image using decode_image function
    dataset = dataset.map(decode_image, num_parallel_calls=AUTOTUNE)
    dataset = dataset.map(shape_image_mask, num_parallel_calls=AUTOTUNE)
    return dataset
```

## Split the dataset into train and test

```
In [ ]: from sklearn.model_selection import train_test_split
train_df, val_df = train_test_split(image_df, test_size=0.2, random_state=42, shuffle=True)
```

```
In [ ]: # separate image path and image label from train_df and val_df
train_image_path = train_df['dicom_path'].values
train_mask_path = train_df['mask_path'].values
val_image_path = val_df['dicom_path'].values
val_mask_path = val_df['mask_path'].values
```

```
In [ ]: train_dataset = train_generator(train_image_path, train_mask_path)
val_dataset = val_generator(val_image_path, val_mask_path)
train_dataset, val_dataset
```

```
Out[ ]: (<ParallelMapDataset shapes: ((256, 256, 3), (256, 256, 1)), types: (tf.float32, tf.float32)>,
<ParallelMapDataset shapes: ((256, 256, 3), (256, 256, 1)), types: (tf.float32, tf.float32)>)
```

```
In [ ]: # batch the train and validation dataset
batch_size = 16
train_ds_batch = train_dataset.batch(batch_size, drop_remainder=True)
val_ds_batch = val_dataset.batch(batch_size, drop_remainder=True)
train_ds_batch, val_ds_batch
```

```
Out[ ]: (<BatchDataset shapes: ((16, 256, 256, 3), (16, 256, 256, 1)), types: (tf.float32, tf.float32)>,
<BatchDataset shapes: ((16, 256, 256, 3), (16, 256, 256, 1)), types: (tf.float32, tf.float32)>)
```

## Download chexnet weights

<https://www.kaggle.com/theewok/chexnet-keras-weights> (<https://www.kaggle.com/theewok/chexnet-keras-weights>)

```
In [ ]: # https://www.kaggle.com/theewok/chexnet-keras-weights
!wget --header="Host: storage.googleapis.com" --header="User-Agent: Mozilla/5.0 (Windows NT 10.0; Win6
4; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/89.0.4389.90 Safari/537.36" --header="Accept: te
xt/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,appli
cation/signed-exchange;v=b3;q=0.9" --header="Accept-Language: en-US,en;q=0.9" --header="Referer: http
s://www.kaggle.com/" --header="Cookie: ext_name=ojsplmecpdpgccookcocabopnaifgidhf" --header="Connectio
n: keep-alive" "https://storage.googleapis.com/kaggle-data-sets/66426/130851/bundle/archive.zip?X-Goog
-Algorithm=G00G4-RSA-SHA256&X-Goog-Credential=gcp-kaggle-com%40kaggle-161607.iam.gserviceaccount.com%2
F20210320%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-Date=20210320T062459Z&X-Goog-Expires=259199&X-Goog-S
ignedHeaders=host&X-Goog-Signature=61c2260050183b8635a727bd0145c8b41e732cb520826b184dfd65c51cd90b9da7c
a80daec6eb5ef7c2789d9c8c88278ee606997fc2f9b80bff2ce93dc52fb035e753ede53adcffb16acdf898142b98575b691170
2cc8a7d1a6f017ba900715fa8253fe16458cf40984ecc7b202e0fd5ca5fea7f4ef04ed69bc91f7905a8533d8a128cc500f92
efc90e11d3c88e69464327eb8c878c05d8dc53cd428d742bfdda9a7d874da2ecf6a13c5560b37876ff406497afdc43033fcdb89
284c61dafba3ffbf900e1a87fd6d0e40c8c6b850f9da137b8306a00b9d8ab38b95f40d727fafd4e6cf0577444ad6708aca
c5f343023d77cb4b2c379e7b73d3e723d0dc6763" -c -O 'archive_2.zip'
```

```
--2021-03-20 06:25:43-- https://storage.googleapis.com/kaggle-data-sets/66426/130851/bundle/archive.
zip?X-Goog-Algorithm=G00G4-RSA-SHA256&X-Goog-Credential=gcp-kaggle-com%40kaggle-161607.iam.gserviceac
count.com%2F20210320%2Fauto%2Fstorage%2Fgoog4_request&X-Goog-Date=20210320T062459Z&X-Goog-Expires=259
199&X-Goog-SignedHeaders=host&X-Goog-Signature=61c2260050183b8635a727bd0145c8b41e732cb520826b184dfd65
c51cd90b9da7ca80daec6eb5ef7c2789d9c8c88278ee606997fc2f9b80bff2ce93dc52fb035e753ede53adcffb16acdf89814
2b98575b6911702cc8a7d1a6f017ba900715fa8253fe16458cf40984ecc7b202e0fd5ca5fea7f4ef04ed69bc91f7905a8533
d8a128cc500f92efc90e11d3c88e69464327eb8c878c05d8dc53cd428d742bfdda9a7d874da2ecf6a13c5560b37876ff4064
97afdc43033fcdb89284c61dafba3ffbf900e1a87fd6d0e40c8c6b850f9da137b8306a00b9d8ab38b95f40d727fafd4e6cf057
7444ad6708aca5f3e343023d77cb4b2c379e7b73d3e723d0dc6763
Resolving storage.googleapis.com (storage.googleapis.com)... 142.250.107.128, 74.125.195.128, 74.125.
142.128, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|142.250.107.128|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 26592319 (25M) [application/zip]
Saving to: 'archive_2.zip'

archive_2.zip      100%[=====] 25.36M 35.0MB/s    in 0.7s

2021-03-20 06:25:44 (35.0 MB/s) - 'archive_2.zip' saved [26592319/26592319]
```

```
In [ ]: # unzip the data
!unzip -qq 'archive_2.zip'
```

## 01. Build UNET model using DenseNet121 backbone with imagenet weights

```
In [ ]: from tensorflow.keras import Model
from tensorflow.keras.applications.densenet import DenseNet121
# https://stackoverflow.com/questions/64390544/unable-to-Load-chexnet-pre-trained-weight-file-to-dense
# net121
# https://www.tensorflow.org/api_docs/python/tf/keras/applications/DenseNet121
dense_net_121 = DenseNet121(input_shape=[256,256,3],weights="imagenet",include_top=False,pooling='avg'
)
base_model_output = Dense(units=14,activation='relu')(dense_net_121.output)
base_model = Model(inputs = dense_net_121.input,outputs=base_model_output)
```

```
In [ ]: # https://www.kaggle.com/gbellport/pre-trained-densenet
output_layer = Dense(1,activation='sigmoid')(base_model.layers[-2].output)
# use this below model with DenseNet121 as backbone(encoder) of Unet model
model = Model(inputs=base_model.inputs, outputs=output_layer)

# define the decoder part of Unet
model1 =UpSampling2D((2,2))(model.layers[-3].output)

# model.get_layer retrieves a layer based on either its name (unique) or index
# concatenate 'pool4_conv' layer from encoder with upsampled layer
model1 = concatenate([model1,model.get_layer('pool4_conv').output])
model1 = Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = UpSampling2D((2,2))(model1)

# concatenate 'pool3_conv' layer from encoder with upsampled layer
model1 = concatenate([model1,model.get_layer('pool3_conv').output])
model1 = Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = Dropout(0.5)(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = UpSampling2D((2,2))(model1)

# concatenate 'pool2_conv' layer from encoder with upsampled layer
model1 = concatenate([model1,model.get_layer('pool2_conv').output])
model1 = Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = Dropout(0.5)(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = UpSampling2D((2,2))(model1)

# concatenate 'conv1/relu' layer from encoder with upsampled layer
model1 = concatenate([model1,model.get_layer('conv1/relu').output])
model1 = Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = Dropout(0.7)(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = UpSampling2D((2,2))(model1)

model1 = Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1 = BatchNormalization()(model1)
model1 = Activation('relu')(model1)
model1 = Conv2D(1,(3,3),padding='same',use_bias=True,kernel_initializer='glorot_normal')(model1)
model1 = Activation('sigmoid')(model1)

unet_imagenet_model=Model(inputs=model.inputs, outputs=model1)
```

```
In [ ]: # print model summary  
unet_imagenet_model.summary()
```

Model: "model\_24"

Layer (type)	Output Shape	Param #	Connected to
input_9 (InputLayer)	[None, 256, 256, 3] 0		
zero_padding2d_16 (ZeroPadding2 (None, 262, 262, 3) 0			input_9[0][0]
conv1/conv (Conv2D)	(None, 128, 128, 64) 9408		zero_padding2d_16[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_17 (ZeroPadding2 (None, 130, 130, 64) 0			conv1/relu[0][0]
pool1 (MaxPooling2D)	(None, 64, 64, 64) 0		zero_padding2d_17[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_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]
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 (Concatenation)	(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 (Activation)	(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 (Activation)	(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 (Concatenation)	(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 (Activation)	(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 (Activation)	(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 (Concatenation)	(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 (Activation)	(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 (Activation)	(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 (Concatenation)	(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_35 (UpSampling2D)	(None, 16, 16, 1024)	0	relu[0][0]
concatenate_28 (Concatenate)	(None, 16, 16, 1536)	0	up_sampling2d_35[0][0] pool4_conv[0][0]
conv2d_77 (Conv2D)	(None, 16, 16, 256)	3538944	concatenate_28[0][0]
batch_normalization_70 (BatchNorm)	(None, 16, 16, 256)	1024	conv2d_77[0][0]
activation_77 (Activation)	(None, 16, 16, 256)	0	batch_normalization_70[0][0]
conv2d_78 (Conv2D)	(None, 16, 16, 256)	589824	activation_77[0][0]
batch_normalization_71 (BatchNorm)	(None, 16, 16, 256)	1024	conv2d_78[0][0]
activation_78 (Activation)	(None, 16, 16, 256)	0	batch_normalization_71[0][0]
up_sampling2d_36 (UpSampling2D)	(None, 32, 32, 256)	0	activation_78[0][0]

concatenate_29 (Concatenate)	(None, 32, 32, 512) 0	up_sampling2d_36[0][0] pool3_conv[0][0]
conv2d_79 (Conv2D)	(None, 32, 32, 128) 589824	concatenate_29[0][0]
batch_normalization_72 (BatchNo)	(None, 32, 32, 128) 512	conv2d_79[0][0]
activation_79 (Activation)	(None, 32, 32, 128) 0	batch_normalization_72[0][0]
conv2d_80 (Conv2D)	(None, 32, 32, 128) 147456	activation_79[0][0]
dropout_21 (Dropout)	(None, 32, 32, 128) 0	conv2d_80[0][0]
batch_normalization_73 (BatchNo)	(None, 32, 32, 128) 512	dropout_21[0][0]
activation_80 (Activation)	(None, 32, 32, 128) 0	batch_normalization_73[0][0]
up_sampling2d_37 (UpSampling2D)	(None, 64, 64, 128) 0	activation_80[0][0]
concatenate_30 (Concatenate)	(None, 64, 64, 256) 0	up_sampling2d_37[0][0] pool2_conv[0][0]
conv2d_81 (Conv2D)	(None, 64, 64, 64) 147456	concatenate_30[0][0]
dropout_22 (Dropout)	(None, 64, 64, 64) 0	conv2d_81[0][0]
batch_normalization_74 (BatchNo)	(None, 64, 64, 64) 256	dropout_22[0][0]
activation_81 (Activation)	(None, 64, 64, 64) 0	batch_normalization_74[0][0]
conv2d_82 (Conv2D)	(None, 64, 64, 64) 36864	activation_81[0][0]
batch_normalization_75 (BatchNo)	(None, 64, 64, 64) 256	conv2d_82[0][0]
activation_82 (Activation)	(None, 64, 64, 64) 0	batch_normalization_75[0][0]
up_sampling2d_38 (UpSampling2D)	(None, 128, 128, 64) 0	activation_82[0][0]
concatenate_31 (Concatenate)	(None, 128, 128, 128) 0	up_sampling2d_38[0][0] conv1/relu[0][0]
conv2d_83 (Conv2D)	(None, 128, 128, 32) 36864	concatenate_31[0][0]
batch_normalization_76 (BatchNo)	(None, 128, 128, 32) 128	conv2d_83[0][0]
activation_83 (Activation)	(None, 128, 128, 32) 0	batch_normalization_76[0][0]
conv2d_84 (Conv2D)	(None, 128, 128, 32) 9216	activation_83[0][0]
dropout_23 (Dropout)	(None, 128, 128, 32) 0	conv2d_84[0][0]
batch_normalization_77 (BatchNo)	(None, 128, 128, 32) 128	dropout_23[0][0]
activation_84 (Activation)	(None, 128, 128, 32) 0	batch_normalization_77[0][0]
up_sampling2d_39 (UpSampling2D)	(None, 256, 256, 32) 0	activation_84[0][0]
conv2d_85 (Conv2D)	(None, 256, 256, 16) 4608	up_sampling2d_39[0][0]
batch_normalization_78 (BatchNo)	(None, 256, 256, 16) 64	conv2d_85[0][0]
activation_85 (Activation)	(None, 256, 256, 16) 0	batch_normalization_78[0][0]
conv2d_86 (Conv2D)	(None, 256, 256, 16) 2304	activation_85[0][0]
batch_normalization_79 (BatchNo)	(None, 256, 256, 16) 64	conv2d_86[0][0]
activation_86 (Activation)	(None, 256, 256, 16) 0	batch_normalization_79[0][0]
conv2d_87 (Conv2D)	(None, 256, 256, 1) 145	activation_86[0][0]
activation_87 (Activation)	(None, 256, 256, 1) 0	conv2d_87[0][0]

```
=====
Total params: 12,144,977
Trainable params: 12,059,345
Non-trainable params: 85,632
```

```
In [ ]: from keras.losses import binary_crossentropy
import keras.backend as K

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

def combined_bce_dice_loss(y_true, y_pred):
    return binary_crossentropy(y_true, y_pred) + dice_loss(y_true, y_pred)

def iou_score(y_true, y_pred):
    smooth = 1.
    def func(y_true, y_pred):
        intersection = (y_true * y_pred).sum()
        union = y_true.sum() + y_pred.sum() - intersection
        x = (intersection + smooth) / (union + smooth)
        x = x.astype(np.float32)
        return x
    return tf.numpy_function(func, [y_true, y_pred], tf.float32)
```

```
In [ ]: # set filepath to save best models
filepath="gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-{epoch:02d}-{val_iou_score:.4f}.hdf5"
model_checkpoint = ModelCheckpoint(filepath=filepath, monitor='val_recall', verbose=1, save_best_only=True, mode='max')

# earlystop
from tensorflow.keras.callbacks import EarlyStopping
earlystop = EarlyStopping(monitor='val_iou_score', min_delta=0.001, mode='max', patience=4, verbose=1, restore_best_weights=True)
```

```
In [ ]: # callback to stop training when desired recall is reached
# https://towardsdatascience.com/neural-network-with-tensorflow-how-to-stop-training-using-callback-5c8d575c18a9
class myCallback(tf.keras.callbacks.Callback):
    def __init__(self, threshold):
        super(myCallback, self).__init__()
        self.threshold = threshold

    def on_epoch_end(self, epoch, logs={}):
        if(logs.get('val_iou_score') > self.threshold):
            print("Training Stopped. Val IOU Score = {} crossed threshold = {}".format(logs.get('val_iou_score'), self.threshold))
            self.model.stop_training = True
```

```
In [ ]: %rm -rf ./log
%load_ext tensorboard
%tensorboard --logdir='./log'
%reload_ext tensorboard
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir='./log')
adam = tf.keras.optimizers.Adam(lr=0.0001)
callback_list = [model_checkpoint, myCallback(threshold=0.9),tensorboard_callback]
unet_imagenet_model.compile(optimizer=adam, loss=combined_bce_dice_loss, metrics=['accuracy',iou_score'])
unet_imagenet_model.fit(train_ds_batch,epochs=1,verbose=1,validation_data=val_ds_batch,callbacks=callback_list)
```



```
Epoch 1/20
133/133 [=====] - 165s 879ms/step - loss: 1.3588 - accuracy: 0.9054 - iou_score: 0.0111 - val_loss: 1.3043 - val_accuracy: 0.9887 - val_iou_score: 0.0137

Epoch 00001: val_iou_score improved from -inf to 0.01374, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-01-0.0137.hdf5
Epoch 2/20
133/133 [=====] - 115s 864ms/step - loss: 1.1535 - accuracy: 0.9879 - iou_score: 0.0157 - val_loss: 1.0909 - val_accuracy: 0.9148 - val_iou_score: 0.0438

Epoch 00002: val_iou_score improved from 0.01374 to 0.04380, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-02-0.0438.hdf5
Epoch 3/20
133/133 [=====] - 115s 863ms/step - loss: 1.0477 - accuracy: 0.9788 - iou_score: 0.0309 - val_loss: 1.1774 - val_accuracy: 0.8731 - val_iou_score: 0.0535

Epoch 00003: val_iou_score improved from 0.04380 to 0.05353, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-03-0.0535.hdf5
Epoch 4/20
133/133 [=====] - 115s 864ms/step - loss: 0.9767 - accuracy: 0.9797 - iou_score: 0.0559 - val_loss: 0.8736 - val_accuracy: 0.9866 - val_iou_score: 0.1004

Epoch 00004: val_iou_score improved from 0.05353 to 0.10037, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-04-0.1004.hdf5
Epoch 5/20
133/133 [=====] - 115s 865ms/step - loss: 0.9300 - accuracy: 0.9801 - iou_score: 0.0769 - val_loss: 0.7985 - val_accuracy: 0.9841 - val_iou_score: 0.1475

Epoch 00005: val_iou_score improved from 0.10037 to 0.14751, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-05-0.1475.hdf5
Epoch 6/20
133/133 [=====] - 116s 867ms/step - loss: 0.8809 - accuracy: 0.9817 - iou_score: 0.1025 - val_loss: 0.7095 - val_accuracy: 0.9850 - val_iou_score: 0.2096

Epoch 00006: val_iou_score improved from 0.14751 to 0.20959, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-06-0.2096.hdf5
Epoch 7/20
133/133 [=====] - 116s 867ms/step - loss: 0.8669 - accuracy: 0.9819 - iou_score: 0.1110 - val_loss: 0.7874 - val_accuracy: 0.9895 - val_iou_score: 0.1577

Epoch 00007: val_iou_score did not improve from 0.20959
Epoch 8/20
133/133 [=====] - 115s 864ms/step - loss: 0.8303 - accuracy: 0.9824 - iou_score: 0.1387 - val_loss: 0.7059 - val_accuracy: 0.9841 - val_iou_score: 0.2160

Epoch 00008: val_iou_score improved from 0.20959 to 0.21600, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-08-0.2160.hdf5
Epoch 9/20
133/133 [=====] - 115s 864ms/step - loss: 0.8202 - accuracy: 0.9836 - iou_score: 0.1414 - val_loss: 0.7130 - val_accuracy: 0.9765 - val_iou_score: 0.2297

Epoch 00009: val_iou_score improved from 0.21600 to 0.22970, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-09-0.2297.hdf5
Epoch 10/20
133/133 [=====] - 115s 863ms/step - loss: 0.7960 - accuracy: 0.9840 - iou_score: 0.1579 - val_loss: 0.6472 - val_accuracy: 0.9900 - val_iou_score: 0.2593

Epoch 00010: val_iou_score improved from 0.22970 to 0.25931, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-10-0.2593.hdf5
Epoch 11/20
133/133 [=====] - 115s 865ms/step - loss: 0.7792 - accuracy: 0.9855 - iou_score: 0.1707 - val_loss: 0.6394 - val_accuracy: 0.9849 - val_iou_score: 0.2715

Epoch 00011: val_iou_score improved from 0.25931 to 0.27153, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-11-0.2715.hdf5
Epoch 12/20
133/133 [=====] - 115s 866ms/step - loss: 0.7873 - accuracy: 0.9848 - iou_score: 0.1670 - val_loss: 0.6926 - val_accuracy: 0.9898 - val_iou_score: 0.2297

Epoch 00012: val_iou_score did not improve from 0.27153
Epoch 13/20
```

```
133/133 [=====] - 115s 862ms/step - loss: 0.7635 - accuracy: 0.9856 - iou_score: 0.1828 - val_loss: 0.8057 - val_accuracy: 0.9888 - val_iou_score: 0.1556

Epoch 00013: val_iou_score did not improve from 0.27153
Epoch 14/20
133/133 [=====] - 114s 857ms/step - loss: 0.7823 - accuracy: 0.9858 - iou_score: 0.1684 - val_loss: 0.6036 - val_accuracy: 0.9865 - val_iou_score: 0.3017

Epoch 00014: val_iou_score improved from 0.27153 to 0.30170, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-14-0.3017.hdf5
Epoch 15/20
133/133 [=====] - 115s 860ms/step - loss: 0.7482 - accuracy: 0.9857 - iou_score: 0.1960 - val_loss: 0.6700 - val_accuracy: 0.9885 - val_iou_score: 0.2497

Epoch 00015: val_iou_score did not improve from 0.30170
Epoch 16/20
133/133 [=====] - 114s 859ms/step - loss: 0.7571 - accuracy: 0.9859 - iou_score: 0.1873 - val_loss: 0.5919 - val_accuracy: 0.9907 - val_iou_score: 0.3050

Epoch 00016: val_iou_score improved from 0.30170 to 0.30497, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-16-0.3050.hdf5
Epoch 17/20
133/133 [=====] - 115s 861ms/step - loss: 0.7502 - accuracy: 0.9864 - iou_score: 0.1929 - val_loss: 0.5909 - val_accuracy: 0.9906 - val_iou_score: 0.3066

Epoch 00017: val_iou_score improved from 0.30497 to 0.30663, saving model to gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-17-0.3066.hdf5
Epoch 18/20
133/133 [=====] - 115s 862ms/step - loss: 0.7812 - accuracy: 0.9858 - iou_score: 0.1697 - val_loss: 0.6811 - val_accuracy: 0.9883 - val_iou_score: 0.2441

Epoch 00018: val_iou_score did not improve from 0.30663
Epoch 19/20
133/133 [=====] - 114s 858ms/step - loss: 0.7479 - accuracy: 0.9855 - iou_score: 0.1948 - val_loss: 0.6930 - val_accuracy: 0.9900 - val_iou_score: 0.2342

Epoch 00019: val_iou_score did not improve from 0.30663
Epoch 20/20
133/133 [=====] - 114s 857ms/step - loss: 0.7297 - accuracy: 0.9860 - iou_score: 0.2103 - val_loss: 0.7722 - val_accuracy: 0.9895 - val_iou_score: 0.1791

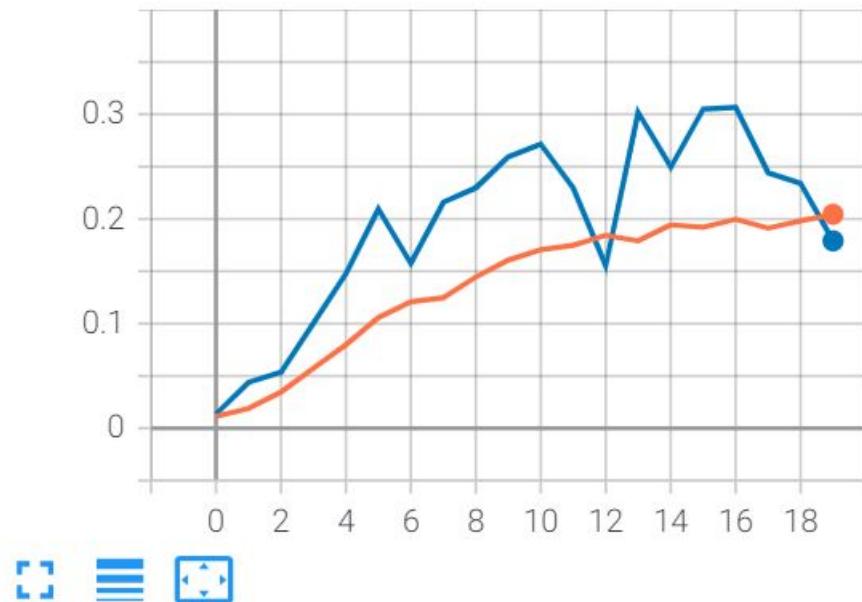
Epoch 00020: val_iou_score did not improve from 0.30663

Out[ ]: <tensorflow.python.keras.callbacks.History at 0x7fd4b1f6e610>
```

## unet\_imagenet\_model: Scalars

epoch\_iou\_score

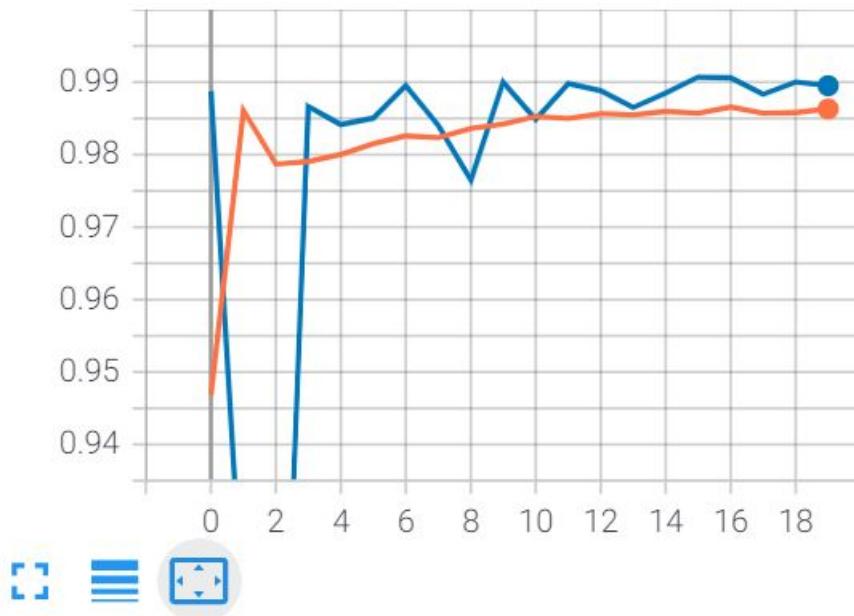
epoch\_iou\_score



## epoch\_accuracy

---

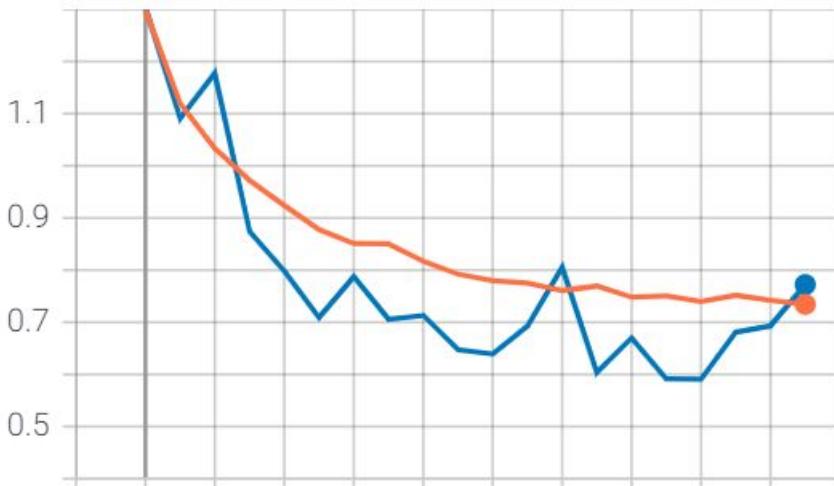
epoch\_accuracy



## epoch\_loss

---

epoch\_loss



```
In [98]: # Load best weights to unet_imagenet_model
from keras.models import load_model
# custom_objects = optional dictionary mapping names (strings) to custom classes or functions to be considered during deserialization
unet_imagenet_model = load_model("gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-17-0.3066.hdf5",
                                    custom_objects={'combined_bce_dice_loss':combined_bce_dice_loss, "iou_score":iou_score})
```

```
In [115]: # randomly predict some images from validation data
no_of_images = 20
for i in range(no_of_images):
    j = np.random.randint(0, len(val_image_path))
    img_path = val_image_path[j]
    msk_path = val_mask_path[j]

    size = 256
    image = tf.io.read_file(img_path)
    image = tfio.image.decode_dicom_image(image, dtype=tf.uint8,color_dim=True,scale='preserve')
    image = tf.image.convert_image_dtype(image, tf.float32)
    image = tf.squeeze(image,[0])
    image = tf.tile(image, tf.constant([1,1,3], tf.int32))
    image = tf.image.resize(image,size=[size,size])
    image = tf.expand_dims(image,axis=0)

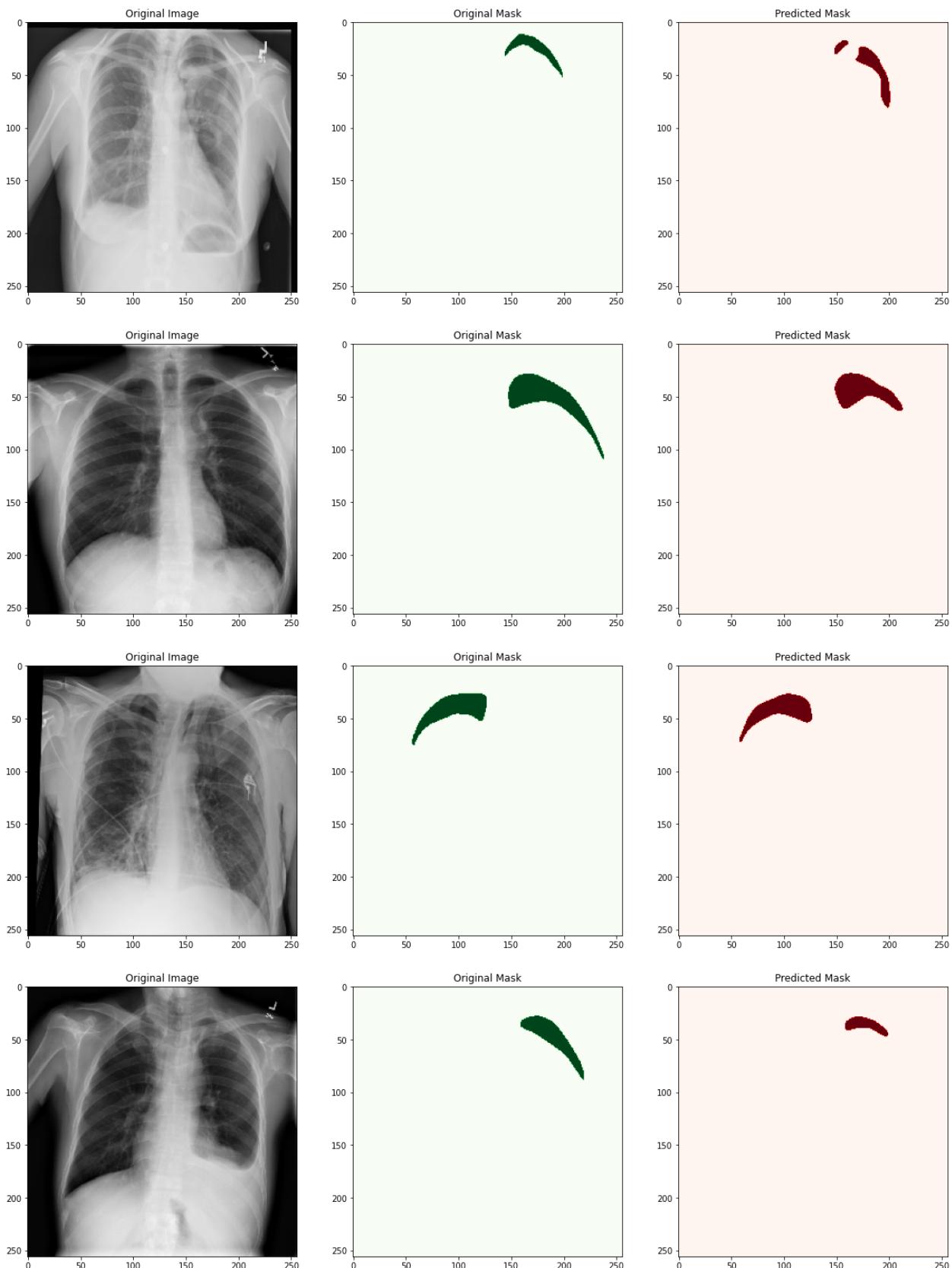
    mask = tf.io.read_file(msk_path)
    mask = tf.image.decode_png(mask, channels=1)
    mask = tf.image.resize(mask, [size, size])
    mask = tf.image.convert_image_dtype(mask, tf.float32)
    mask = tf.expand_dims(mask, axis=0)

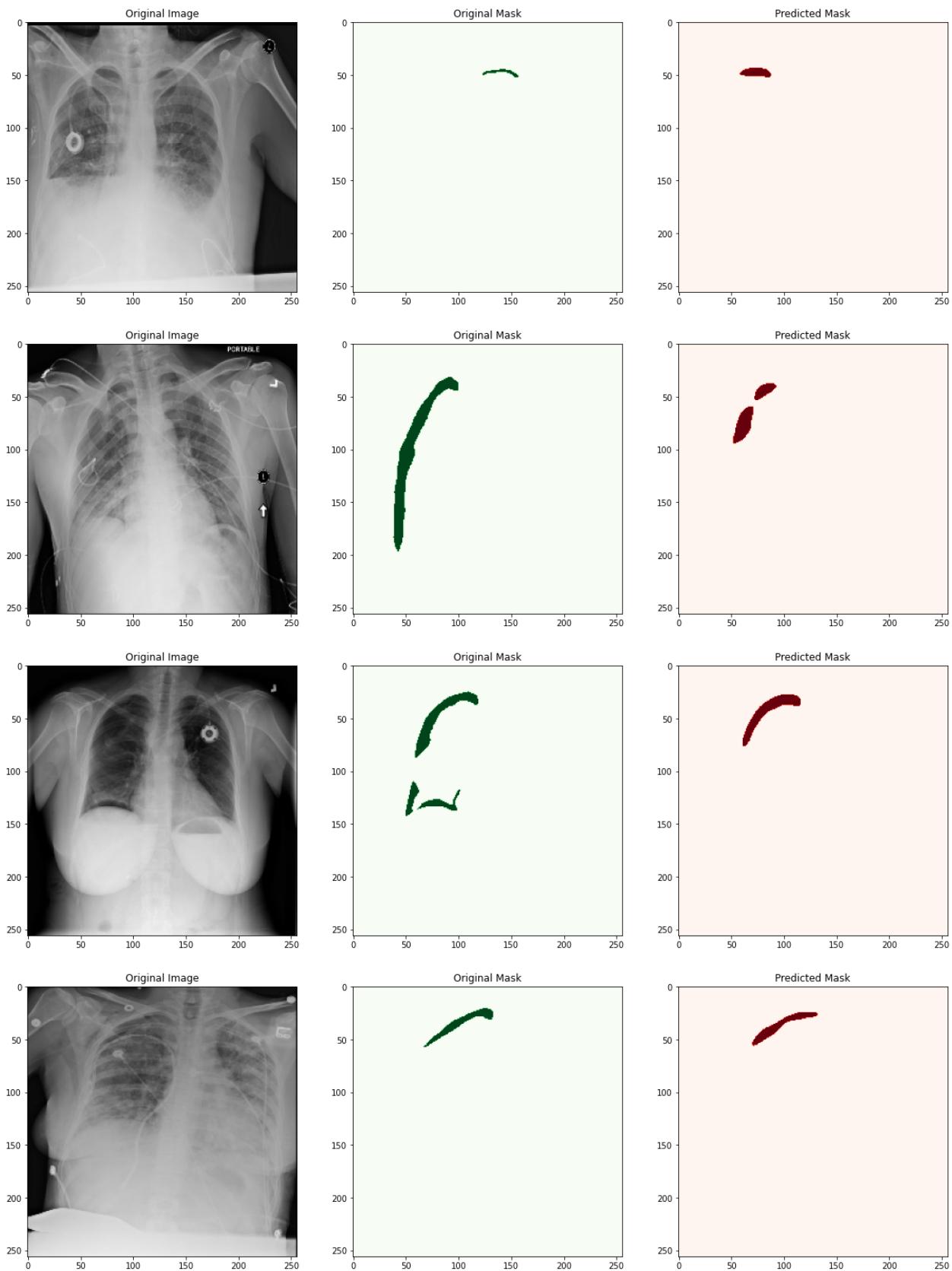
    pred = unet_imagenet_model.predict(image)
    pred_mask = (pred[0]>0.5).astype(np.uint8)

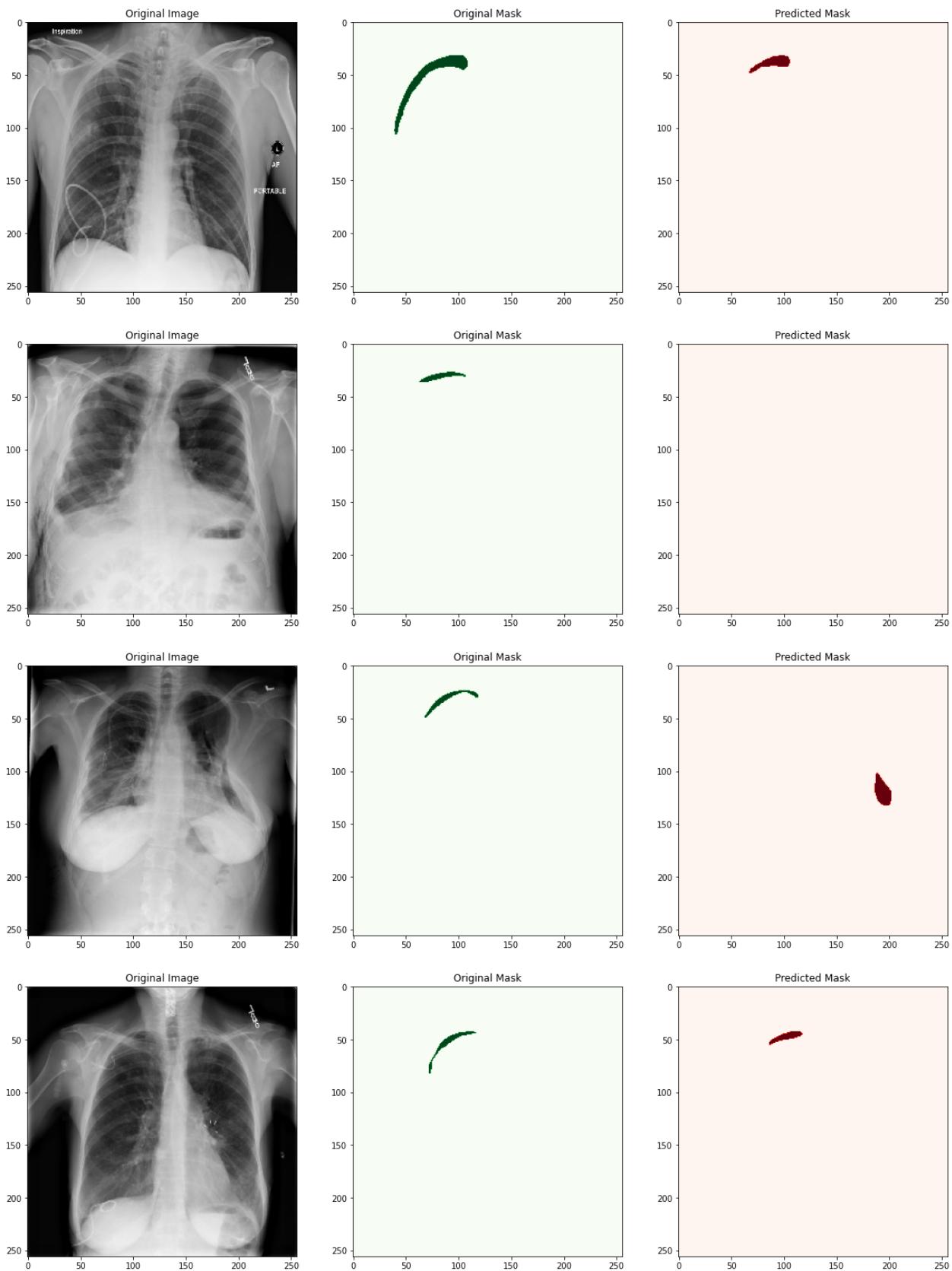
    plt.figure(figsize=(20,6))
    plt.subplot(131)
    plt.title("Original Image")
    plt.imshow(np.squeeze(image[0]),cmap='gray')

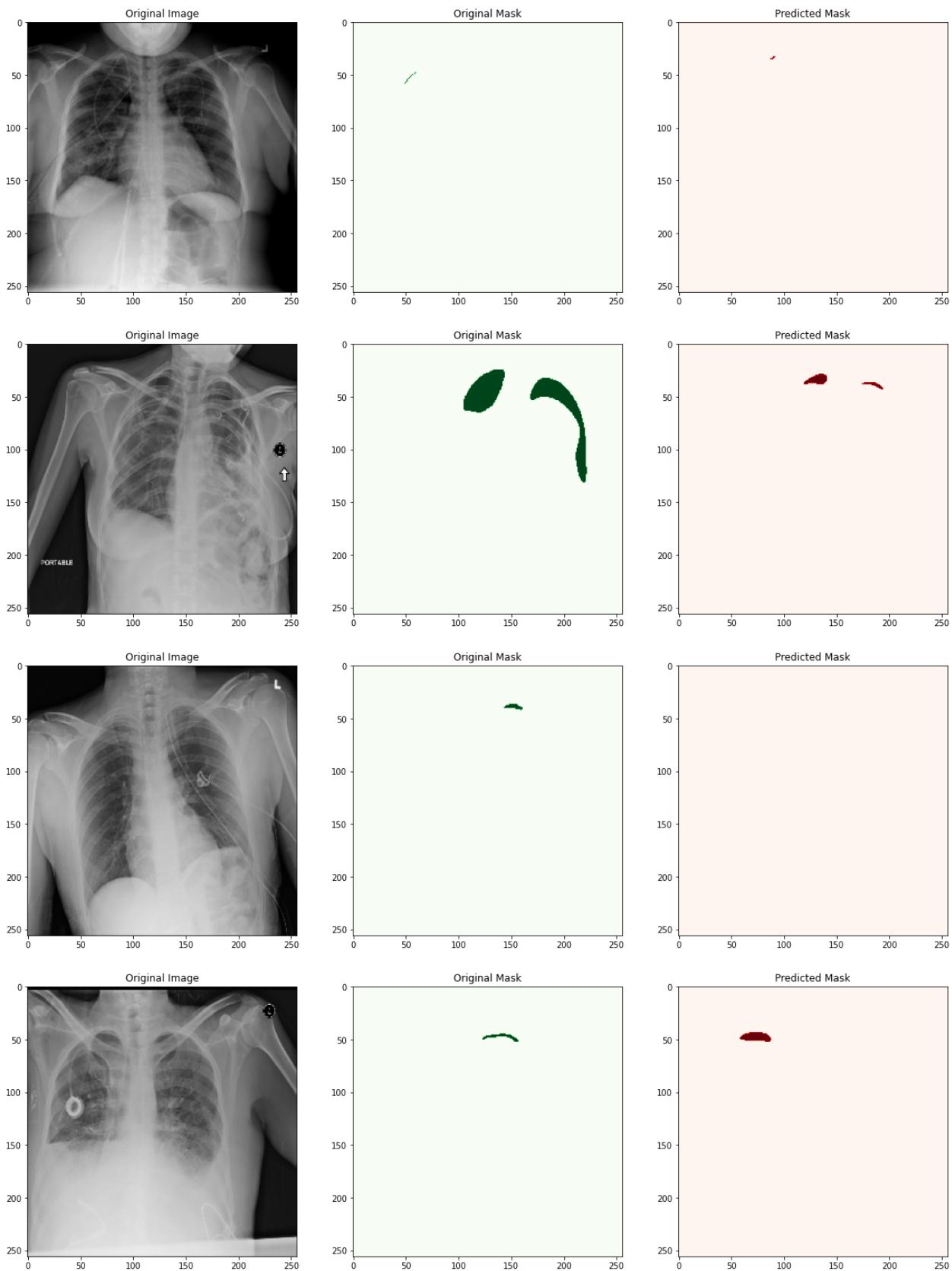
    plt.subplot(132)
    plt.title("Original Mask")
    plt.imshow(np.squeeze(mask[0]),cmap='Greens')

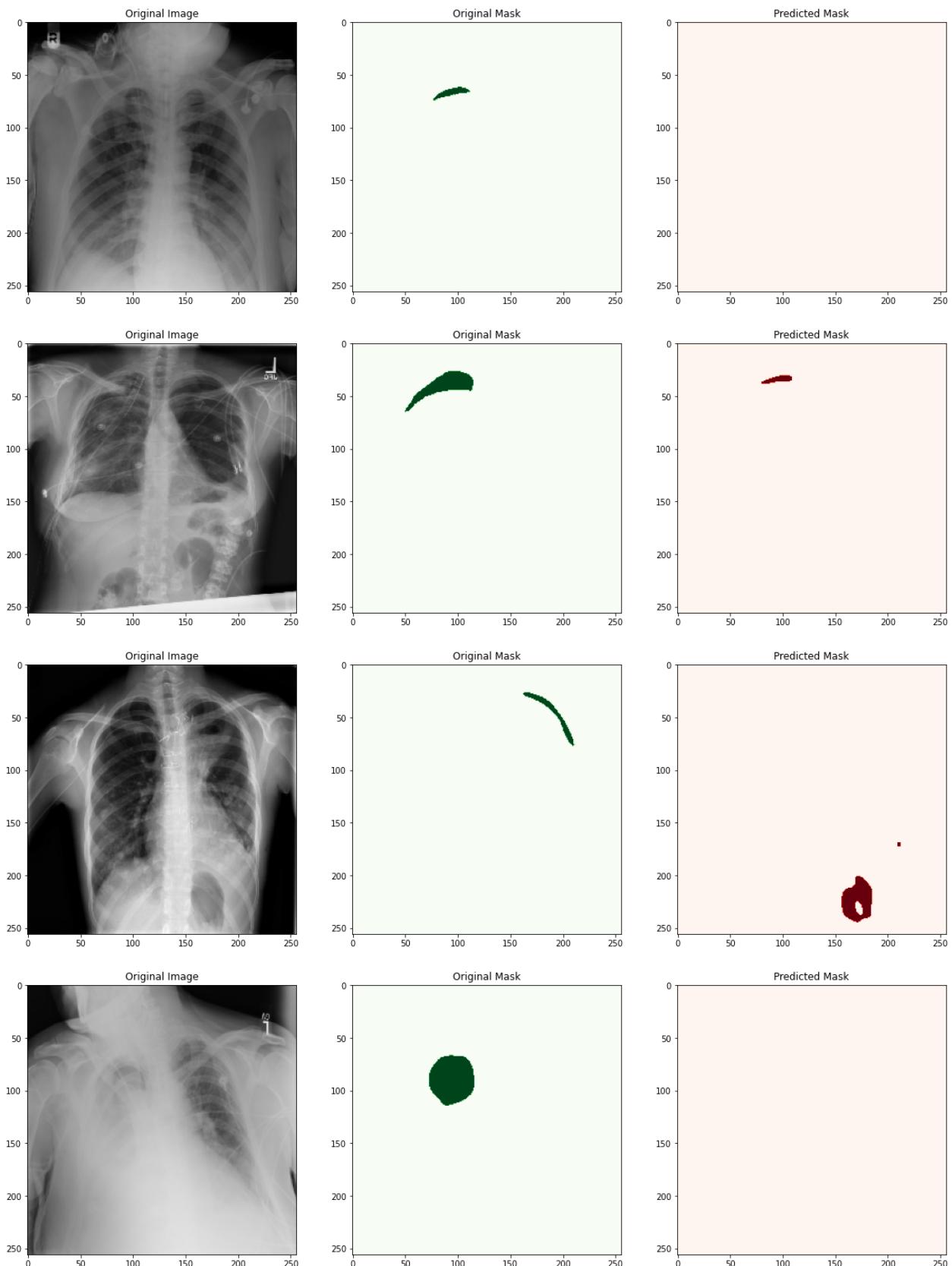
    plt.subplot(133)
    plt.title("Predicted Mask")
    plt.imshow(np.squeeze(pred_mask).astype(np.uint8),cmap='Reds')
    plt.show()
```











```
In [5]: #reference :https://stackoverflow.com/questions/8356501/python-format-tabular-output
from beautifultable import BeautifulTable
table = BeautifulTable()
table.column_headers= ["Model", "IOU Score", "Validation IOU Score", "Loss", "Validation Loss"]
table.append_row(["unet_imagenet_model", "0.1929", "0.3066", "0.7502", "0.5909"])
print(table)
```

Model	IOU Score	Validation IOU Score	Loss	Validation Loss
unet_imagenet_mod	0.193	0.307	0.75	0.591

```
C:\Anaconda3\lib\site-packages\beautifultable\utils.py:113: FutureWarning: 'BeautifulTable.column_headers' has been deprecated in 'v1.0.0' and will be removed in 'v1.2.0'. Use 'BTColumnCollection.headers' instead.
  warnings.warn(message, FutureWarning)
C:\Anaconda3\lib\site-packages\beautifultable\utils.py:113: FutureWarning: 'BeautifulTable.append_row' has been deprecated in 'v1.0.0' and will be removed in 'v1.2.0'. Use 'BTRowCollection.append' instead.
  warnings.warn(message, FutureWarning)
```

## 02. Build UNET model using DenseNet121 backbone with chexnet weights

```
In [ ]: from tensorflow.keras import Model
from tensorflow.keras.applications.densenet import DenseNet121
# https://stackoverflow.com/questions/64390544/unable-to-Load-chexnet-pre-trained-weight-file-to-dense
net121
# https://www.tensorflow.org/api_docs/python/tf/keras/applications/DenseNet121
dense_net_121 = DenseNet121(input_shape=[256,256,3],weights="imagenet",include_top=False,pooling='avg')
base_model_output = Dense(units=14,activation='relu')(dense_net_121.output)
base_model = Model(inputs = dense_net_121.input,outputs=base_model_output)

# Load chexnet weights in DenseNet121
# Loads all Layer weights, either from a TensorFlow or an HDF5 weight file
base_model.load_weights('./brucechou1983_CheXNet_Keras_0.3.0_weights.h5')
```

```
In [ ]: # https://www.kaggle.com/gbellport/pre-trained-densenet
output_layer = Dense(1,activation='sigmoid')(base_model.layers[-2].output)
# use this below model with DenseNet121 as backbone(encoder) of Unet model
model = Model(inputs=base_model.inputs, outputs=output_layer)

# define the decoder part of Unet
model1 =UpSampling2D((2,2))(model.layers[-3].output)

# model.get_layer retrieves a layer based on either its name (unique) or index
# concatenate 'pool4_conv' layer from encoder with upsampled layer
model1 = concatenate([model1,model.get_layer('pool4_conv').output])
model1 = Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= Conv2D(256,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= UpSampling2D((2,2))(model1)

# concatenate 'pool3_conv' layer from encoder with upsampled layer
model1= concatenate([model1,model.get_layer('pool3_conv').output])
model1= Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= Conv2D(128,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= Dropout(0.5)(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= UpSampling2D((2,2))(model1)

# concatenate 'pool2_conv' layer from encoder with upsampled layer
model1= concatenate([model1,model.get_layer('pool2_conv').output])
model1= Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= Dropout(0.5)(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= Conv2D(64,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= UpSampling2D((2,2))(model1)

# concatenate 'conv1/relu' layer from encoder with upsampled layer
model1= concatenate([model1,model.get_layer('conv1/relu').output])
model1= Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= Conv2D(32,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= Dropout(0.7)(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= UpSampling2D((2,2))(model1)

model1= Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= Conv2D(16,(3,3),padding='same',use_bias=False,kernel_initializer='glorot_normal')(model1)
model1= BatchNormalization()(model1)
model1= Activation('relu')(model1)
model1= Conv2D(1,(3,3),padding='same',use_bias=True,kernel_initializer='glorot_normal')(model1)
model1= Activation('sigmoid')(model1)

unet_chexnet_model=Model(inputs=model.inputs, outputs=model1)
```

```
In [ ]: # print model summary  
unet_chexnet_model.summary()
```

Model: "model\_5"

Layer (type)	Output Shape	Param #	Connected to
input_2 (InputLayer)	[None, 256, 256, 3]	0	
zero_padding2d_2 (ZeroPadding2D)	(None, 262, 262, 3)	0	input_2[0][0]
conv1/conv (Conv2D)	(None, 128, 128, 64)	9408	zero_padding2d_2[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_3 (ZeroPadding2D)	(None, 130, 130, 64)	0	conv1/relu[0][0]
pool1 (MaxPooling2D)	(None, 64, 64, 64)	0	zero_padding2d_3[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_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]
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 (Concatenation)	(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 (Activation)	(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 (Activation)	(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 (Concatenation)	(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 (Activation)	(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 (Activation)	(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 (Concatenation)	(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 (Activation)	(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 (Activation)	(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 (Concatenation)	(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_5 (UpSampling2D)	(None, 16, 16, 1024)	0	relu[0][0]
concatenate_4 (Concatenate)	(None, 16, 16, 1536)	0	up_sampling2d_5[0][0] pool4_conv[0][0]
conv2d_11 (Conv2D)	(None, 16, 16, 256)	3538944	concatenate_4[0][0]
batch_normalization_10 (BatchNorm)	(None, 16, 16, 256)	1024	conv2d_11[0][0]
activation_11 (Activation)	(None, 16, 16, 256)	0	batch_normalization_10[0][0]
conv2d_12 (Conv2D)	(None, 16, 16, 256)	589824	activation_11[0][0]
batch_normalization_11 (BatchNorm)	(None, 16, 16, 256)	1024	conv2d_12[0][0]
activation_12 (Activation)	(None, 16, 16, 256)	0	batch_normalization_11[0][0]
up_sampling2d_6 (UpSampling2D)	(None, 32, 32, 256)	0	activation_12[0][0]

concatenate_5 (Concatenate)	(None, 32, 32, 512) 0	up_sampling2d_6[0][0] pool3_conv[0][0]
conv2d_13 (Conv2D)	(None, 32, 32, 128) 589824	concatenate_5[0][0]
batch_normalization_12 (BatchNo)	(None, 32, 32, 128) 512	conv2d_13[0][0]
activation_13 (Activation)	(None, 32, 32, 128) 0	batch_normalization_12[0][0]
conv2d_14 (Conv2D)	(None, 32, 32, 128) 147456	activation_13[0][0]
dropout_3 (Dropout)	(None, 32, 32, 128) 0	conv2d_14[0][0]
batch_normalization_13 (BatchNo)	(None, 32, 32, 128) 512	dropout_3[0][0]
activation_14 (Activation)	(None, 32, 32, 128) 0	batch_normalization_13[0][0]
up_sampling2d_7 (UpSampling2D)	(None, 64, 64, 128) 0	activation_14[0][0]
concatenate_6 (Concatenate)	(None, 64, 64, 256) 0	up_sampling2d_7[0][0] pool2_conv[0][0]
conv2d_15 (Conv2D)	(None, 64, 64, 64) 147456	concatenate_6[0][0]
dropout_4 (Dropout)	(None, 64, 64, 64) 0	conv2d_15[0][0]
batch_normalization_14 (BatchNo)	(None, 64, 64, 64) 256	dropout_4[0][0]
activation_15 (Activation)	(None, 64, 64, 64) 0	batch_normalization_14[0][0]
conv2d_16 (Conv2D)	(None, 64, 64, 64) 36864	activation_15[0][0]
batch_normalization_15 (BatchNo)	(None, 64, 64, 64) 256	conv2d_16[0][0]
activation_16 (Activation)	(None, 64, 64, 64) 0	batch_normalization_15[0][0]
up_sampling2d_8 (UpSampling2D)	(None, 128, 128, 64) 0	activation_16[0][0]
concatenate_7 (Concatenate)	(None, 128, 128, 128) 0	up_sampling2d_8[0][0] conv1/relu[0][0]
conv2d_17 (Conv2D)	(None, 128, 128, 32) 36864	concatenate_7[0][0]
batch_normalization_16 (BatchNo)	(None, 128, 128, 32) 128	conv2d_17[0][0]
activation_17 (Activation)	(None, 128, 128, 32) 0	batch_normalization_16[0][0]
conv2d_18 (Conv2D)	(None, 128, 128, 32) 9216	activation_17[0][0]
dropout_5 (Dropout)	(None, 128, 128, 32) 0	conv2d_18[0][0]
batch_normalization_17 (BatchNo)	(None, 128, 128, 32) 128	dropout_5[0][0]
activation_18 (Activation)	(None, 128, 128, 32) 0	batch_normalization_17[0][0]
up_sampling2d_9 (UpSampling2D)	(None, 256, 256, 32) 0	activation_18[0][0]
conv2d_19 (Conv2D)	(None, 256, 256, 16) 4608	up_sampling2d_9[0][0]
batch_normalization_18 (BatchNo)	(None, 256, 256, 16) 64	conv2d_19[0][0]
activation_19 (Activation)	(None, 256, 256, 16) 0	batch_normalization_18[0][0]
conv2d_20 (Conv2D)	(None, 256, 256, 16) 2304	activation_19[0][0]
batch_normalization_19 (BatchNo)	(None, 256, 256, 16) 64	conv2d_20[0][0]
activation_20 (Activation)	(None, 256, 256, 16) 0	batch_normalization_19[0][0]
conv2d_21 (Conv2D)	(None, 256, 256, 1) 145	activation_20[0][0]
activation_21 (Activation)	(None, 256, 256, 1) 0	conv2d_21[0][0]

```
=====
Total params: 12,144,977
Trainable params: 12,059,345
Non-trainable params: 85,632
```

---

```
In [ ]: # train unet_chexnet_model
%rm -rf ./log
%load_ext tensorboard
%tensorboard --logdir='./log'
%reload_ext tensorboard
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir='./log')
adam = tf.keras.optimizers.Adam(lr=0.0001)
callback_list = [model_checkpoint, myCallback(threshold=0.9),tensorboard_callback]
unet_chexnet_model.compile(optimizer=adam, loss=combined_bce_dice_loss, metrics=['accuracy',iou_score])
unet_chexnet_model.fit(train_ds_batch,epochs=20,verbose=1,validation_data=val_ds_batch,callbacks=callback_list)
```

The tensorboard extension is already loaded. To reload it, use:  
%reload\_ext tensorboard

```
Epoch 1/20
133/133 [=====] - 128s 886ms/step - loss: 1.5509 - accuracy: 0.7467 - iou_score: 0.0116 - val_loss: 1.3079 - val_accuracy: 0.9879 - val_iou_score: 0.0117

Epoch 00001: val_iou_score did not improve from 0.30663
Epoch 2/20
133/133 [=====] - 114s 856ms/step - loss: 1.2247 - accuracy: 0.9884 - iou_score: 0.0119 - val_loss: 1.1328 - val_accuracy: 0.9888 - val_iou_score: 0.0173

Epoch 00002: val_iou_score did not improve from 0.30663
Epoch 3/20
133/133 [=====] - 114s 856ms/step - loss: 1.1129 - accuracy: 0.9888 - iou_score: 0.0175 - val_loss: 1.0171 - val_accuracy: 0.9885 - val_iou_score: 0.0328

Epoch 00003: val_iou_score did not improve from 0.30663
Epoch 4/20
133/133 [=====] - 114s 854ms/step - loss: 1.0515 - accuracy: 0.9827 - iou_score: 0.0289 - val_loss: 0.9765 - val_accuracy: 0.9849 - val_iou_score: 0.0473

Epoch 00004: val_iou_score did not improve from 0.30663
Epoch 5/20
133/133 [=====] - 114s 858ms/step - loss: 1.0047 - accuracy: 0.9774 - iou_score: 0.0416 - val_loss: 0.8632 - val_accuracy: 0.9847 - val_iou_score: 0.1071

Epoch 00005: val_iou_score did not improve from 0.30663
Epoch 6/20
133/133 [=====] - 114s 856ms/step - loss: 0.9608 - accuracy: 0.9783 - iou_score: 0.0614 - val_loss: 0.7752 - val_accuracy: 0.9838 - val_iou_score: 0.1669

Epoch 00006: val_iou_score did not improve from 0.30663
Epoch 7/20
133/133 [=====] - 114s 856ms/step - loss: 0.9076 - accuracy: 0.9805 - iou_score: 0.0893 - val_loss: 0.7203 - val_accuracy: 0.9857 - val_iou_score: 0.2036

Epoch 00007: val_iou_score did not improve from 0.30663
Epoch 8/20
133/133 [=====] - 114s 856ms/step - loss: 0.8755 - accuracy: 0.9813 - iou_score: 0.1072 - val_loss: 0.7123 - val_accuracy: 0.9863 - val_iou_score: 0.2133

Epoch 00008: val_iou_score did not improve from 0.30663
Epoch 9/20
133/133 [=====] - 114s 856ms/step - loss: 0.8654 - accuracy: 0.9821 - iou_score: 0.1144 - val_loss: 0.6603 - val_accuracy: 0.9868 - val_iou_score: 0.2512

Epoch 00009: val_iou_score did not improve from 0.30663
Epoch 10/20
133/133 [=====] - 114s 856ms/step - loss: 0.8114 - accuracy: 0.9834 - iou_score: 0.1505 - val_loss: 0.6617 - val_accuracy: 0.9854 - val_iou_score: 0.2538

Epoch 00010: val_iou_score did not improve from 0.30663
Epoch 11/20
133/133 [=====] - 114s 856ms/step - loss: 0.8194 - accuracy: 0.9834 - iou_score: 0.1449 - val_loss: 0.6625 - val_accuracy: 0.9877 - val_iou_score: 0.2528

Epoch 00011: val_iou_score did not improve from 0.30663
Epoch 12/20
133/133 [=====] - 114s 855ms/step - loss: 0.8130 - accuracy: 0.9835 - iou_score: 0.1487 - val_loss: 0.6561 - val_accuracy: 0.9881 - val_iou_score: 0.2610

Epoch 00012: val_iou_score did not improve from 0.30663
Epoch 13/20
133/133 [=====] - 114s 856ms/step - loss: 0.8078 - accuracy: 0.9844 - iou_score: 0.1531 - val_loss: 0.7025 - val_accuracy: 0.9808 - val_iou_score: 0.2404

Epoch 00013: val_iou_score did not improve from 0.30663
Epoch 14/20
133/133 [=====] - 114s 854ms/step - loss: 0.8064 - accuracy: 0.9843 - iou_score: 0.1546 - val_loss: 0.6187 - val_accuracy: 0.9884 - val_iou_score: 0.2869

Epoch 00014: val_iou_score did not improve from 0.30663
Epoch 15/20
```

```
133/133 [=====] - 114s 853ms/step - loss: 0.7937 - accuracy: 0.9847 - iou_score: 0.1643 - val_loss: 0.6493 - val_accuracy: 0.9887 - val_iou_score: 0.2649

Epoch 00015: val_iou_score did not improve from 0.30663
Epoch 16/20
133/133 [=====] - 114s 856ms/step - loss: 0.7853 - accuracy: 0.9860 - iou_score: 0.1682 - val_loss: 0.6385 - val_accuracy: 0.9884 - val_iou_score: 0.2755

Epoch 00016: val_iou_score did not improve from 0.30663
Epoch 17/20
133/133 [=====] - 114s 852ms/step - loss: 0.7855 - accuracy: 0.9856 - iou_score: 0.1672 - val_loss: 0.6520 - val_accuracy: 0.9868 - val_iou_score: 0.2674

Epoch 00017: val_iou_score did not improve from 0.30663
Epoch 18/20
133/133 [=====] - 115s 862ms/step - loss: 0.7843 - accuracy: 0.9849 - iou_score: 0.1708 - val_loss: 0.6380 - val_accuracy: 0.9876 - val_iou_score: 0.2805

Epoch 00018: val_iou_score did not improve from 0.30663
Epoch 19/20
133/133 [=====] - 115s 859ms/step - loss: 0.7789 - accuracy: 0.9853 - iou_score: 0.1754 - val_loss: 0.6500 - val_accuracy: 0.9894 - val_iou_score: 0.2698

Epoch 00019: val_iou_score did not improve from 0.30663
Epoch 20/20
133/133 [=====] - 114s 856ms/step - loss: 0.7669 - accuracy: 0.9852 - iou_score: 0.1859 - val_loss: 0.6370 - val_accuracy: 0.9884 - val_iou_score: 0.2782

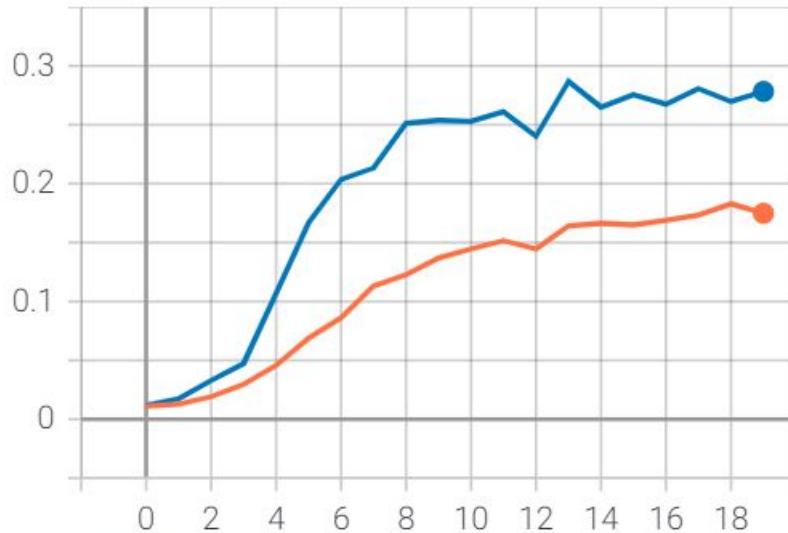
Epoch 00020: val_iou_score did not improve from 0.30663
```

Out[ ]: <tensorflow.python.keras.callbacks.History at 0x7fd49a40af0>

## unet\_chexnet\_model: Scalars

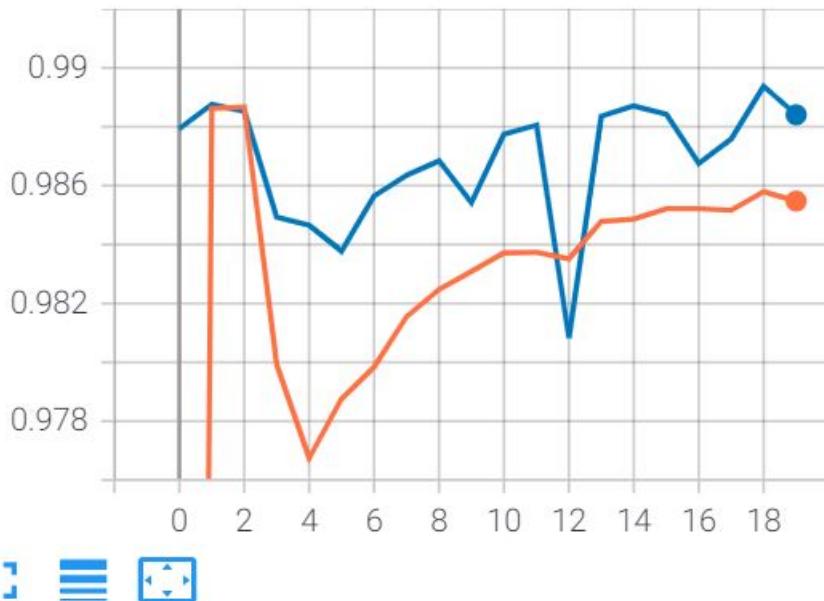
epoch\_iou\_score

epoch\_iou\_score



## epoch\_accuracy

### epoch\_accuracy



## epoch loss

```
In [101]: # save best weights after training
from keras.models import load_model
unet_chexnet_model.save('gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-20-0.2782.hdf5')
```

```
In [102]: # Load best weights to unet_chexnet_model
from keras.models import load_model
# custom_objects = optional dictionary mapping names (strings) to custom classes or functions to be considered during deserialization
unet_chexnet_model = load_model("gdrive/My Drive/Colab Notebooks/cs2_pneumothorax/segmentation/weights-20-0.2782.hdf5",
                                custom_objects={'combined_bce_dice_loss':combined_bce_dice_loss, "iou_score":iou_score})
```

```
In [119]: # predict some images from validation dataset
no_of_images = 20
for i in range(no_of_images):
    j = np.random.randint(0, len(val_image_path))
    img_path = val_image_path[j]
    msk_path = val_mask_path[j]

    size = 256
    image = tf.io.read_file(img_path)
    image = tfio.image.decode_dicom_image(image, dtype=tf.uint8,color_dim=True,scale='preserve')
    image = tf.image.convert_image_dtype(image, tf.float32)
    image = tf.squeeze(image,[0])
    image = tf.tile(image, tf.constant([1,1,3], tf.int32))
    image = tf.image.resize(image,size=[size,size])
    image = tf.expand_dims(image,axis=0)

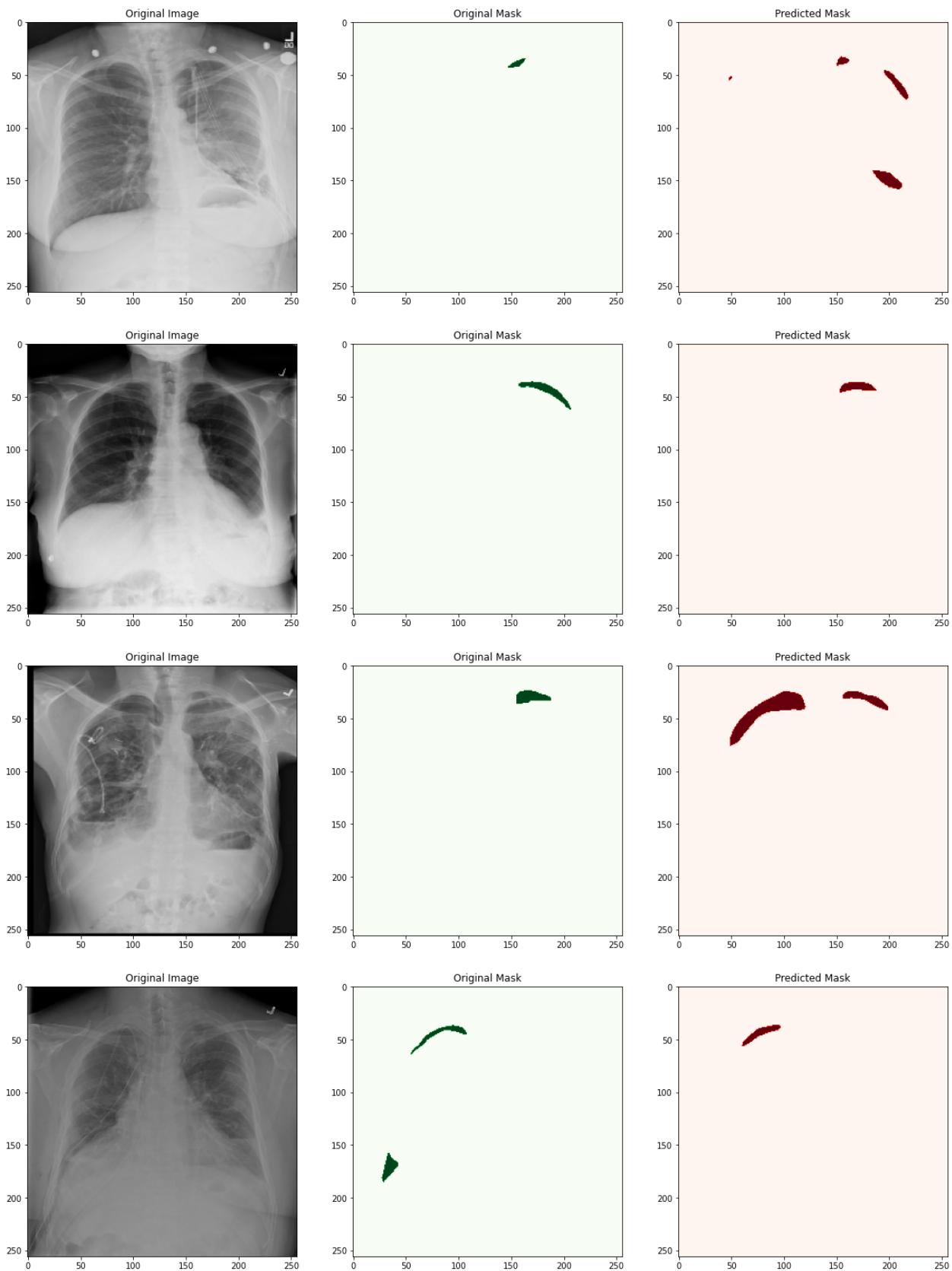
    mask = tf.io.read_file(msk_path)
    mask = tf.image.decode_png(mask, channels=1)
    mask = tf.image.resize(mask, [size, size])
    mask = tf.image.convert_image_dtype(mask, tf.float32)
    mask = tf.expand_dims(mask, axis=0)

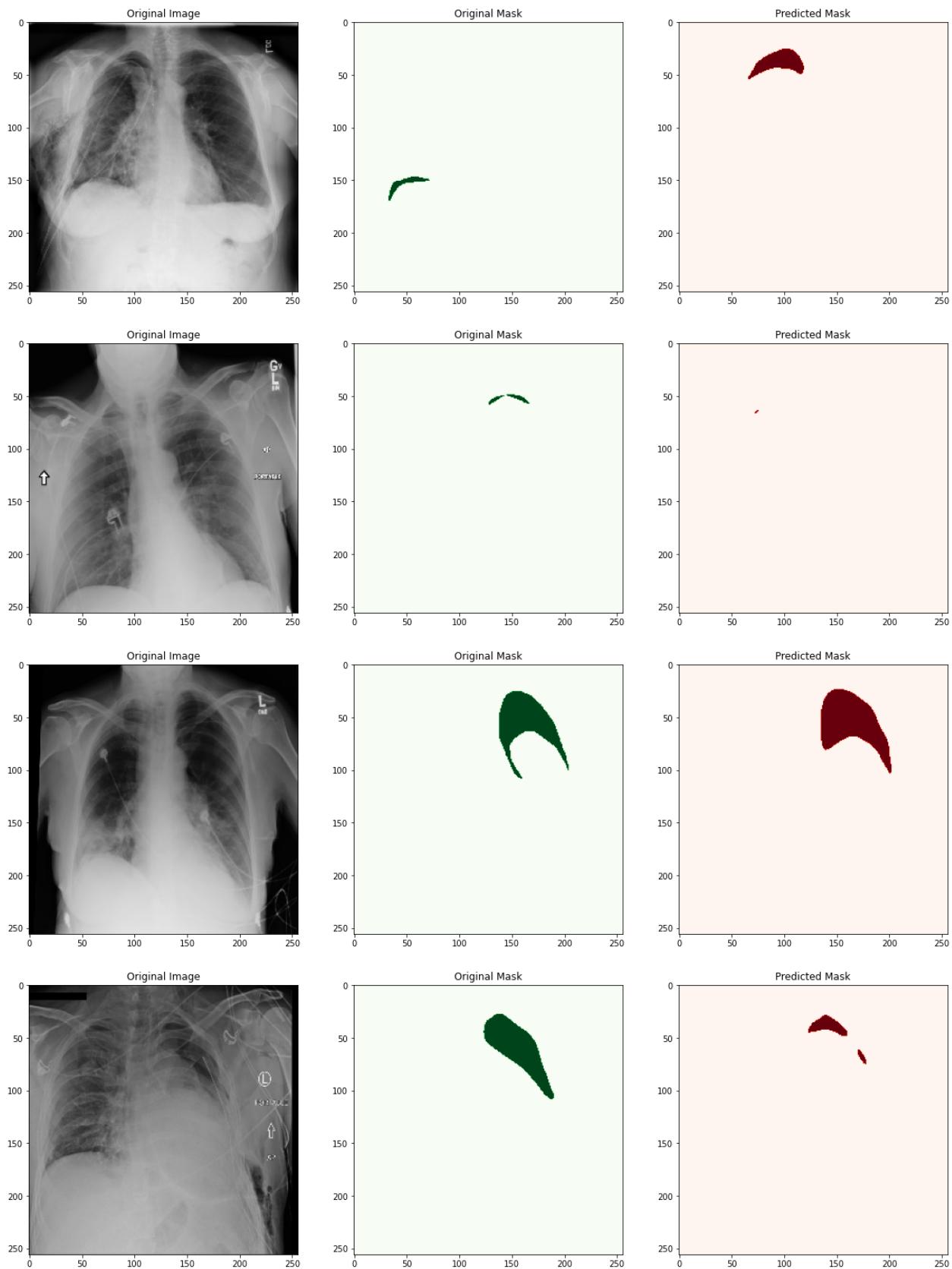
    pred = unet_chexnet_model.predict(image)
    pred_mask = (pred[0]>0.5).astype(np.uint8)

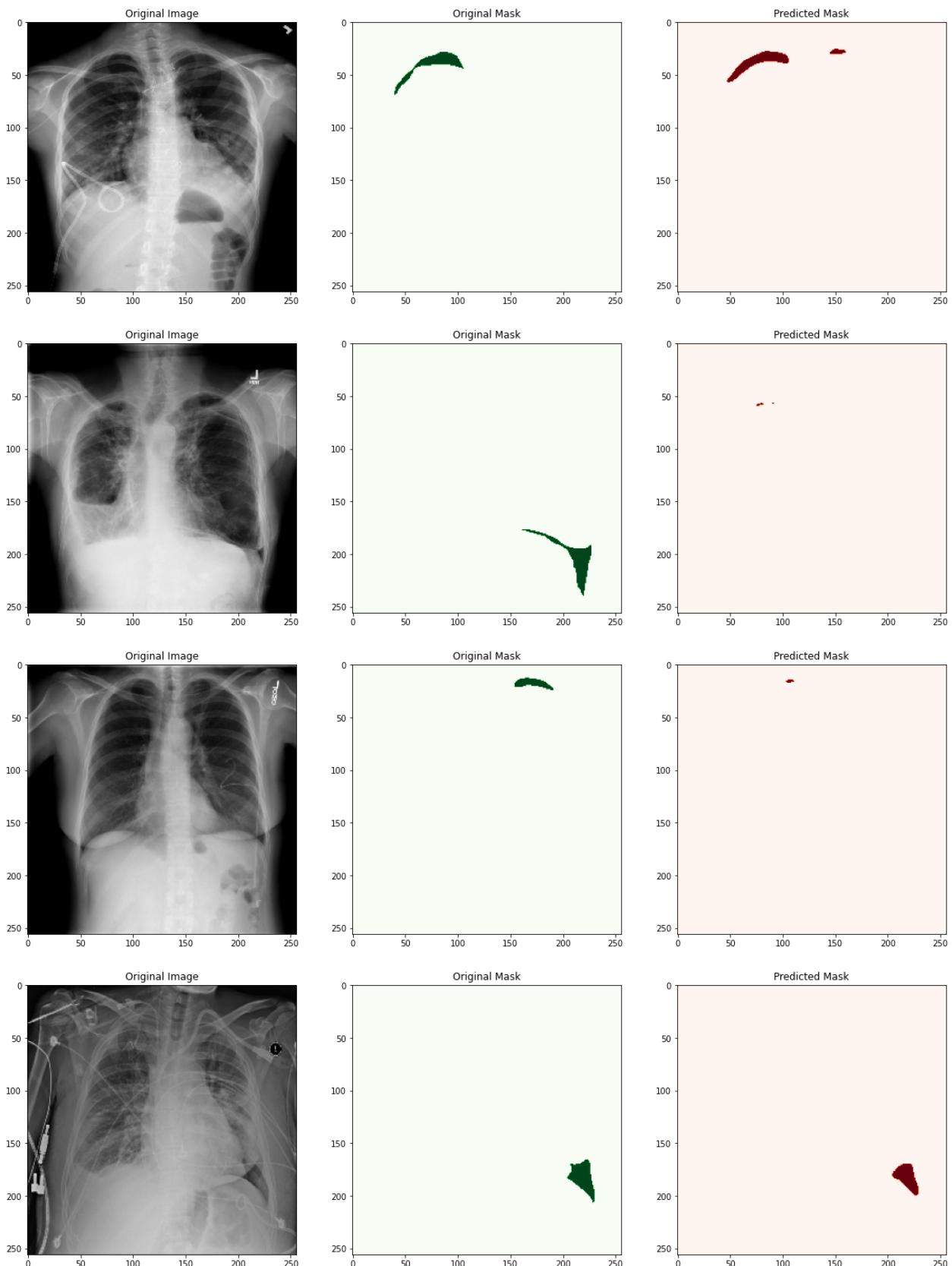
    plt.figure(figsize=(20,6))
    plt.subplot(131)
    plt.title("Original Image")
    plt.imshow(np.squeeze(image[0]),cmap='gray')

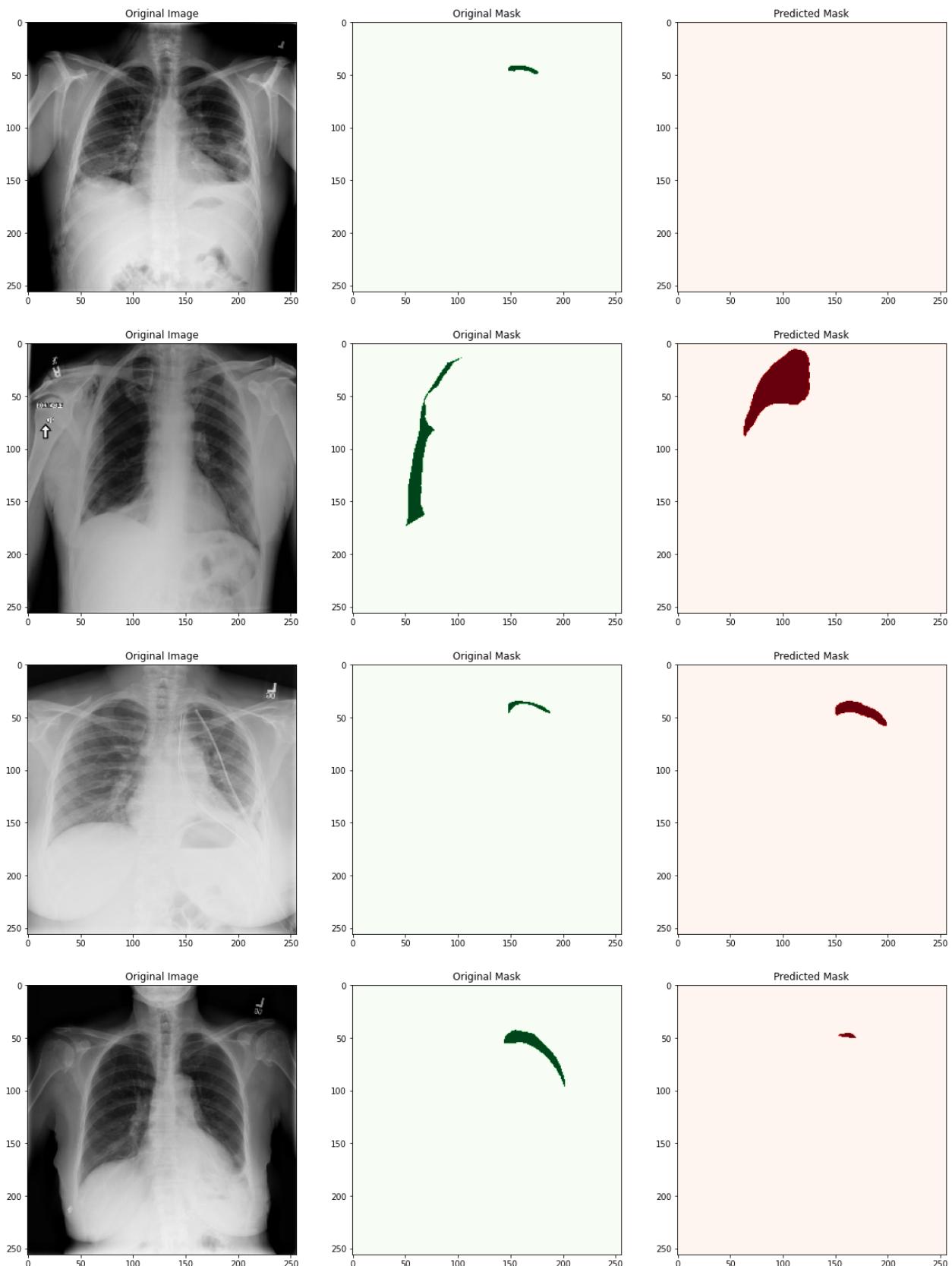
    plt.subplot(132)
    plt.title("Original Mask")
    plt.imshow(np.squeeze(mask[0]),cmap='Greens')

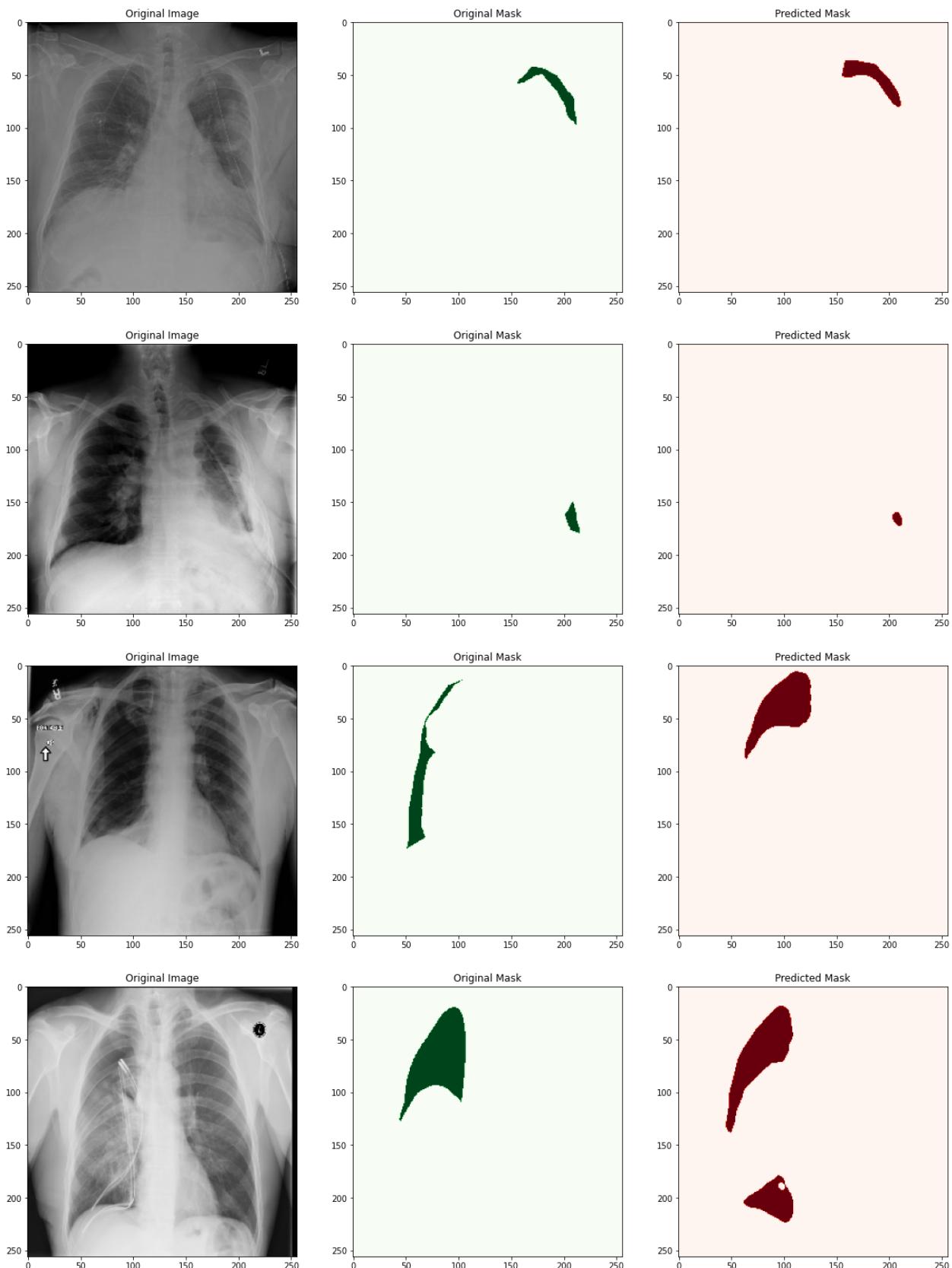
    plt.subplot(133)
    plt.title("Predicted Mask")
    plt.imshow(np.squeeze(pred_mask).astype(np.uint8),cmap='Reds')
    plt.show()
```











```
In [6]: table.append_row(["unet_chexnet_model", "0.1708", "0.2805", "0.7843", "0.6380"])
print(table)
```

Model	IOU Score	Validation IOU Score	Loss	Validation Loss
unet_imagenet_mod el	0.193	0.307	0.75	0.591
unet_chexnet_mod 1	0.171	0.281	0.784	0.638

```
C:\Anaconda3\lib\site-packages\beautifultable\utils.py:113: FutureWarning: 'BeautifulTable.append_row' has been deprecated in 'v1.0.0' and will be removed in 'v1.2.0'. Use 'BTRowCollection.append' instead.
warnings.warn(message, FutureWarning)
```

## Conclusion:

I have taken Intersection Over Union (IOU) score as the metric to measure the performance of the model. Loss function is defined as a combined loss binary\_crossentropy and dice\_loss(these are described in the literature survey notebook).

1. For UNET model built using DenseNet121 with imagenet weights gives IOU = 0.307 and Loss = 0.591
2. For UNET model built using DenseNet121 with chexnet weights gives IOU = 0.281 and Loss = 638

Even though chexnet weights are trained in x-ray images, in my case UNET model with imagenet weights gives better performance i.e. higher IOU score and lower loss. I will use unet\_imagenet\_model weights for the final prediction.