

```
In [1]: pip install segmentation-models
```

```
Collecting segmentation-models
  Downloading segmentation_models-1.0.1-py3-none-any.whl (33 kB)
Collecting efficientnet==1.0.0
  Downloading efficientnet-1.0.0-py3-none-any.whl (17 kB)
Collecting image-classifiers==1.0.0
  Downloading image_classifiers-1.0.0-py3-none-any.whl (19 kB)
Collecting keras-applications<=1.0.8,>=1.0.7
  Downloading Keras_Applications-1.0.8-py3-none-any.whl (50 kB)
    |██████████| 50 kB 4.4 MB/s
Requirement already satisfied: scikit-image in /usr/local/lib/python3.7/dist-packages (from efficientnet==1.0.0->segmentation-models) (0.1.6.2)
Requirement already satisfied: h5py in /usr/local/lib/python3.7/dist-packages (from keras-applications<=1.0.8,>=1.0.7->segmentation-models) (3.1.0)
Requirement already satisfied: numpy>=1.9.1 in /usr/local/lib/python3.7/dist-packages (from keras-applications<=1.0.8,>=1.0.7->segmentation-models) (1.19.5)
Requirement already satisfied: cached-property in /usr/local/lib/python3.7/dist-packages (from h5py->keras-applications<=1.0.8,>=1.0.7->segmentation-models) (1.5.2)
Requirement already satisfied: matplotlib!=3.0.0,>=2.0.0 in /usr/local/lib/python3.7/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models) (3.2.2)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.7/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models) (2.4.1)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.7/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models) (7.1.2)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.7/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models) (1.1.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.7/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models) (2.6.3)
Requirement already satisfied: scipy>=0.19.0 in /usr/local/lib/python3.7/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models) (1.4.1)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.7/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (2.8.2)
Requirement already satisfied: pyparsing!=2.0.4,!!=2.1.2,!!=2.1.6,>=2.0.1 in /usr/local/lib/python3.7/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (2.4.7)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (0.10.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (1.3.2)
Requirement already satisfied: six in /usr/local/lib/python3.7/dist-packages (from cycler>=0.10->matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0.0->segmentation-models) (1.15.0)
Installing collected packages: keras-applications, image-classifiers, efficientnet, segmentation-models
Successfully installed efficientnet-1.0.0 image-classifiers-1.0.0 keras-applications-1.0.8 segmentation-models-1.0.1
```

```
In [2]: import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
import os
import pickle
import matplotlib.patches as patches
import re
import random
from sklearn.model_selection import train_test_split
import cv2
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")
from keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.utils import plot_model
from PIL import Image
import tensorflow as tf
import keras
from keras import backend as K
from keras.models import Model,load_model
from keras.regularizers import l2
import datetime
%load_ext tensorboard
import segmentation_models
from segmentation_models import Unet
from segmentation_models import get_preprocessing
import imgaug.augmenters as iaa
import segmentation_models as sm
sm.set_framework('tf.keras')
sm.framework()
from tensorflow.keras.losses import binary_crossentropy
```

Segmentation Models: using `keras` framework.

```
In [3]: from google.colab import drive  
drive.mount('/content/drive')
```

Mounted at /content/drive

```
In [4]: with open('/content/drive//My Drive/Steel_Detection /data.pkl','rb') as f:  
    train=pickle.load(f)
```

```
In [5]: train.head()
```

	image_id	rle_1	rle_2	rle_3	rle_4	defect	stratify	defect_1	defect_2	defect_3	defect_4	total_defects
		29102 12										
		29346 24										
0	0002cc93b.jpg	29602 24				1	1	1	0	0	0	1
		29858 24										
		30114 24 3...										
1	00031f466.jpg					0	0	0	0	0	0	0
2	000418bfc.jpg					0	0	0	0	0	0	0
3	000789191.jpg					0	0	0	0	0	0	0
		18661 28										
		18863 82										
4	0007a71bf.jpg	19091 110				1	3	0	0	1	0	1
		19347 110										
		19603 11...										

```
In [6]: train.shape
```

(12568, 12)

```
In [5]: #https://scikit-learn.org/stable/modules/generated/skLearn.model_selection.train_test_split.html
x_train,x_test=train_test_split(train,test_size=0.10,stratify=train['stratify'],random_state=0)
x_train,x_val=train_test_split(x_train,test_size=0.20,stratify=x_train['stratify'],random_state=0)
print("x_train {}".format(x_train.shape)," x_val {}".format(x_val.shape)," x_test {}".format(x_te
st.shape))
print("=*100)
```

```
train_1=x_train[x_train['defect_1']==1][['image_id','rle_1']].rename(columns={'image_id':'image_id','rle_1':'rle'})
train_2=x_train[x_train['defect_2']==1][['image_id','rle_2']].rename(columns={'image_id':'image_id','rle_2':'rle'})
train_3=x_train[x_train['defect_3']==1][['image_id','rle_3']].rename(columns={'image_id':'image_id','rle_3':'rle'})
train_4=x_train[x_train['defect_4']==1][['image_id','rle_4']].rename(columns={'image_id':'image_id','rle_4':'rle'})
print("train_1 {}".format(train_1.shape)," train_2 {}".format(train_2.shape)," train_3 {}".format(
train_3.shape)," train_4 {}".format(train_4.shape))
print("*"*100)

val_1=x_val[x_val['defect_1']==1][['image_id','rle_1']].rename(columns={'image_id':'image_id','rle_1':'rle'})
val_2=x_val[x_val['defect_2']==1][['image_id','rle_2']].rename(columns={'image_id':'image_id','rle_2':'rle'})
val_3=x_val[x_val['defect_3']==1][['image_id','rle_3']].rename(columns={'image_id':'image_id','rle_3':'rle'})
val_4=x_val[x_val['defect_4']==1][['image_id','rle_4']].rename(columns={'image_id':'image_id','rle_4':'rle'})
print("val_1 {}".format(val_1.shape)," val_2 {}".format(val_2.shape)," val_3 {}".format(val_3.shape),
" val_4 {}".format(val_4.shape))
print("*"*100)

test_1=x_test[x_test['defect_1']==1][['image_id','rle_1']].rename(columns={'image_id':'image_id',
'rle_1':'rle'})
test_2=x_test[x_test['defect_2']==1][['image_id','rle_2']].rename(columns={'image_id':'image_id',
'rle_2':'rle'})
test_3=x_test[x_test['defect_3']==1][['image_id','rle_3']].rename(columns={'image_id':'image_id',
'rle_3':'rle'})
test_4=x_test[x_test['defect_4']==1][['image_id','rle_4']].rename(columns={'image_id':'image_id',
'rle_4':'rle'})
```

```

print("test_1 {}".format(test_1.shape), " test_2 {}".format(test_2.shape), " test_3 {}".format(test_3.shape), " test_4 {}".format(test_4.shape))

x_train (9048, 12)  x_val (2263, 12)  x_test (1257, 12)
=====
train_1 (646, 2)  train_2 (174, 2)  train_3 (3714, 2)  train_4 (581, 2)
=====
val_1 (161, 2)  val_2 (50, 2)  val_3 (924, 2)  val_4 (142, 2)
=====
test_1 (90, 2)  test_2 (23, 2)  test_3 (512, 2)  test_4 (78, 2)

```

- Data is divided with respect to 4 defects because different segmentation model is trained for each 4 defects .

```

In [6]: #https://stackoverflow.com/questions/31273652/how-to-calculate-dice-coefficient-for-measuring-accuracy-of-image-segmentation-i
def dice_coef(y_true,y_pred):
    y_true_f=tf.reshape(tf.dtypes.cast(y_true, tf.float32),[-1])
    y_pred_f=tf.reshape(tf.dtypes.cast(y_pred, tf.float32),[-1])
    intersection=tf.reduce_sum(y_true_f*y_pred_f)
    return (2. * intersection + 1.) / (tf.reduce_sum(y_true_f) + tf.reduce_sum(y_pred_f) + 1.)

#https://stackoverflow.com/questions/49785133/keras-dice-coefficient-loss-function-is-negative-and-increasing-with-epochs
def dice_loss(y_true, y_pred):
    y_true_f = tf.reshape(y_true, [-1])
    y_pred_f = tf.reshape(y_pred, [-1])
    return (1-dice_coefficient(y_true, y_pred))

#defining function for calculation of loss function: binary cross entropy + dice loss
def bce_dice_loss(y_true, y_pred):
    y_true_f = tf.reshape(y_true, [-1])
    y_pred_f = tf.reshape(y_pred, [-1])
    return binary_crossentropy(y_true, y_pred) + (1-dice_coef(y_true, y_pred))

```

```
In [7]: #https://www.kaggle.com/paulorzp/rle-functions-run-length-encode-decode
def rle_to_mask(rle):
    # CONVERT RLE TO MASK
    if (pd.isnull(rle))|(rle=='')|(rle=='-1'):
        return np.zeros((256,800),dtype=np.uint8) #If the EncodedPixels string is empty an empty
mask is returned

    height=256
    width=1600
    mask=np.zeros(width*height,dtype=np.uint8)

    array=np.asarray([int(x) for x in rle.split()])
    starts=array[0::2]-1
    lengths=array[1::2]
    for index,start in enumerate(starts):
        mask[int(start):int(start+lengths[index])]=1

    return mask.reshape((height,width),order='F')[::,::2]
```

- The imgaug library provides a very useful feature called Augmentation pipeline. Such a pipeline is a sequence of steps that can be applied in a fixed or random order. This also gives the flexibility to apply certain transformations to a few images and other transformations to other images.
- [\(https://www.kaggle.com/parulpandey/overview-of-popular-image-augmentation-packages\)](https://www.kaggle.com/parulpandey/overview-of-popular-image-augmentation-packages)

In [8]:

```
"""
Implementing custom data generator
#https://towardsdatascience.com/implementing-custom-data-generators-in-keras-de56f013581c
#https://www.kaggle.com/cdeotte/keras-unet-with-eda
"""

class train_DataGenerator(keras.utils.Sequence):
```

```
def __init__(self,dataframe,batch_size=4,shuffle=True,preprocess=None,info={}):
    self.batch_size = batch_size
    self.df = dataframe
    self.indices = self.df.index.tolist()
    self.preprocess = preprocess
    self.shuffle = shuffle
    self.on_epoch_end()

def __len__(self):
    return len(self.indices) // (self.batch_size)

def __getitem__(self, index):
    index = self.index[index * self.batch_size:(index + 1) * self.batch_size]
    batch = [self.indices[k] for k in index]

    X, y = self.__get_data(batch)
    return X, y

def on_epoch_end(self):
    self.index = np.arange(len(self.indices))
    if self.shuffle == True:
        np.random.shuffle(self.index)

def __get_data(self, batch):
    train_datagen = ImageDataGenerator()
    #https://www.geeksforgeeks.org/python-select-random-value-from-a-list/

    X=np.empty((self.batch_size,256,800,3),dtype=np.float32) # image place-holders
    Y=np.empty((self.batch_size,256,800,1),dtype=np.int8)# 1 mask place-holders

    for i,id in enumerate(batch):
        X[i,:] = Image.open('/content/drive//My Drive/Steel_Detection /train_images/' + str(self.df[
'image_id'].loc[id])).resize((800,256))
```

```
Y[i,:,:,:,0]=rle_to_mask(self.df['rle'].loc[id])

t=random.choice([0,0,20,30,40])
z=random.choice([0.9,1])
flip=random.choice(['True','False'])
"""

https://theailearner.com/2019/07/06/imagedatagenerator-apply\_transform-method/
https://www.tensorflow.org/api\_docs/python/tf/keras/preprocessing/image/ImageDataGenerator
tx and ty: These are the shifts in the vertical and the horizontal directions respectively.
For instance, tx=20 will shift the image vertically by 20 pixels
zx and zy: This zooms the image in the vertical and horizontal directions respectively.
If less than 1, the image is zoomed in otherwise zoomed out."""

param={'flip_horizontal':flip,'flip_vertical':flip,'tx':t,'ty':t,'zx':z,'zy':z,}
for i,e in enumerate(X):
    X[i] = train_datagen.apply_transform(e,transform_parameters=param)
for i,f in enumerate(Y):
    Y[i] = train_datagen.apply_transform(f,transform_parameters=param)

# preprocess input
if self.preprocess!=None: X = self.preprocess(X)

return X,Y
```

```
In [9]: # Implementing custom data generator
#https://towardsdatascience.com/implementing-custom-data-generators-in-keras-de56f013581c
class test_DataGenerator(keras.utils.Sequence):

    def __init__(self,dataframe,batch_size=1,shuffle=False,preprocess=None,info={}):
        self.batch_size = batch_size
        self.df = dataframe
        self.indices = self.df.index.tolist()
        self.preprocess = preprocess
        self.shuffle = shuffle
```

```
    self.on_epoch_end()

    def __len__(self):
        return len(self.indices) // (self.batch_size)

    def __getitem__(self, index):
        index = self.index[index * self.batch_size:(index + 1) * self.batch_size]
        batch = [self.indices[k] for k in index]

        X, y = self.__get_data(batch)
        return X, y

    def on_epoch_end(self):
        self.index = np.arange(len(self.indices))
        if self.shuffle == True:
            np.random.shuffle(self.index)

    def __get_data(self, batch):
        X = np.empty((self.batch_size, 256, 800, 3), dtype=np.float32) # image place-holders
        Y = np.empty((self.batch_size, 256, 800, 1), dtype=np.int8) # 1 mask place-holders

        for i, id in enumerate(batch):
            X[i,] = Image.open('/content/drive//My Drive/Steel_Detection /train_images/' + str(self.df['image_id'].loc[id])).resize((800, 256))
            Y[i,:,:,:]=rle_to_mask(self.df['rle'].loc[id])

            # preprocess input
            if self.preprocess!=None: X = self.preprocess(X)

        return X,Y
```

- Load UNET with pre-training on Imagenet data with backbone model as efficientnetb5.

```
In [10]: #https://segmentation-models.readthedocs.io/en/latest/tutorial.html  
#LOAD UNET WITH PRETRAINING FROM IMAGENET  
#https://segmentation-models.readthedocs.io/en/latest/tutorial.html  
preprocess=get_preprocessing('efficientnetb5')  
model=Unet('efficientnetb5',classes=1,activation='sigmoid',encoder_weights='imagenet')  
model._name="Segmentation_Model"  
model.summary()
```

```
Downloading data from https://github.com/Callidior/keras-applications/releases/download/efficientnet/efficientnet-b5_weights_tf_dim_ordering_tf_kernels_autoaugment_notop.h5
115515392/115515256 [=====] - 1s 0us/step
115523584/115515256 [=====] - 1s 0us/step
Model: "Segmentation_Model"
```

Layer (type)	Output Shape	Param #	Connected to
<hr/>			
input_1 (InputLayer)	[None, None, None, 0]		
stem_conv (Conv2D)	(None, None, None, 4 1296)		input_1[0][0]
stem_bn (BatchNormalization)	(None, None, None, 4 192)		stem_conv[0][0]
stem_activation (Activation)	(None, None, None, 4 0)		stem_bn[0][0]
block1a_dwconv (DepthwiseConv2D)	(None, None, None, 4 432)		stem_activation[0][0]
block1a_bn (BatchNormalization)	(None, None, None, 4 192)		block1a_dwconv[0][0]
block1a_activation (Activation)	(None, None, None, 4 0)		block1a_bn[0][0]
block1a_se_squeeze (GlobalAvera	(None, 48)	0	block1a_activation[0][0]
block1a_se_reshape (Reshape)	(None, 1, 1, 48)	0	block1a_se_squeeze[0][0]
block1a_se_reduce (Conv2D)	(None, 1, 1, 12)	588	block1a_se_reshape[0][0]
block1a_se_expand (Conv2D)	(None, 1, 1, 48)	624	block1a_se_reduce[0][0]
block1a_se_excite (Multiply)	(None, None, None, 4 0)		block1a_activation[0][0] block1a_se_expand[0][0]
block1a_project_conv (Conv2D)	(None, None, None, 2 1152)		block1a_se_excite[0][0]
block1a_project_bn (BatchNormal	(None, None, None, 2 96)		block1a_project_conv[0][0]
block1b_dwconv (DepthwiseConv2D)	(None, None, None, 2 216)		block1a_project_bn[0][0]
block1b_bn (BatchNormalization)	(None, None, None, 2 96)		block1b_dwconv[0][0]
block1b_activation (Activation)	(None, None, None, 2 0)		block1b_bn[0][0]

block1b_se_squeeze (GlobalAvera (None, 24)	0	block1b_activation[0][0]
block1b_se_reshape (Reshape) (None, 1, 1, 24)	0	block1b_se_squeeze[0][0]
block1b_se_reduce (Conv2D) (None, 1, 1, 6)	150	block1b_se_reshape[0][0]
block1b_se_expand (Conv2D) (None, 1, 1, 24)	168	block1b_se_reduce[0][0]
block1b_se_excite (Multiply) (None, None, None, 2 0		block1b_activation[0][0] block1b_se_expand[0][0]
block1b_project_conv (Conv2D) (None, None, None, 2 576		block1b_se_excite[0][0]
block1b_project_bn (BatchNormal (None, None, None, 2 96		block1b_project_conv[0][0]
block1b_drop (FixedDropout) (None, None, None, 2 0		block1b_project_bn[0][0]
block1b_add (Add) (None, None, None, 2 0		block1b_drop[0][0] block1a_project_bn[0][0]
block1c_dwconv (DepthwiseConv2D (None, None, None, 2 216		block1b_add[0][0]
block1c_bn (BatchNormalization) (None, None, None, 2 96		block1c_dwconv[0][0]
block1c_activation (Activation) (None, None, None, 2 0		block1c_bn[0][0]
block1c_se_squeeze (GlobalAvera (None, 24)	0	block1c_activation[0][0]
block1c_se_reshape (Reshape) (None, 1, 1, 24)	0	block1c_se_squeeze[0][0]
block1c_se_reduce (Conv2D) (None, 1, 1, 6)	150	block1c_se_reshape[0][0]
block1c_se_expand (Conv2D) (None, 1, 1, 24)	168	block1c_se_reduce[0][0]
block1c_se_excite (Multiply) (None, None, None, 2 0		block1c_activation[0][0] block1c_se_expand[0][0]
block1c_project_conv (Conv2D) (None, None, None, 2 576		block1c_se_excite[0][0]
block1c_project_bn (BatchNormal (None, None, None, 2 96		block1c_project_conv[0][0]
block1c_drop (FixedDropout) (None, None, None, 2 0		block1c_project_bn[0][0]

block1c_add (Add)	(None, None, None, 2 0	block1c_drop[0][0] block1b_add[0][0]
block2a_expand_conv (Conv2D)	(None, None, None, 1 3456	block1c_add[0][0]
block2a_expand_bn (BatchNormali	(None, None, None, 1 576	block2a_expand_conv[0][0]
block2a_expand_activation (Acti	(None, None, None, 1 0	block2a_expand_bn[0][0]
block2a_dwconv (DepthwiseConv2D	(None, None, None, 1 1296	block2a_expand_activation[0][0]
block2a_bn (BatchNormalizatio	(None, None, None, 1 576	block2a_dwconv[0][0]
block2a_activation (Activation)	(None, None, None, 1 0	block2a_bn[0][0]
block2a_se_squeeze (GlobalAvera	(None, 144) 0	block2a_activation[0][0]
block2a_se_reshape (Reshape)	(None, 1, 1, 144) 0	block2a_se_squeeze[0][0]
block2a_se_reduce (Conv2D)	(None, 1, 1, 6) 870	block2a_se_reshape[0][0]
block2a_se_expand (Conv2D)	(None, 1, 1, 144) 1008	block2a_se_reduce[0][0]
block2a_se_excite (Multiply)	(None, None, None, 1 0	block2a_activation[0][0] block2a_se_expand[0][0]
block2a_project_conv (Conv2D)	(None, None, None, 4 5760	block2a_se_excite[0][0]
block2a_project_bn (BatchNormal	(None, None, None, 4 160	block2a_project_conv[0][0]
block2b_expand_conv (Conv2D)	(None, None, None, 2 9600	block2a_project_bn[0][0]
block2b_expand_bn (BatchNormali	(None, None, None, 2 960	block2b_expand_conv[0][0]
block2b_expand_activation (Acti	(None, None, None, 2 0	block2b_expand_bn[0][0]
block2b_dwconv (DepthwiseConv2D	(None, None, None, 2 2160	block2b_expand_activation[0][0]
block2b_bn (BatchNormalizatio	(None, None, None, 2 960	block2b_dwconv[0][0]
block2b_activation (Activation)	(None, None, None, 2 0	block2b_bn[0][0]
block2b_se_squeeze (GlobalAvera	(None, 240) 0	block2b_activation[0][0]

block2b_se_reshape (Reshape)	(None, 1, 1, 240)	0	block2b_se_squeeze[0][0]
block2b_se_reduce (Conv2D)	(None, 1, 1, 10)	2410	block2b_se_reshape[0][0]
block2b_se_expand (Conv2D)	(None, 1, 1, 240)	2640	block2b_se_reduce[0][0]
block2b_se_excite (Multiply)	(None, None, None, 2 0		block2b_activation[0][0] block2b_se_expand[0][0]
block2b_project_conv (Conv2D)	(None, None, None, 4 9600		block2b_se_excite[0][0]
block2b_project_bn (BatchNormal	(None, None, None, 4 160		block2b_project_conv[0][0]
block2b_drop (FixedDropout)	(None, None, None, 4 0		block2b_project_bn[0][0]
block2b_add (Add)	(None, None, None, 4 0		block2b_drop[0][0] block2a_project_bn[0][0]
block2c_expand_conv (Conv2D)	(None, None, None, 2 9600		block2b_add[0][0]
block2c_expand_bn (BatchNormali	(None, None, None, 2 960		block2c_expand_conv[0][0]
block2c_expand_activation (Acti	(None, None, None, 2 0		block2c_expand_bn[0][0]
block2c_dwconv (DepthwiseConv2D	(None, None, None, 2 2160		block2c_expand_activation[0][0]
block2c_bn (BatchNormalization)	(None, None, None, 2 960		block2c_dwconv[0][0]
block2c_activation (Activation)	(None, None, None, 2 0		block2c_bn[0][0]
block2c_se_squeeze (GlobalAvera	(None, 240)	0	block2c_activation[0][0]
block2c_se_reshape (Reshape)	(None, 1, 1, 240)	0	block2c_se_squeeze[0][0]
block2c_se_reduce (Conv2D)	(None, 1, 1, 10)	2410	block2c_se_reshape[0][0]
block2c_se_expand (Conv2D)	(None, 1, 1, 240)	2640	block2c_se_reduce[0][0]
block2c_se_excite (Multiply)	(None, None, None, 2 0		block2c_activation[0][0] block2c_se_expand[0][0]
block2c_project_conv (Conv2D)	(None, None, None, 4 9600		block2c_se_excite[0][0]

block2c_project_bn (BatchNormal (None, None, None, 4 160		block2c_project_conv[0][0]
block2c_drop (FixedDropout) (None, None, None, 4 0		block2c_project_bn[0][0]
block2c_add (Add) (None, None, None, 4 0		block2c_drop[0][0] block2b_add[0][0]
block2d_expand_conv (Conv2D) (None, None, None, 2 9600		block2c_add[0][0]
block2d_expand_bn (BatchNormali (None, None, None, 2 960		block2d_expand_conv[0][0]
block2d_expand_activation (Acti (None, None, None, 2 0		block2d_expand_bn[0][0]
block2d_dwconv (DepthwiseConv2D (None, None, None, 2 2160		block2d_expand_activation[0][0]
block2d_bn (BatchNormalization) (None, None, None, 2 960		block2d_dwconv[0][0]
block2d_activation (Activation) (None, None, None, 2 0		block2d_bn[0][0]
block2d_se_squeeze (GlobalAvera (None, 240)	0	block2d_activation[0][0]
block2d_se_reshape (Reshape) (None, 1, 1, 240)	0	block2d_se_squeeze[0][0]
block2d_se_reduce (Conv2D) (None, 1, 1, 10)	2410	block2d_se_reshape[0][0]
block2d_se_expand (Conv2D) (None, 1, 1, 240)	2640	block2d_se_reduce[0][0]
block2d_se_excite (Multiply) (None, None, None, 2 0		block2d_activation[0][0] block2d_se_expand[0][0]
block2d_project_conv (Conv2D) (None, None, None, 4 9600		block2d_se_excite[0][0]
block2d_project_bn (BatchNormal (None, None, None, 4 160		block2d_project_conv[0][0]
block2d_drop (FixedDropout) (None, None, None, 4 0		block2d_project_bn[0][0]
block2d_add (Add) (None, None, None, 4 0		block2d_drop[0][0] block2c_add[0][0]
block2e_expand_conv (Conv2D) (None, None, None, 2 9600		block2d_add[0][0]
block2e_expand_bn (BatchNormali (None, None, None, 2 960		block2e_expand_conv[0][0]

block2e_expand_activation (Acti	(None, None, None, 2 0	block2e_expand_bn[0][0]
block2e_dwconv (DepthwiseConv2D	(None, None, None, 2 2160	block2e_expand_activation[0][0]
block2e_bn (BatchNormalizatio	(None, None, None, 2 960	block2e_dwconv[0][0]
block2e_activation (Activatio	(None, None, None, 2 0	block2e_bn[0][0]
block2e_se_squeeze (GlobalAvera	(None, 240)	0 block2e_activation[0][0]
block2e_se_reshape (Reshape)	(None, 1, 1, 240)	0 block2e_se_squeeze[0][0]
block2e_se_reduce (Conv2D)	(None, 1, 1, 10)	2410 block2e_se_reshape[0][0]
block2e_se_expand (Conv2D)	(None, 1, 1, 240)	2640 block2e_se_reduce[0][0]
block2e_se_excite (Multiply)	(None, None, None, 2 0	block2e_activation[0][0] block2e_se_expand[0][0]
block2e_project_conv (Conv2D)	(None, None, None, 4 9600	block2e_se_excite[0][0]
block2e_project_bn (BatchNorma	(None, None, None, 4 160	block2e_project_conv[0][0]
block2e_drop (FixedDropout)	(None, None, None, 4 0	block2e_project_bn[0][0]
block2e_add (Add)	(None, None, None, 4 0	block2e_drop[0][0] block2d_add[0][0]
block3a_expand_conv (Conv2D)	(None, None, None, 2 9600	block2e_add[0][0]
block3a_expand_bn (BatchNormali	(None, None, None, 2 960	block3a_expand_conv[0][0]
block3a_expand_activation (Acti	(None, None, None, 2 0	block3a_expand_bn[0][0]
block3a_dwconv (DepthwiseConv2D	(None, None, None, 2 6000	block3a_expand_activation[0][0]
block3a_bn (BatchNormalizatio	(None, None, None, 2 960	block3a_dwconv[0][0]
block3a_activation (Activatio	(None, None, None, 2 0	block3a_bn[0][0]
block3a_se_squeeze (GlobalAvera	(None, 240)	0 block3a_activation[0][0]

block3a_se_reshape (Reshape)	(None, 1, 1, 240)	0	block3a_se_squeeze[0][0]
block3a_se_reduce (Conv2D)	(None, 1, 1, 10)	2410	block3a_se_reshape[0][0]
block3a_se_expand (Conv2D)	(None, 1, 1, 240)	2640	block3a_se_reduce[0][0]
block3a_se_excite (Multiply)	(None, None, None, 20)		block3a_activation[0][0] block3a_se_expand[0][0]
block3a_project_conv (Conv2D)	(None, None, None, 6)	15360	block3a_se_excite[0][0]
block3a_project_bn (BatchNormal)	(None, None, None, 6)	256	block3a_project_conv[0][0]
block3b_expand_conv (Conv2D)	(None, None, None, 3)	24576	block3a_project_bn[0][0]
block3b_expand_bn (BatchNormali	(None, None, None, 3)	1536	block3b_expand_conv[0][0]
block3b_expand_activation (Acti	(None, None, None, 3)	0	block3b_expand_bn[0][0]
block3b_dwconv (DepthwiseConv2D)	(None, None, None, 3)	9600	block3b_expand_activation[0][0]
block3b_bn (BatchNormalization)	(None, None, None, 3)	1536	block3b_dwconv[0][0]
block3b_activation (Activation)	(None, None, None, 3)	0	block3b_bn[0][0]
block3b_se_squeeze (GlobalAvera	(None, 384)	0	block3b_activation[0][0]
block3b_se_reshape (Reshape)	(None, 1, 1, 384)	0	block3b_se_squeeze[0][0]
block3b_se_reduce (Conv2D)	(None, 1, 1, 16)	6160	block3b_se_reshape[0][0]
block3b_se_expand (Conv2D)	(None, 1, 1, 384)	6528	block3b_se_reduce[0][0]
block3b_se_excite (Multiply)	(None, None, None, 3)	0	block3b_activation[0][0] block3b_se_expand[0][0]
block3b_project_conv (Conv2D)	(None, None, None, 6)	24576	block3b_se_excite[0][0]
block3b_project_bn (BatchNormal	(None, None, None, 6)	256	block3b_project_conv[0][0]
block3b_drop (FixedDropout)	(None, None, None, 6)	0	block3b_project_bn[0][0]
block3b_add (Add)	(None, None, None, 6)	0	block3b_drop[0][0]

block3a\_project\_bn[0][0]

block3c_expand_conv (Conv2D)	(None, None, None, 3 24576	block3b_add[0][0]
block3c_expand_bn (BatchNormali	(None, None, None, 3 1536	block3c_expand_conv[0][0]
block3c_expand_activation (Acti	(None, None, None, 3 0	block3c_expand_bn[0][0]
block3c_dwconv (DepthwiseConv2D	(None, None, None, 3 9600	block3c_expand_activation[0][0]
block3c_bn (BatchNormalizatio	(None, None, None, 3 1536	block3c_dwconv[0][0]
block3c_activation (Activation)	(None, None, None, 3 0	block3c_bn[0][0]
block3c_se_squeeze (GlobalAvera	(None, 384) 0	block3c_activation[0][0]
block3c_se_reshape (Reshape)	(None, 1, 1, 384) 0	block3c_se_squeeze[0][0]
block3c_se_reduce (Conv2D)	(None, 1, 1, 16) 6160	block3c_se_reshape[0][0]
block3c_se_expand (Conv2D)	(None, 1, 1, 384) 6528	block3c_se_reduce[0][0]
block3c_se_excite (Multiply)	(None, None, None, 3 0	block3c_activation[0][0] block3c_se_expand[0][0]
block3c_project_conv (Conv2D)	(None, None, None, 6 24576	block3c_se_excite[0][0]
block3c_project_bn (BatchNormal	(None, None, None, 6 256	block3c_project_conv[0][0]
block3c_drop (FixedDropout)	(None, None, None, 6 0	block3c_project_bn[0][0]
block3c_add (Add)	(None, None, None, 6 0	block3c_drop[0][0] block3b_add[0][0]
block3d_expand_conv (Conv2D)	(None, None, None, 3 24576	block3c_add[0][0]
block3d_expand_bn (BatchNormali	(None, None, None, 3 1536	block3d_expand_conv[0][0]
block3d_expand_activation (Acti	(None, None, None, 3 0	block3d_expand_bn[0][0]
block3d_dwconv (DepthwiseConv2D	(None, None, None, 3 9600	block3d_expand_activation[0][0]
block3d_bn (BatchNormalizatio	(None, None, None, 3 1536	block3d_dwconv[0][0]

block3d_activation (Activation) (None, None, None, 3 0			block3d_bn[0][0]
block3d_se_squeeze (GlobalAvera (None, 384)	0		block3d_activation[0][0]
block3d_se_reshape (Reshape) (None, 1, 1, 384)	0		block3d_se_squeeze[0][0]
block3d_se_reduce (Conv2D) (None, 1, 1, 16)	6160		block3d_se_reshape[0][0]
block3d_se_expand (Conv2D) (None, 1, 1, 384)	6528		block3d_se_reduce[0][0]
block3d_se_excite (Multiply) (None, None, None, 3 0			block3d_activation[0][0] block3d_se_expand[0][0]
block3d_project_conv (Conv2D) (None, None, None, 6 24576			block3d_se_excite[0][0]
block3d_project_bn (BatchNormal (None, None, None, 6 256			block3d_project_conv[0][0]
block3d_drop (FixedDropout) (None, None, None, 6 0			block3d_project_bn[0][0]
block3d_add (Add) (None, None, None, 6 0			block3d_drop[0][0] block3c_add[0][0]
block3e_expand_conv (Conv2D) (None, None, None, 3 24576			block3d_add[0][0]
block3e_expand_bn (BatchNormali (None, None, None, 3 1536			block3e_expand_conv[0][0]
block3e_expand_activation (Acti (None, None, None, 3 0			block3e_expand_bn[0][0]
block3e_dwconv (DepthwiseConv2D (None, None, None, 3 9600			block3e_expand_activation[0][0]
block3e_bn (BatchNormalization) (None, None, None, 3 1536			block3e_dwconv[0][0]
block3e_activation (Activation) (None, None, None, 3 0			block3e_bn[0][0]
block3e_se_squeeze (GlobalAvera (None, 384)	0		block3e_activation[0][0]
block3e_se_reshape (Reshape) (None, 1, 1, 384)	0		block3e_se_squeeze[0][0]
block3e_se_reduce (Conv2D) (None, 1, 1, 16)	6160		block3e_se_reshape[0][0]
block3e_se_expand (Conv2D) (None, 1, 1, 384)	6528		block3e_se_reduce[0][0]

block3e_se_excite (Multiply)	(None, None, None, 3 0	block3e_activation[0][0] block3e_se_expand[0][0]	
block3e_project_conv (Conv2D)	(None, None, None, 6 24576	block3e_se_excite[0][0]	
block3e_project_bn (BatchNormal	(None, None, None, 6 256	block3e_project_conv[0][0]	
block3e_drop (FixedDropout)	(None, None, None, 6 0	block3e_project_bn[0][0]	
block3e_add (Add)	(None, None, None, 6 0	block3e_drop[0][0] block3d_add[0][0]	
block4a_expand_conv (Conv2D)	(None, None, None, 3 24576	block3e_add[0][0]	
block4a_expand_bn (BatchNormali	(None, None, None, 3 1536	block4a_expand_conv[0][0]	
block4a_expand_activation (Acti	(None, None, None, 3 0	block4a_expand_bn[0][0]	
block4a_dwconv (DepthwiseConv2D	(None, None, None, 3 3456	block4a_expand_activation[0][0]	
block4a_bn (BatchNormalization)	(None, None, None, 3 1536	block4a_dwconv[0][0]	
block4a_activation (Activation)	(None, None, None, 3 0	block4a_bn[0][0]	
block4a_se_squeeze (GlobalAvera	(None, 384)	0	block4a_activation[0][0]
block4a_se_reshape (Reshape)	(None, 1, 1, 384)	0	block4a_se_squeeze[0][0]
block4a_se_reduce (Conv2D)	(None, 1, 1, 16)	6160	block4a_se_reshape[0][0]
block4a_se_expand (Conv2D)	(None, 1, 1, 384)	6528	block4a_se_reduce[0][0]
block4a_se_excite (Multiply)	(None, None, None, 3 0	block4a_activation[0][0] block4a_se_expand[0][0]	
block4a_project_conv (Conv2D)	(None, None, None, 1 49152	block4a_se_excite[0][0]	
block4a_project_bn (BatchNormal	(None, None, None, 1 512	block4a_project_conv[0][0]	
block4b_expand_conv (Conv2D)	(None, None, None, 7 98304	block4a_project_bn[0][0]	
block4b_expand_bn (BatchNormali	(None, None, None, 7 3072	block4b_expand_conv[0][0]	

block4b_expand_activation (Activation) (None, None, None, 7 0		block4b_expand_bn[0][0]
block4b_dwconv (DepthwiseConv2D (None, None, None, 7 6912		block4b_expand_activation[0][0]
block4b_bn (BatchNormalization) (None, None, None, 7 3072		block4b_dwconv[0][0]
block4b_activation (Activation) (None, None, None, 7 0		block4b_bn[0][0]
block4b_se_squeeze (GlobalAvera (None, 768)	0	block4b_activation[0][0]
block4b_se_reshape (Reshape) (None, 1, 1, 768)	0	block4b_se_squeeze[0][0]
block4b_se_reduce (Conv2D) (None, 1, 1, 32)	24608	block4b_se_reshape[0][0]
block4b_se_expand (Conv2D) (None, 1, 1, 768)	25344	block4b_se_reduce[0][0]
block4b_se_excite (Multiply) (None, None, None, 7 0		block4b_activation[0][0] block4b_se_expand[0][0]
block4b_project_conv (Conv2D) (None, None, None, 1 98304		block4b_se_excite[0][0]
block4b_project_bn (BatchNormal (None, None, None, 1 512		block4b_project_conv[0][0]
block4b_drop (FixedDropout) (None, None, None, 1 0		block4b_project_bn[0][0]
block4b_add (Add) (None, None, None, 1 0		block4b_drop[0][0] block4a_project_bn[0][0]
block4c_expand_conv (Conv2D) (None, None, None, 7 98304		block4b_add[0][0]
block4c_expand_bn (BatchNormali (None, None, None, 7 3072		block4c_expand_conv[0][0]
block4c_expand_activation (Acti (None, None, None, 7 0		block4c_expand_bn[0][0]
block4c_dwconv (DepthwiseConv2D (None, None, None, 7 6912		block4c_expand_activation[0][0]
block4c_bn (BatchNormalization) (None, None, None, 7 3072		block4c_dwconv[0][0]
block4c_activation (Activation) (None, None, None, 7 0		block4c_bn[0][0]
block4c_se_squeeze (GlobalAvera (None, 768)	0	block4c_activation[0][0]
block4c_se_reshape (Reshape) (None, 1, 1, 768)	0	block4c_se_squeeze[0][0]

block4c_se_reduce (Conv2D)	(None, 1, 1, 32)	24608	block4c_se_reshape[0][0]
block4c_se_expand (Conv2D)	(None, 1, 1, 768)	25344	block4c_se_reduce[0][0]
block4c_se_excite (Multiply)	(None, None, None, 7 0		block4c_activation[0][0] block4c_se_expand[0][0]
block4c_project_conv (Conv2D)	(None, None, None, 1 98304		block4c_se_excite[0][0]
block4c_project_bn (BatchNormal	(None, None, None, 1 512		block4c_project_conv[0][0]
block4c_drop (FixedDropout)	(None, None, None, 1 0		block4c_project_bn[0][0]
block4c_add (Add)	(None, None, None, 1 0		block4c_drop[0][0] block4b_add[0][0]
block4d_expand_conv (Conv2D)	(None, None, None, 7 98304		block4c_add[0][0]
block4d_expand_bn (BatchNormali	(None, None, None, 7 3072		block4d_expand_conv[0][0]
block4d_expand_activation (Acti	(None, None, None, 7 0		block4d_expand_bn[0][0]
block4d_dwconv (DepthwiseConv2D	(None, None, None, 7 6912		block4d_expand_activation[0][0]
block4d_bn (BatchNormalization)	(None, None, None, 7 3072		block4d_dwconv[0][0]
block4d_activation (Activation)	(None, None, None, 7 0		block4d_bn[0][0]
block4d_se_squeeze (GlobalAvera	(None, 768)	0	block4d_activation[0][0]
block4d_se_reshape (Reshape)	(None, 1, 1, 768)	0	block4d_se_squeeze[0][0]
block4d_se_reduce (Conv2D)	(None, 1, 1, 32)	24608	block4d_se_reshape[0][0]
block4d_se_expand (Conv2D)	(None, 1, 1, 768)	25344	block4d_se_reduce[0][0]
block4d_se_excite (Multiply)	(None, None, None, 7 0		block4d_activation[0][0] block4d_se_expand[0][0]
block4d_project_conv (Conv2D)	(None, None, None, 1 98304		block4d_se_excite[0][0]
block4d_project_bn (BatchNormal	(None, None, None, 1 512		block4d_project_conv[0][0]

block4d_drop (FixedDropout)	(None, None, None, 1 0	block4d_project_bn[0][0]
block4d_add (Add)	(None, None, None, 1 0	block4d_drop[0][0] block4c_add[0][0]
block4e_expand_conv (Conv2D)	(None, None, None, 7 98304	block4d_add[0][0]
block4e_expand_bn (BatchNormali	(None, None, None, 7 3072	block4e_expand_conv[0][0]
block4e_expand_activation (Acti	(None, None, None, 7 0	block4e_expand_bn[0][0]
block4e_dwconv (DepthwiseConv2D	(None, None, None, 7 6912	block4e_expand_activation[0][0]
block4e_bn (BatchNormalizatio	(None, None, None, 7 3072	block4e_dwconv[0][0]
block4e_activation (Activation)	(None, None, None, 7 0	block4e_bn[0][0]
block4e_se_squeeze (GlobalAvera	(None, 768) 0	block4e_activation[0][0]
block4e_se_reshape (Reshape)	(None, 1, 1, 768) 0	block4e_se_squeeze[0][0]
block4e_se_reduce (Conv2D)	(None, 1, 1, 32) 24608	block4e_se_reshape[0][0]
block4e_se_expand (Conv2D)	(None, 1, 1, 768) 25344	block4e_se_reduce[0][0]
block4e_se_excite (Multiply)	(None, None, None, 7 0	block4e_activation[0][0] block4e_se_expand[0][0]
block4e_project_conv (Conv2D)	(None, None, None, 1 98304	block4e_se_excite[0][0]
block4e_project_bn (BatchNormal	(None, None, None, 1 512	block4e_project_conv[0][0]
block4e_drop (FixedDropout)	(None, None, None, 1 0	block4e_project_bn[0][0]
block4e_add (Add)	(None, None, None, 1 0	block4e_drop[0][0] block4d_add[0][0]
block4f_expand_conv (Conv2D)	(None, None, None, 7 98304	block4e_add[0][0]
block4f_expand_bn (BatchNormali	(None, None, None, 7 3072	block4f_expand_conv[0][0]
block4f_expand_activation (Acti	(None, None, None, 7 0	block4f_expand_bn[0][0]

block4f_dwconv (DepthwiseConv2D (None, None, None, 7 6912		block4f_expand_activation[0][0]
block4f_bn (BatchNormalization) (None, None, None, 7 3072		block4f_dwconv[0][0]
block4f_activation (Activation) (None, None, None, 7 0		block4f_bn[0][0]
block4f_se_squeeze (GlobalAvera (None, 768)	0	block4f_activation[0][0]
block4f_se_reshape (Reshape) (None, 1, 1, 768)	0	block4f_se_squeeze[0][0]
block4f_se_reduce (Conv2D) (None, 1, 1, 32)	24608	block4f_se_reshape[0][0]
block4f_se_expand (Conv2D) (None, 1, 1, 768)	25344	block4f_se_reduce[0][0]
block4f_se_excite (Multiply) (None, None, None, 7 0		block4f_activation[0][0] block4f_se_expand[0][0]
block4f_project_conv (Conv2D) (None, None, None, 1 98304		block4f_se_excite[0][0]
block4f_project_bn (BatchNormal (None, None, None, 1 512		block4f_project_conv[0][0]
block4f_drop (FixedDropout) (None, None, None, 1 0		block4f_project_bn[0][0]
block4f_add (Add) (None, None, None, 1 0		block4f_drop[0][0] block4e_add[0][0]
block4g_expand_conv (Conv2D) (None, None, None, 7 98304		block4f_add[0][0]
block4g_expand_bn (BatchNormali (None, None, None, 7 3072		block4g_expand_conv[0][0]
block4g_expand_activation (Acti (None, None, None, 7 0		block4g_expand_bn[0][0]
block4g_dwconv (DepthwiseConv2D (None, None, None, 7 6912		block4g_expand_activation[0][0]
block4g_bn (BatchNormalization) (None, None, None, 7 3072		block4g_dwconv[0][0]
block4g_activation (Activation) (None, None, None, 7 0		block4g_bn[0][0]
block4g_se_squeeze (GlobalAvera (None, 768)	0	block4g_activation[0][0]
block4g_se_reshape (Reshape) (None, 1, 1, 768)	0	block4g_se_squeeze[0][0]

block4g_se_reduce (Conv2D)	(None, 1, 1, 32)	24608	block4g_se_reshape[0][0]
block4g_se_expand (Conv2D)	(None, 1, 1, 768)	25344	block4g_se_reduce[0][0]
block4g_se_excite (Multiply)	(None, None, None, 7 0		block4g_activation[0][0] block4g_se_expand[0][0]
block4g_project_conv (Conv2D)	(None, None, None, 1	98304	block4g_se_excite[0][0]
block4g_project_bn (BatchNormal	(None, None, None, 1	512	block4g_project_conv[0][0]
block4g_drop (FixedDropout)	(None, None, None, 1 0		block4g_project_bn[0][0]
block4g_add (Add)	(None, None, None, 1 0		block4g_drop[0][0] block4f_add[0][0]
block5a_expand_conv (Conv2D)	(None, None, None, 7	98304	block4g_add[0][0]
block5a_expand_bn (BatchNormali	(None, None, None, 7	3072	block5a_expand_conv[0][0]
block5a_expand_activation (Acti	(None, None, None, 7 0		block5a_expand_bn[0][0]
block5a_dwconv (DepthwiseConv2D	(None, None, None, 7	19200	block5a_expand_activation[0][0]
block5a_bn (BatchNormalization)	(None, None, None, 7	3072	block5a_dwconv[0][0]
block5a_activation (Activation)	(None, None, None, 7 0		block5a_bn[0][0]
block5a_se_squeeze (GlobalAvera	(None, 768)	0	block5a_activation[0][0]
block5a_se_reshape (Reshape)	(None, 1, 1, 768)	0	block5a_se_squeeze[0][0]
block5a_se_reduce (Conv2D)	(None, 1, 1, 32)	24608	block5a_se_reshape[0][0]
block5a_se_expand (Conv2D)	(None, 1, 1, 768)	25344	block5a_se_reduce[0][0]
block5a_se_excite (Multiply)	(None, None, None, 7 0		block5a_activation[0][0] block5a_se_expand[0][0]
block5a_project_conv (Conv2D)	(None, None, None, 1	135168	block5a_se_excite[0][0]
block5a_project_bn (BatchNormal	(None, None, None, 1	704	block5a_project_conv[0][0]

block5b_expand_conv (Conv2D) (None, None, None, 1 185856		block5a_project_bn[0][0]
block5b_expand_bn (BatchNormali (None, None, None, 1 4224		block5b_expand_conv[0][0]
block5b_expand_activation (Acti (None, None, None, 1 0		block5b_expand_bn[0][0]
block5b_dwconv (DepthwiseConv2D (None, None, None, 1 26400		block5b_expand_activation[0][0]
block5b_bn (BatchNormalization) (None, None, None, 1 4224		block5b_dwconv[0][0]
block5b_activation (Activation) (None, None, None, 1 0		block5b_bn[0][0]
block5b_se_squeeze (GlobalAvera (None, 1056)	0	block5b_activation[0][0]
block5b_se_reshape (Reshape) (None, 1, 1, 1056)	0	block5b_se_squeeze[0][0]
block5b_se_reduce (Conv2D) (None, 1, 1, 44)	46508	block5b_se_reshape[0][0]
block5b_se_expand (Conv2D) (None, 1, 1, 1056)	47520	block5b_se_reduce[0][0]
block5b_se_excite (Multiply) (None, None, None, 1 0		block5b_activation[0][0] block5b_se_expand[0][0]
block5b_project_conv (Conv2D) (None, None, None, 1 185856		block5b_se_excite[0][0]
block5b_project_bn (BatchNormal (None, None, None, 1 704		block5b_project_conv[0][0]
block5b_drop (FixedDropout) (None, None, None, 1 0		block5b_project_bn[0][0]
block5b_add (Add) (None, None, None, 1 0		block5b_drop[0][0] block5a_project_bn[0][0]
block5c_expand_conv (Conv2D) (None, None, None, 1 185856		block5b_add[0][0]
block5c_expand_bn (BatchNormali (None, None, None, 1 4224		block5c_expand_conv[0][0]
block5c_expand_activation (Acti (None, None, None, 1 0		block5c_expand_bn[0][0]
block5c_dwconv (DepthwiseConv2D (None, None, None, 1 26400		block5c_expand_activation[0][0]
block5c_bn (BatchNormalization) (None, None, None, 1 4224		block5c_dwconv[0][0]
block5c_activation (Activation) (None, None, None, 1 0		block5c_bn[0][0]

block5c_se_squeeze (GlobalAvera	(None, 1056)	0	block5c_activation[0][0]
block5c_se_reshape (Reshape)	(None, 1, 1, 1056)	0	block5c_se_squeeze[0][0]
block5c_se_reduce (Conv2D)	(None, 1, 1, 44)	46508	block5c_se_reshape[0][0]
block5c_se_expand (Conv2D)	(None, 1, 1, 1056)	47520	block5c_se_reduce[0][0]
block5c_se_excite (Multiply)	(None, None, None, 1 0		block5c_activation[0][0] block5c_se_expand[0][0]
block5c_project_conv (Conv2D)	(None, None, None, 1 185856		block5c_se_excite[0][0]
block5c_project_bn (BatchNormal	(None, None, None, 1 704		block5c_project_conv[0][0]
block5c_drop (FixedDropout)	(None, None, None, 1 0		block5c_project_bn[0][0]
block5c_add (Add)	(None, None, None, 1 0		block5c_drop[0][0] block5b_add[0][0]
block5d_expand_conv (Conv2D)	(None, None, None, 1 185856		block5c_add[0][0]
block5d_expand_bn (BatchNormali	(None, None, None, 1 4224		block5d_expand_conv[0][0]
block5d_expand_activation (Acti	(None, None, None, 1 0		block5d_expand_bn[0][0]
block5d_dwconv (DepthwiseConv2D	(None, None, None, 1 26400		block5d_expand_activation[0][0]
block5d_bn (BatchNormalizatio	(None, None, None, 1 4224		block5d_dwconv[0][0]
block5d_activation (Activation)	(None, None, None, 1 0		block5d_bn[0][0]
block5d_se_squeeze (GlobalAvera	(None, 1056)	0	block5d_activation[0][0]
block5d_se_reshape (Reshape)	(None, 1, 1, 1056)	0	block5d_se_squeeze[0][0]
block5d_se_reduce (Conv2D)	(None, 1, 1, 44)	46508	block5d_se_reshape[0][0]
block5d_se_expand (Conv2D)	(None, 1, 1, 1056)	47520	block5d_se_reduce[0][0]
block5d_se_excite (Multiply)	(None, None, None, 1 0		block5d_activation[0][0] block5d_se_expand[0][0]

block5d_project_conv (Conv2D) (None, None, None, 1 185856		block5d_se_excite[0][0]
block5d_project_bn (BatchNormal (None, None, None, 1 704		block5d_project_conv[0][0]
block5d_drop (FixedDropout) (None, None, None, 1 0		block5d_project_bn[0][0]
block5d_add (Add) (None, None, None, 1 0		block5d_drop[0][0] block5c_add[0][0]
block5e_expand_conv (Conv2D) (None, None, None, 1 185856		block5d_add[0][0]
block5e_expand_bn (BatchNormali (None, None, None, 1 4224		block5e_expand_conv[0][0]
block5e_expand_activation (Acti (None, None, None, 1 0		block5e_expand_bn[0][0]
block5e_dwconv (DepthwiseConv2D (None, None, None, 1 26400		block5e_expand_activation[0][0]
block5e_bn (BatchNormalization) (None, None, None, 1 4224		block5e_dwconv[0][0]
block5e_activation (Activation) (None, None, None, 1 0		block5e_bn[0][0]
block5e_se_squeeze (GlobalAvera (None, 1056)	0	block5e_activation[0][0]
block5e_se_reshape (Reshape) (None, 1, 1, 1056)	0	block5e_se_squeeze[0][0]
block5e_se_reduce (Conv2D) (None, 1, 1, 44)	46508	block5e_se_reshape[0][0]
block5e_se_expand (Conv2D) (None, 1, 1, 1056)	47520	block5e_se_reduce[0][0]
block5e_se_excite (Multiply) (None, None, None, 1 0		block5e_activation[0][0] block5e_se_expand[0][0]
block5e_project_conv (Conv2D) (None, None, None, 1 185856		block5e_se_excite[0][0]
block5e_project_bn (BatchNormal (None, None, None, 1 704		block5e_project_conv[0][0]
block5e_drop (FixedDropout) (None, None, None, 1 0		block5e_project_bn[0][0]
block5e_add (Add) (None, None, None, 1 0		block5e_drop[0][0] block5d_add[0][0]
block5f_expand_conv (Conv2D) (None, None, None, 1 185856		block5e_add[0][0]

block5f_expand_bn (BatchNormali (None, None, None, 1 4224		block5f_expand_conv[0][0]
block5f_expand_activation (Acti (None, None, None, 1 0		block5f_expand_bn[0][0]
block5f_dwconv (DepthwiseConv2D (None, None, None, 1 26400		block5f_expand_activation[0][0]
block5f_bn (BatchNormalization) (None, None, None, 1 4224		block5f_dwconv[0][0]
block5f_activation (Activation) (None, None, None, 1 0		block5f_bn[0][0]
block5f_se_squeeze (GlobalAvera (None, 1056)	0	block5f_activation[0][0]
block5f_se_reshape (Reshape) (None, 1, 1, 1056)	0	block5f_se_squeeze[0][0]
block5f_se_reduce (Conv2D) (None, 1, 1, 44)	46508	block5f_se_reshape[0][0]
block5f_se_expand (Conv2D) (None, 1, 1, 1056)	47520	block5f_se_reduce[0][0]
block5f_se_excite (Multiply) (None, None, None, 1 0		block5f_activation[0][0] block5f_se_expand[0][0]
block5f_project_conv (Conv2D) (None, None, None, 1 185856		block5f_se_excite[0][0]
block5f_project_bn (BatchNormal (None, None, None, 1 704		block5f_project_conv[0][0]
block5f_drop (FixedDropout) (None, None, None, 1 0		block5f_project_bn[0][0]
block5f_add (Add) (None, None, None, 1 0		block5f_drop[0][0] block5e_add[0][0]
block5g_expand_conv (Conv2D) (None, None, None, 1 185856		block5f_add[0][0]
block5g_expand_bn (BatchNormali (None, None, None, 1 4224		block5g_expand_conv[0][0]
block5g_expand_activation (Acti (None, None, None, 1 0		block5g_expand_bn[0][0]
block5g_dwconv (DepthwiseConv2D (None, None, None, 1 26400		block5g_expand_activation[0][0]
block5g_bn (BatchNormalization) (None, None, None, 1 4224		block5g_dwconv[0][0]
block5g_activation (Activation) (None, None, None, 1 0		block5g_bn[0][0]

block5g_se_squeeze (GlobalAvera (None, 1056)	0	block5g_activation[0][0]
block5g_se_reshape (Reshape) (None, 1, 1, 1056)	0	block5g_se_squeeze[0][0]
block5g_se_reduce (Conv2D) (None, 1, 1, 44)	46508	block5g_se_reshape[0][0]
block5g_se_expand (Conv2D) (None, 1, 1, 1056)	47520	block5g_se_reduce[0][0]
block5g_se_excite (Multiply) (None, None, None, 1 0		block5g_activation[0][0] block5g_se_expand[0][0]
block5g_project_conv (Conv2D) (None, None, None, 1 185856		block5g_se_excite[0][0]
block5g_project_bn (BatchNormal (None, None, None, 1 704		block5g_project_conv[0][0]
block5g_drop (FixedDropout) (None, None, None, 1 0		block5g_project_bn[0][0]
block5g_add (Add) (None, None, None, 1 0		block5g_drop[0][0] block5f_add[0][0]
block6a_expand_conv (Conv2D) (None, None, None, 1 185856		block5g_add[0][0]
block6a_expand_bn (BatchNormali (None, None, None, 1 4224		block6a_expand_conv[0][0]
block6a_expand_activation (Acti (None, None, None, 1 0		block6a_expand_bn[0][0]
block6a_dwconv (DepthwiseConv2D (None, None, None, 1 26400		block6a_expand_activation[0][0]
block6a_bn (BatchNormalization) (None, None, None, 1 4224		block6a_dwconv[0][0]
block6a_activation (Activation) (None, None, None, 1 0		block6a_bn[0][0]
block6a_se_squeeze (GlobalAvera (None, 1056)	0	block6a_activation[0][0]
block6a_se_reshape (Reshape) (None, 1, 1, 1056)	0	block6a_se_squeeze[0][0]
block6a_se_reduce (Conv2D) (None, 1, 1, 44)	46508	block6a_se_reshape[0][0]
block6a_se_expand (Conv2D) (None, 1, 1, 1056)	47520	block6a_se_reduce[0][0]
block6a_se_excite (Multiply) (None, None, None, 1 0		block6a_activation[0][0] block6a_se_expand[0][0]

block6a_project_conv (Conv2D) (None, None, None, 3 321024		block6a_se_excite[0][0]
block6a_project_bn (BatchNormal (None, None, None, 3 1216		block6a_project_conv[0][0]
block6b_expand_conv (Conv2D) (None, None, None, 1 554496		block6a_project_bn[0][0]
block6b_expand_bn (BatchNormali (None, None, None, 1 7296		block6b_expand_conv[0][0]
block6b_expand_activation (Acti (None, None, None, 1 0		block6b_expand_bn[0][0]
block6b_dwconv (DepthwiseConv2D (None, None, None, 1 45600		block6b_expand_activation[0][0]
block6b_bn (BatchNormalization) (None, None, None, 1 7296		block6b_dwconv[0][0]
block6b_activation (Activation) (None, None, None, 1 0		block6b_bn[0][0]
block6b_se_squeeze (GlobalAvera (None, 1824)	0	block6b_activation[0][0]
block6b_se_reshape (Reshape) (None, 1, 1, 1824)	0	block6b_se_squeeze[0][0]
block6b_se_reduce (Conv2D) (None, 1, 1, 76)	138700	block6b_se_reshape[0][0]
block6b_se_expand (Conv2D) (None, 1, 1, 1824)	140448	block6b_se_reduce[0][0]
block6b_se_excite (Multiply) (None, None, None, 1 0		block6b_activation[0][0] block6b_se_expand[0][0]
block6b_project_conv (Conv2D) (None, None, None, 3 554496		block6b_se_excite[0][0]
block6b_project_bn (BatchNormal (None, None, None, 3 1216		block6b_project_conv[0][0]
block6b_drop (FixedDropout) (None, None, None, 3 0		block6b_project_bn[0][0]
block6b_add (Add) (None, None, None, 3 0		block6b_drop[0][0] block6a_project_bn[0][0]
block6c_expand_conv (Conv2D) (None, None, None, 1 554496		block6b_add[0][0]
block6c_expand_bn (BatchNormali (None, None, None, 1 7296		block6c_expand_conv[0][0]
block6c_expand_activation (Acti (None, None, None, 1 0		block6c_expand_bn[0][0]
block6c_dwconv (DepthwiseConv2D (None, None, None, 1 45600		block6c_expand_activation[0][0]

block6c_bn (BatchNormalization) (None, None, None, 1 7296		block6c_dwconv[0][0]
block6c_activation (Activation) (None, None, None, 1 0		block6c_bn[0][0]
block6c_se_squeeze (GlobalAvera (None, 1824)	0	block6c_activation[0][0]
block6c_se_reshape (Reshape) (None, 1, 1, 1824)	0	block6c_se_squeeze[0][0]
block6c_se_reduce (Conv2D) (None, 1, 1, 76)	138700	block6c_se_reshape[0][0]
block6c_se_expand (Conv2D) (None, 1, 1, 1824)	140448	block6c_se_reduce[0][0]
block6c_se_excite (Multiply) (None, None, None, 1 0		block6c_activation[0][0] block6c_se_expand[0][0]
block6c_project_conv (Conv2D) (None, None, None, 3 554496		block6c_se_excite[0][0]
block6c_project_bn (BatchNormal (None, None, None, 3 1216		block6c_project_conv[0][0]
block6c_drop (FixedDropout) (None, None, None, 3 0		block6c_project_bn[0][0]
block6c_add (Add) (None, None, None, 3 0		block6c_drop[0][0] block6b_add[0][0]
block6d_expand_conv (Conv2D) (None, None, None, 1 554496		block6c_add[0][0]
block6d_expand_bn (BatchNormali (None, None, None, 1 7296		block6d_expand_conv[0][0]
block6d_expand_activation (Acti (None, None, None, 1 0		block6d_expand_bn[0][0]
block6d_dwconv (DepthwiseConv2D (None, None, None, 1 45600		block6d_expand_activation[0][0]
block6d_bn (BatchNormalization) (None, None, None, 1 7296		block6d_dwconv[0][0]
block6d_activation (Activation) (None, None, None, 1 0		block6d_bn[0][0]
block6d_se_squeeze (GlobalAvera (None, 1824)	0	block6d_activation[0][0]
block6d_se_reshape (Reshape) (None, 1, 1, 1824)	0	block6d_se_squeeze[0][0]
block6d_se_reduce (Conv2D) (None, 1, 1, 76)	138700	block6d_se_reshape[0][0]

block6d_se_expand (Conv2D)	(None, 1, 1, 1824)	140448	block6d_se_reduce[0][0]
block6d_se_excite (Multiply)	(None, None, None, 1 0		block6d_activation[0][0] block6d_se_expand[0][0]
block6d_project_conv (Conv2D)	(None, None, None, 3	554496	block6d_se_excite[0][0]
block6d_project_bn (BatchNormal	(None, None, None, 3	1216	block6d_project_conv[0][0]
block6d_drop (FixedDropout)	(None, None, None, 3	0	block6d_project_bn[0][0]
block6d_add (Add)	(None, None, None, 3	0	block6d_drop[0][0] block6c_add[0][0]
block6e_expand_conv (Conv2D)	(None, None, None, 1	554496	block6d_add[0][0]
block6e_expand_bn (BatchNormali	(None, None, None, 1	7296	block6e_expand_conv[0][0]
block6e_expand_activation (Acti	(None, None, None, 1	0	block6e_expand_bn[0][0]
block6e_dwconv (DepthwiseConv2D	(None, None, None, 1	45600	block6e_expand_activation[0][0]
block6e_bn (BatchNormalization)	(None, None, None, 1	7296	block6e_dwconv[0][0]
block6e_activation (Activation)	(None, None, None, 1	0	block6e_bn[0][0]
block6e_se_squeeze (GlobalAvera	(None, 1824)	0	block6e_activation[0][0]
block6e_se_reshape (Reshape)	(None, 1, 1, 1824)	0	block6e_se_squeeze[0][0]
block6e_se_reduce (Conv2D)	(None, 1, 1, 76)	138700	block6e_se_reshape[0][0]
block6e_se_expand (Conv2D)	(None, 1, 1, 1824)	140448	block6e_se_reduce[0][0]
block6e_se_excite (Multiply)	(None, None, None, 1	0	block6e_activation[0][0] block6e_se_expand[0][0]
block6e_project_conv (Conv2D)	(None, None, None, 3	554496	block6e_se_excite[0][0]
block6e_project_bn (BatchNormal	(None, None, None, 3	1216	block6e_project_conv[0][0]
block6e_drop (FixedDropout)	(None, None, None, 3	0	block6e_project_bn[0][0]

block6e_add (Add)	(None, None, None, 3 0	block6e_drop[0][0] block6d_add[0][0]
block6f_expand_conv (Conv2D)	(None, None, None, 1 554496	block6e_add[0][0]
block6f_expand_bn (BatchNormali	(None, None, None, 1 7296	block6f_expand_conv[0][0]
block6f_expand_activation (Acti	(None, None, None, 1 0	block6f_expand_bn[0][0]
block6f_dwconv (DepthwiseConv2D	(None, None, None, 1 45600	block6f_expand_activation[0][0]
block6f_bn (BatchNormalizatio	(None, None, None, 1 7296	block6f_dwconv[0][0]
block6f_activation (Activation)	(None, None, None, 1 0	block6f_bn[0][0]
block6f_se_squeeze (GlobalAvera	(None, 1824) 0	block6f_activation[0][0]
block6f_se_reshape (Reshape)	(None, 1, 1, 1824) 0	block6f_se_squeeze[0][0]
block6f_se_reduce (Conv2D)	(None, 1, 1, 76) 138700	block6f_se_reshape[0][0]
block6f_se_expand (Conv2D)	(None, 1, 1, 1824) 140448	block6f_se_reduce[0][0]
block6f_se_excite (Multiply)	(None, None, None, 1 0	block6f_activation[0][0] block6f_se_expand[0][0]
block6f_project_conv (Conv2D)	(None, None, None, 3 554496	block6f_se_excite[0][0]
block6f_project_bn (BatchNormal	(None, None, None, 3 1216	block6f_project_conv[0][0]
block6f_drop (FixedDropout)	(None, None, None, 3 0	block6f_project_bn[0][0]
block6f_add (Add)	(None, None, None, 3 0	block6f_drop[0][0] block6e_add[0][0]
block6g_expand_conv (Conv2D)	(None, None, None, 1 554496	block6f_add[0][0]
block6g_expand_bn (BatchNormali	(None, None, None, 1 7296	block6g_expand_conv[0][0]
block6g_expand_activation (Acti	(None, None, None, 1 0	block6g_expand_bn[0][0]
block6g_dwconv (DepthwiseConv2D	(None, None, None, 1 45600	block6g_expand_activation[0][0]

block6g_bn (BatchNormalization) (None, None, None, 1 7296		block6g_dwconv[0][0]
block6g_activation (Activation) (None, None, None, 1 0		block6g_bn[0][0]
block6g_se_squeeze (GlobalAvera (None, 1824)	0	block6g_activation[0][0]
block6g_se_reshape (Reshape) (None, 1, 1, 1824)	0	block6g_se_squeeze[0][0]
block6g_se_reduce (Conv2D) (None, 1, 1, 76)	138700	block6g_se_reshape[0][0]
block6g_se_expand (Conv2D) (None, 1, 1, 1824)	140448	block6g_se_reduce[0][0]
block6g_se_excite (Multiply) (None, None, None, 1 0		block6g_activation[0][0] block6g_se_expand[0][0]
block6g_project_conv (Conv2D) (None, None, None, 3 554496		block6g_se_excite[0][0]
block6g_project_bn (BatchNormal (None, None, None, 3 1216		block6g_project_conv[0][0]
block6g_drop (FixedDropout) (None, None, None, 3 0		block6g_project_bn[0][0]
block6g_add (Add) (None, None, None, 3 0		block6g_drop[0][0] block6f_add[0][0]
block6h_expand_conv (Conv2D) (None, None, None, 1 554496		block6g_add[0][0]
block6h_expand_bn (BatchNormali (None, None, None, 1 7296		block6h_expand_conv[0][0]
block6h_expand_activation (Acti (None, None, None, 1 0		block6h_expand_bn[0][0]
block6h_dwconv (DepthwiseConv2D (None, None, None, 1 45600		block6h_expand_activation[0][0]
block6h_bn (BatchNormalization) (None, None, None, 1 7296		block6h_dwconv[0][0]
block6h_activation (Activation) (None, None, None, 1 0		block6h_bn[0][0]
block6h_se_squeeze (GlobalAvera (None, 1824)	0	block6h_activation[0][0]
block6h_se_reshape (Reshape) (None, 1, 1, 1824)	0	block6h_se_squeeze[0][0]
block6h_se_reduce (Conv2D) (None, 1, 1, 76)	138700	block6h_se_reshape[0][0]
block6h_se_expand (Conv2D) (None, 1, 1, 1824)	140448	block6h_se_reduce[0][0]

block6h_se_excite (Multiply)	(None, None, None, 1 0)	block6h_activation[0][0] block6h_se_expand[0][0]
block6h_project_conv (Conv2D)	(None, None, None, 3 554496)	block6h_se_excite[0][0]
block6h_project_bn (BatchNormal)	(None, None, None, 3 1216)	block6h_project_conv[0][0]
block6h_drop (FixedDropout)	(None, None, None, 3 0)	block6h_project_bn[0][0]
block6h_add (Add)	(None, None, None, 3 0)	block6h_drop[0][0] block6g_add[0][0]
block6i_expand_conv (Conv2D)	(None, None, None, 1 554496)	block6h_add[0][0]
block6i_expand_bn (BatchNormali)	(None, None, None, 1 7296)	block6i_expand_conv[0][0]
block6i_expand_activation (Acti	(None, None, None, 1 0)	block6i_expand_bn[0][0]
block6i_dwconv (DepthwiseConv2D)	(None, None, None, 1 45600)	block6i_expand_activation[0][0]
block6i_bn (BatchNormalization)	(None, None, None, 1 7296)	block6i_dwconv[0][0]
block6i_activation (Activation)	(None, None, None, 1 0)	block6i_bn[0][0]
block6i_se_squeeze (GlobalAvera	(None, 1824) 0	block6i_activation[0][0]
block6i_se_reshape (Reshape)	(None, 1, 1, 1824) 0	block6i_se_squeeze[0][0]
block6i_se_reduce (Conv2D)	(None, 1, 1, 76) 138700	block6i_se_reshape[0][0]
block6i_se_expand (Conv2D)	(None, 1, 1, 1824) 140448	block6i_se_reduce[0][0]
block6i_se_excite (Multiply)	(None, None, None, 1 0)	block6i_activation[0][0] block6i_se_expand[0][0]
block6i_project_conv (Conv2D)	(None, None, None, 3 554496)	block6i_se_excite[0][0]
block6i_project_bn (BatchNormal)	(None, None, None, 3 1216)	block6i_project_conv[0][0]
block6i_drop (FixedDropout)	(None, None, None, 3 0)	block6i_project_bn[0][0]
block6i_add (Add)	(None, None, None, 3 0)	block6i_drop[0][0]

## Segmentation\_models

block6h\_add[0][0]

block7a_expand_conv (Conv2D)	(None, None, None, 1 554496	block6i_add[0][0]
block7a_expand_bn (BatchNormali	(None, None, None, 1 7296	block7a_expand_conv[0][0]
block7a_expand_activation (Acti	(None, None, None, 1 0	block7a_expand_bn[0][0]
block7a_dwconv (DepthwiseConv2D	(None, None, None, 1 16416	block7a_expand_activation[0][0]
block7a_bn (BatchNormalizatio	(None, None, None, 1 7296	block7a_dwconv[0][0]
block7a_activation (Activation)	(None, None, None, 1 0	block7a_bn[0][0]
block7a_se_squeeze (GlobalAvera	(None, 1824) 0	block7a_activation[0][0]
block7a_se_reshape (Reshape)	(None, 1, 1, 1824) 0	block7a_se_squeeze[0][0]
block7a_se_reduce (Conv2D)	(None, 1, 1, 76) 138700	block7a_se_reshape[0][0]
block7a_se_expand (Conv2D)	(None, 1, 1, 1824) 140448	block7a_se_reduce[0][0]
block7a_se_excite (Multiply)	(None, None, None, 1 0	block7a_activation[0][0] block7a_se_expand[0][0]
block7a_project_conv (Conv2D)	(None, None, None, 5 933888	block7a_se_excite[0][0]
block7a_project_bn (BatchNormal	(None, None, None, 5 2048	block7a_project_conv[0][0]
block7b_expand_conv (Conv2D)	(None, None, None, 3 1572864	block7a_project_bn[0][0]
block7b_expand_bn (BatchNormali	(None, None, None, 3 12288	block7b_expand_conv[0][0]
block7b_expand_activation (Acti	(None, None, None, 3 0	block7b_expand_bn[0][0]
block7b_dwconv (DepthwiseConv2D	(None, None, None, 3 27648	block7b_expand_activation[0][0]
block7b_bn (BatchNormalizatio	(None, None, None, 3 12288	block7b_dwconv[0][0]
block7b_activation (Activation)	(None, None, None, 3 0	block7b_bn[0][0]
block7b_se_squeeze (GlobalAvera	(None, 3072) 0	block7b_activation[0][0]

block7b_se_reshape (Reshape)	(None, 1, 1, 3072)	0	block7b_se_squeeze[0][0]
block7b_se_reduce (Conv2D)	(None, 1, 1, 128)	393344	block7b_se_reshape[0][0]
block7b_se_expand (Conv2D)	(None, 1, 1, 3072)	396288	block7b_se_reduce[0][0]
block7b_se_excite (Multiply)	(None, None, None, 3 0		block7b_activation[0][0] block7b_se_expand[0][0]
block7b_project_conv (Conv2D)	(None, None, None, 5 1572864		block7b_se_excite[0][0]
block7b_project_bn (BatchNormal	(None, None, None, 5 2048		block7b_project_conv[0][0]
block7b_drop (FixedDropout)	(None, None, None, 5 0		block7b_project_bn[0][0]
block7b_add (Add)	(None, None, None, 5 0		block7b_drop[0][0] block7a_project_bn[0][0]
block7c_expand_conv (Conv2D)	(None, None, None, 3 1572864		block7b_add[0][0]
block7c_expand_bn (BatchNormali	(None, None, None, 3 12288		block7c_expand_conv[0][0]
block7c_expand_activation (Acti	(None, None, None, 3 0		block7c_expand_bn[0][0]
block7c_dwconv (DepthwiseConv2D	(None, None, None, 3 27648		block7c_expand_activation[0][0]
block7c_bn (BatchNormalizatio	(None, None, None, 3 12288		block7c_dwconv[0][0]
block7c_activation (Activation)	(None, None, None, 3 0		block7c_bn[0][0]
block7c_se_squeeze (GlobalAvera	(None, 3072)	0	block7c_activation[0][0]
block7c_se_reshape (Reshape)	(None, 1, 1, 3072)	0	block7c_se_squeeze[0][0]
block7c_se_reduce (Conv2D)	(None, 1, 1, 128)	393344	block7c_se_reshape[0][0]
block7c_se_expand (Conv2D)	(None, 1, 1, 3072)	396288	block7c_se_reduce[0][0]
block7c_se_excite (Multiply)	(None, None, None, 3 0		block7c_activation[0][0] block7c_se_expand[0][0]
block7c_project_conv (Conv2D)	(None, None, None, 5 1572864		block7c_se_excite[0][0]

block7c_project_bn (BatchNormal (None, None, None, 5 2048		block7c_project_conv[0][0]
block7c_drop (FixedDropout) (None, None, None, 5 0		block7c_project_bn[0][0]
block7c_add (Add) (None, None, None, 5 0		block7c_drop[0][0] block7b_add[0][0]
top_conv (Conv2D) (None, None, None, 2 1048576		block7c_add[0][0]
top_bn (BatchNormalization) (None, None, None, 2 8192		top_conv[0][0]
top_activation (Activation) (None, None, None, 2 0		top_bn[0][0]
decoder_stage0_upsampling (UpSa (None, None, None, 2 0		top_activation[0][0]
decoder_stage0_concat (Concaten (None, None, None, 3 0		decoder_stage0_upsampling[0][0] block6a_expand_activation[0][0]
decoder_stage0a_conv (Conv2D) (None, None, None, 2 7151616		decoder_stage0_concat[0][0]
decoder_stage0a_bn (BatchNormal (None, None, None, 2 1024		decoder_stage0a_conv[0][0]
decoder_stage0a_relu (Activatio (None, None, None, 2 0		decoder_stage0a_bn[0][0]
decoder_stage0b_conv (Conv2D) (None, None, None, 2 589824		decoder_stage0a_relu[0][0]
decoder_stage0b_bn (BatchNormal (None, None, None, 2 1024		decoder_stage0b_conv[0][0]
decoder_stage0b_relu (Activatio (None, None, None, 2 0		decoder_stage0b_bn[0][0]
decoder_stage1_upsampling (UpSa (None, None, None, 2 0		decoder_stage0b_relu[0][0]
decoder_stage1_concat (Concaten (None, None, None, 6 0		decoder_stage1_upsampling[0][0] block4a_expand_activation[0][0]
decoder_stage1a_conv (Conv2D) (None, None, None, 1 737280		decoder_stage1_concat[0][0]
decoder_stage1a_bn (BatchNormal (None, None, None, 1 512		decoder_stage1a_conv[0][0]
decoder_stage1a_relu (Activatio (None, None, None, 1 0		decoder_stage1a_bn[0][0]
decoder_stage1b_conv (Conv2D) (None, None, None, 1 147456		decoder_stage1a_relu[0][0]

decoder_stage1b_bn (BatchNormal (None, None, None, 1 512	decoder_stage1b_conv[0][0]
decoder_stage1b_relu (Activatio (None, None, None, 1 0	decoder_stage1b_bn[0][0]
decoder_stage2_upsampling (UpSa (None, None, None, 1 0	decoder_stage1b_relu[0][0]
decoder_stage2_concat (Concaten (None, None, None, 3 0	decoder_stage2_upsampling[0][0] block3a_expand_activation[0][0]
decoder_stage2a_conv (Conv2D) (None, None, None, 6 211968	decoder_stage2_concat[0][0]
decoder_stage2a_bn (BatchNormal (None, None, None, 6 256	decoder_stage2a_conv[0][0]
decoder_stage2a_relu (Activatio (None, None, None, 6 0	decoder_stage2a_bn[0][0]
decoder_stage2b_conv (Conv2D) (None, None, None, 6 36864	decoder_stage2a_relu[0][0]
decoder_stage2b_bn (BatchNormal (None, None, None, 6 256	decoder_stage2b_conv[0][0]
decoder_stage2b_relu (Activatio (None, None, None, 6 0	decoder_stage2b_bn[0][0]
decoder_stage3_upsampling (UpSa (None, None, None, 6 0	decoder_stage2b_relu[0][0]
decoder_stage3_concat (Concaten (None, None, None, 2 0	decoder_stage3_upsampling[0][0] block2a_expand_activation[0][0]
decoder_stage3a_conv (Conv2D) (None, None, None, 3 59904	decoder_stage3_concat[0][0]
decoder_stage3a_bn (BatchNormal (None, None, None, 3 128	decoder_stage3a_conv[0][0]
decoder_stage3a_relu (Activatio (None, None, None, 3 0	decoder_stage3a_bn[0][0]
decoder_stage3b_conv (Conv2D) (None, None, None, 3 9216	decoder_stage3a_relu[0][0]
decoder_stage3b_bn (BatchNormal (None, None, None, 3 128	decoder_stage3b_conv[0][0]
decoder_stage3b_relu (Activatio (None, None, None, 3 0	decoder_stage3b_bn[0][0]
decoder_stage4_upsampling (UpSa (None, None, None, 3 0	decoder_stage3b_relu[0][0]
decoder_stage4a_conv (Conv2D) (None, None, None, 1 4608	decoder_stage4_upsampling[0][0]
decoder_stage4a_bn (BatchNormal (None, None, None, 1 64	decoder_stage4a_conv[0][0]

decoder_stage4a_relu (Activation)	(None, None, None, 1 0	decoder_stage4a_bn[0][0]
decoder_stage4b_conv (Conv2D)	(None, None, None, 1 2304	decoder_stage4a_relu[0][0]
decoder_stage4b_bn (BatchNormal)	(None, None, None, 1 64	decoder_stage4b_conv[0][0]
decoder_stage4b_relu (Activation)	(None, None, None, 1 0	decoder_stage4b_bn[0][0]
final_conv (Conv2D)	(None, None, None, 1 145	decoder_stage4b_relu[0][0]
sigmoid (Activation)	(None, None, None, 1 0	final_conv[0][0]
=====		
Total params:	37,468,673	
Trainable params:	37,293,953	
Non-trainable params:	174,720	

## Defect\_1

```
In [ ]: train_batch=train_DataGenerator(train_1,shuffle=True,preprocess=preprocess)
valid_batch=test_DataGenerator(val_1,preprocess=preprocess)

log_dir=os.path.join("logs",datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard=tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1,write_graph=True,write_grads=True)

checkpoint_filepath='/content/drive//My Drive/Steel_Detection /segmentation_defect_1.h5'
model_checkpoint_callback=tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_filepath,monitor='val_dice_coef',mode='max',save_best_only=True)
#https://keras.io/api/metrics/
#https://keras.io/api/losses/probabilistic_losses/#categorical_crossentropy-function
model.compile(optimizer='adam',loss=bce_dice_loss,metrics=[dice_coef])
callback=[model_checkpoint_callback,tensorboard]
#https://datascience.stackexchange.com/questions/34444/what-is-the-difference-between-fit-and-fit-generator-in-keras
history=model.fit_generator(train_batch,validation_data=valid_batch,epochs=25,verbose=1,callback=callback)
```

```
WARNING:tensorflow: `write_grads` will be ignored in TensorFlow 2.0 for the `TensorBoard` Callback.  
Epoch 1/25  
161/161 [=====] - 401s 2s/step - loss: 0.7842 - dice_coef: 0.3252 - val_loss: 1.3187 - val_dice_coef: 0.2270  
Epoch 2/25  
161/161 [=====] - 309s 2s/step - loss: 0.4681 - dice_coef: 0.5726 - val_loss: 0.5883 - val_dice_coef: 0.4733  
Epoch 3/25  
161/161 [=====] - 308s 2s/step - loss: 0.4221 - dice_coef: 0.6153 - val_loss: 0.6416 - val_dice_coef: 0.4135  
Epoch 4/25  
161/161 [=====] - 308s 2s/step - loss: 0.4222 - dice_coef: 0.6143 - val_loss: 0.4695 - val_dice_coef: 0.5744  
Epoch 5/25  
161/161 [=====] - 309s 2s/step - loss: 0.3886 - dice_coef: 0.6466 - val_loss: 0.4617 - val_dice_coef: 0.5833  
Epoch 6/25  
161/161 [=====] - 309s 2s/step - loss: 0.3839 - dice_coef: 0.6495 - val_loss: 0.4399 - val_dice_coef: 0.5989  
Epoch 7/25  
161/161 [=====] - 308s 2s/step - loss: 0.3750 - dice_coef: 0.6586 - val_loss: 0.4763 - val_dice_coef: 0.5718  
Epoch 8/25  
161/161 [=====] - 308s 2s/step - loss: 0.3642 - dice_coef: 0.6682 - val_loss: 0.4522 - val_dice_coef: 0.5918  
Epoch 9/25  
161/161 [=====] - 309s 2s/step - loss: 0.3586 - dice_coef: 0.6736 - val_loss: 0.4515 - val_dice_coef: 0.5955  
Epoch 10/25  
161/161 [=====] - 308s 2s/step - loss: 0.3529 - dice_coef: 0.6785 - val_loss: 0.4785 - val_dice_coef: 0.5687  
Epoch 11/25  
161/161 [=====] - 308s 2s/step - loss: 0.3477 - dice_coef: 0.6826 - val_loss: 0.4635 - val_dice_coef: 0.5803  
Epoch 12/25  
161/161 [=====] - 309s 2s/step - loss: 0.3376 - dice_coef: 0.6933 - val_loss: 0.4660 - val_dice_coef: 0.5814  
Epoch 13/25  
161/161 [=====] - 309s 2s/step - loss: 0.3356 - dice_coef: 0.6941 - val_loss: 0.4462 - val_dice_coef: 0.5990  
Epoch 14/25  
161/161 [=====] - 308s 2s/step - loss: 0.3324 - dice_coef: 0.6974 - val_loss: 0.5267 - val_dice_coef: 0.5257  
Epoch 15/25  
161/161 [=====] - 308s 2s/step - loss: 0.3482 - dice_coef: 0.6822 - val_loss: 0.5011 - val_dice_coef: 0.5579  
Epoch 16/25  
161/161 [=====] - 308s 2s/step - loss: 0.3238 - dice_coef: 0.7049 - val_loss: 0.4368 - val_dice_coef: 0.6082  
Epoch 17/25  
161/161 [=====] - 309s 2s/step - loss: 0.3084 - dice_coef: 0.7196 - val_loss: 0.4526 - val_dice_coef: 0.5925  
Epoch 18/25  
161/161 [=====] - 308s 2s/step - loss: 0.3025 - dice_coef: 0.7247 - val_loss: 0.4444 - val_dice_coef: 0.5986  
Epoch 19/25  
161/161 [=====] - 308s 2s/step - loss: 0.2987 - dice_coef: 0.7278 - val_loss: 0.4328 - val_dice_coef: 0.6092  
Epoch 20/25  
161/161 [=====] - 309s 2s/step - loss: 0.3029 - dice_coef: 0.7242 - val_loss: 0.4771 - val_dice_coef: 0.5746  
Epoch 21/25  
161/161 [=====] - 308s 2s/step - loss: 0.3000 - dice_coef: 0.7269 - val_loss: 0.4800 - val_dice_coef: 0.5750
```

```
Epoch 22/25
161/161 [=====] - 308s 2s/step - loss: 0.2920 - dice_coef: 0.7346 - val_loss: 0.4475 - val_dice_coef: 0.5988
Epoch 23/25
161/161 [=====] - 310s 2s/step - loss: 0.2925 - dice_coef: 0.7342 - val_loss: 0.4296 - val_dice_coef: 0.6138
Epoch 24/25
161/161 [=====] - 309s 2s/step - loss: 0.2776 - dice_coef: 0.7470 - val_loss: 0.4658 - val_dice_coef: 0.5899
Epoch 25/25
161/161 [=====] - 309s 2s/step - loss: 0.2826 - dice_coef: 0.7429 - val_loss: 0.4810 - val_dice_coef: 0.5744
```

```
In [ ]: %tensorboard --logdir logs
```

```
In [ ]: print('Training Dataset:\n')
print(model.evaluate(test_DataGenerator(train_1, preprocess=preprocess), verbose=1))
print("=="*100)
print('\nValidation Dataset:\n')
print(model.evaluate(test_DataGenerator(val_1, preprocess=preprocess), verbose=1))
print("=="*100)
print('\nTest Dataset:\n')
print(model.evaluate(test_DataGenerator(test_1, preprocess=preprocess), verbose=1))
```

Training Dataset:

```
646/646 [=====] - 86s 133ms/step - loss: 0.4497 - dice_coef: 0.6004
[0.4497349858283996, 0.6004406809806824]
=====
```

Validation Dataset:

```
161/161 [=====] - 21s 132ms/step - loss: 0.4810 - dice_coef: 0.5744
[0.48095887899398804, 0.5743771195411682]
=====
```

Test Dataset:

```
90/90 [=====] - 24s 272ms/step - loss: 0.4949 - dice_coef: 0.5632
[0.4948919415473938, 0.563205361366272]
```

- For validation,test datasets loss increases and metrics decreases as compared with train data thus better to train model for more epochs (e.g. epoch =100) which might help to reduce loss and increase dice coefficient on unseen data.

```
In [ ]: def rle2mask(rle):  
    # CONVERT RLE TO MASK  
    if (pd.isnull(rle))|(rle=='')|(rle=='-1'):  
        return np.zeros((256,1600) ,dtype=np.uint8)  
  
    height= 256  
    width = 1600  
    mask= np.zeros( width*height ,dtype=np.uint8)  
  
    array = np.asarray([int(x) for x in rle.split()])  
    starts = array[0::2]-1  
    lengths = array[1::2]  
    for index, start in enumerate(starts):  
        mask[int(start):int(start+lengths[index])] = 1  
  
    return mask.reshape( (height,width), order='F' )
```

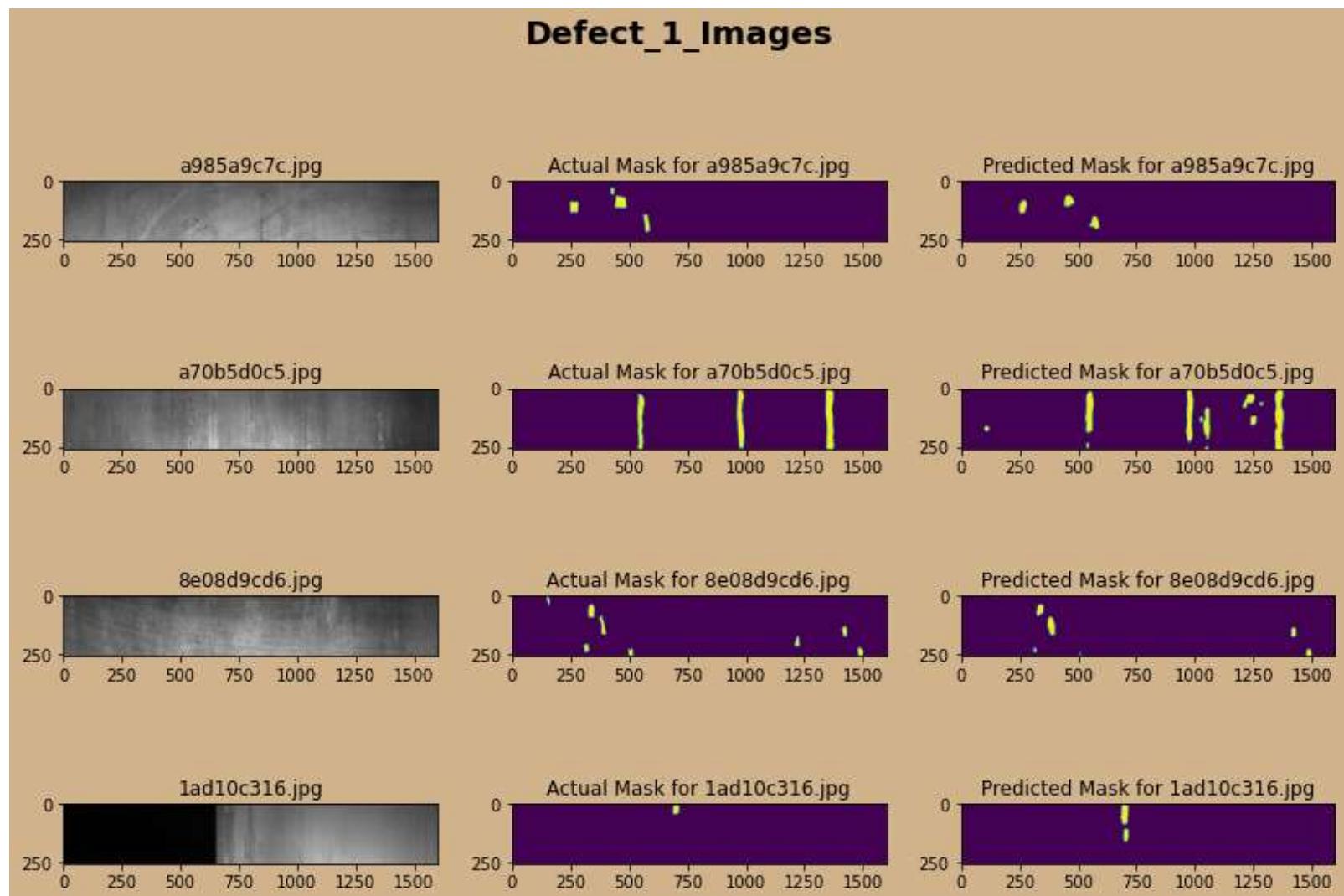
```
In [ ]: model=load_model('/content/drive//My Drive/Steel_Detection /segmentation_defect_1.h5',custom_objects={'bce_dice_loss':bce_dice_loss,'dice_coef':dice_coef})
```

```
In [ ]: def plot_mask(rle_defect,k,pred):
    train_folder_path='/content/drive//My Drive/Steel_Detection /train_images/'
    # Create figure and axes
    fig,ax=plt.subplots(4,3,figsize=(14,9))
    fig.suptitle('Defect_'+str(k)+'_Images',fontsize=20,fontweight='bold')
    for i in range(4):
        image_id=rle_defect[i][0]
        rle=rle_defect[i][1]
        im=Image.open(train_folder_path+str(image_id))
        ax[i,0].imshow(im)
        ax[i,0].set_title(image_id)
        mask=rle2mask(rle)
        ax[i,1].imshow(mask)
        ax[i,1].set_title("Actual Mask for "+str(image_id))
        c1=Image.fromarray(pred[i][:,:,0])
        ax[i,2].imshow(np.array(c1.resize((1600,256)))>0.5)
        ax[i,2].set_title("Predicted Mask for "+str(image_id))
    fig.set_facecolor("tan")
    plt.show()
```

## Train Dataset

```
In [ ]: train_preds=model.predict_generator(test_DataGenerator(train_1[10:14],preprocess=preprocess),verbose=1)
```

```
In [ ]: plot_mask(train_1[10:14].values,1,train_preds)
```

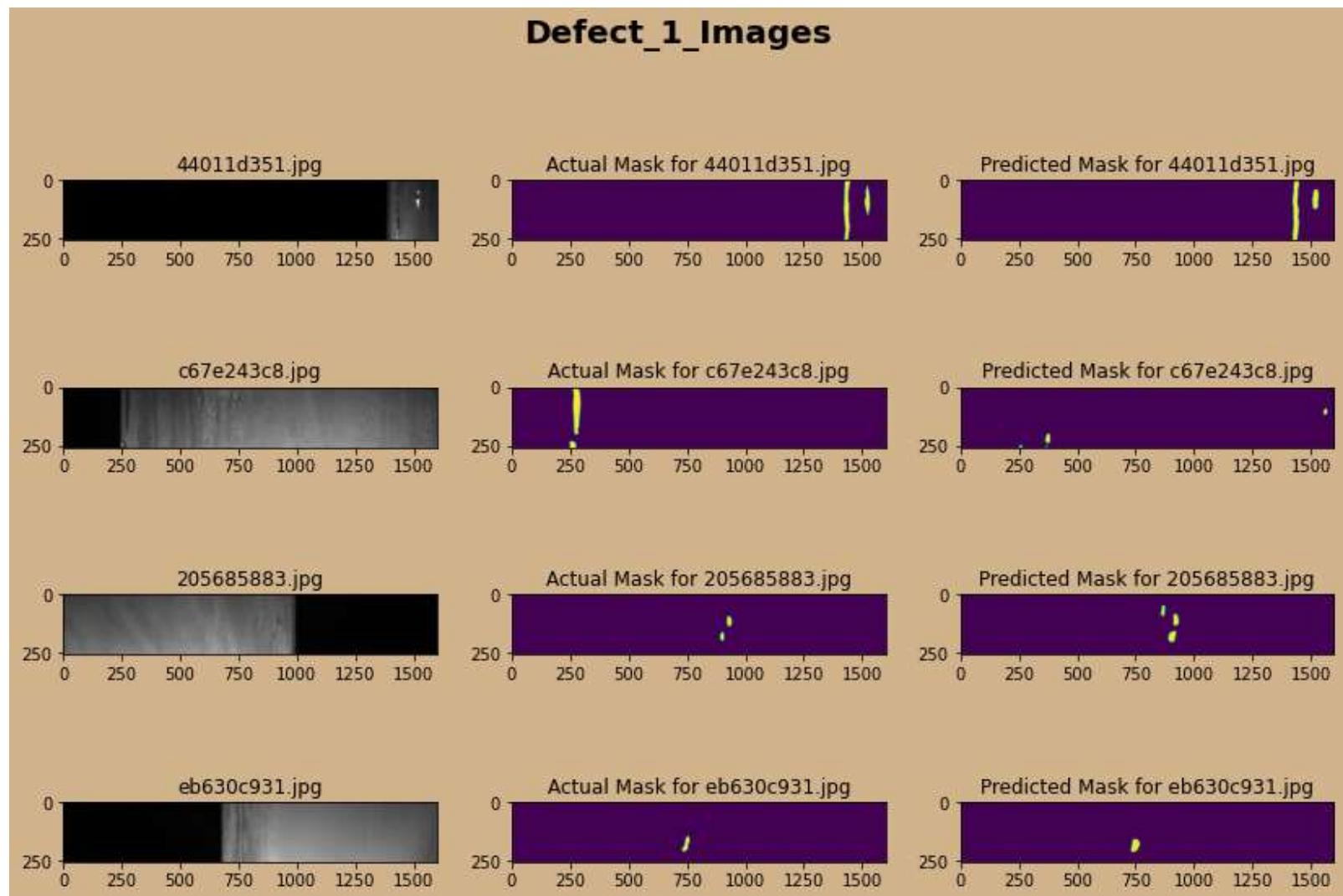


## Validation Dataset

```
In [ ]: val_preds=model.predict_generator(test_DataGenerator(val_1[10:14],preprocess=preprocess),verbose=1  
 )
```

```
4/4 [=====] - 2s 512ms/step
```

```
In [ ]: plot_mask(val_1[10:14].values,1,val_preds)
```

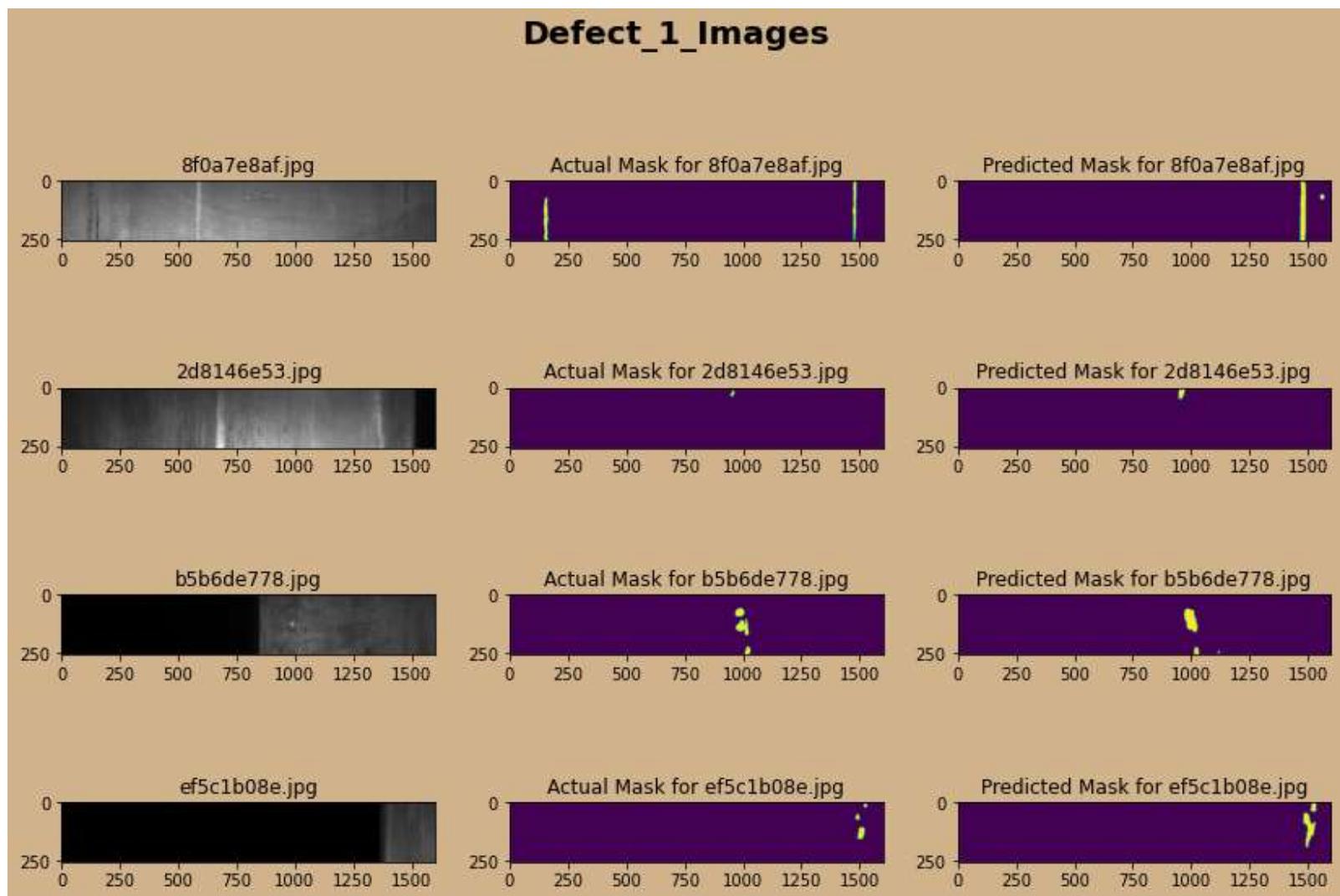


## Test Dataset

```
In [ ]: test_preds=model.predict_generator(test_DataGenerator(test_1[10:14],preprocess=preprocess),verbose=1)
```

```
4/4 [=====] - 2s 561ms/step
```

```
In [ ]: plot_mask(test_1[10:14].values,1,test_preds)
```



## Defect\_2

```
In [ ]: train_batch=train_DataGenerator(train_2,shuffle=True,preprocess=preprocess)
valid_batch=test_DataGenerator(val_2,preprocess=preprocess)

log_dir=os.path.join("logs",datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard=tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1,write_graph=True,write_grads=True)

checkpoint_filepath='/content/drive//My Drive/Steel_Detection /segmentation_defect_2.h5'
model_checkpoint_callback=tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_filepath,monitor='val_dice_coef',mode='max',save_best_only=True)
#https://keras.io/api/metrics/
#https://keras.io/api/losses/probabilistic_losses/#categorical_crossentropy-function
model.compile(optimizer='adam',loss=bce_dice_loss,metrics=[dice_coef])
callback=[model_checkpoint_callback,tensorboard]
#https://datascience.stackexchange.com/questions/34444/what-is-the-difference-between-fit-and-fit-generator-in-keras
history=model.fit_generator(train_batch,validation_data=valid_batch,epochs=25,verbose=1,callback=callback)
```

```
WARNING:tensorflow: `write_grads` will be ignored in TensorFlow 2.0 for the `TensorBoard` Callback.  
Epoch 1/25  
43/43 [=====] - 154s 3s/step - loss: 0.6302 - dice_coef: 0.4142 - val_loss: 0.6010 - val_dice_coef: 0.4476  
Epoch 2/25  
43/43 [=====] - 84s 2s/step - loss: 0.4300 - dice_coef: 0.6002 - val_loss: 0.4826 - val_dice_coef: 0.5500  
Epoch 3/25  
43/43 [=====] - 84s 2s/step - loss: 0.3890 - dice_coef: 0.6380 - val_loss: 0.4668 - val_dice_coef: 0.5685  
Epoch 4/25  
43/43 [=====] - 84s 2s/step - loss: 0.3637 - dice_coef: 0.6619 - val_loss: 0.5025 - val_dice_coef: 0.5352  
Epoch 5/25  
43/43 [=====] - 84s 2s/step - loss: 0.3514 - dice_coef: 0.6730 - val_loss: 0.4878 - val_dice_coef: 0.5491  
Epoch 6/25  
43/43 [=====] - 84s 2s/step - loss: 0.3548 - dice_coef: 0.6706 - val_loss: 0.4747 - val_dice_coef: 0.5576  
Epoch 7/25  
43/43 [=====] - 84s 2s/step - loss: 0.3529 - dice_coef: 0.6725 - val_loss: 0.4897 - val_dice_coef: 0.5503  
Epoch 8/25  
43/43 [=====] - 85s 2s/step - loss: 0.3321 - dice_coef: 0.6914 - val_loss: 0.4419 - val_dice_coef: 0.5894  
Epoch 9/25  
43/43 [=====] - 85s 2s/step - loss: 0.3270 - dice_coef: 0.6973 - val_loss: 0.4738 - val_dice_coef: 0.5662  
Epoch 10/25  
43/43 [=====] - 86s 2s/step - loss: 0.2962 - dice_coef: 0.7251 - val_loss: 0.4800 - val_dice_coef: 0.5515  
Epoch 11/25  
43/43 [=====] - 86s 2s/step - loss: 0.2969 - dice_coef: 0.7245 - val_loss: 0.4638 - val_dice_coef: 0.5685  
Epoch 12/25  
43/43 [=====] - 86s 2s/step - loss: 0.2879 - dice_coef: 0.7322 - val_loss: 0.4287 - val_dice_coef: 0.6001  
Epoch 13/25  
43/43 [=====] - 85s 2s/step - loss: 0.2846 - dice_coef: 0.7358 - val_loss: 0.4558 - val_dice_coef: 0.5744  
Epoch 14/25  
43/43 [=====] - 86s 2s/step - loss: 0.2749 - dice_coef: 0.7448 - val_loss: 0.4269 - val_dice_coef: 0.6017  
Epoch 15/25  
43/43 [=====] - 86s 2s/step - loss: 0.2726 - dice_coef: 0.7469 - val_loss: 0.5022 - val_dice_coef: 0.5291  
Epoch 16/25  
43/43 [=====] - 85s 2s/step - loss: 0.2917 - dice_coef: 0.7298 - val_loss: 0.5188 - val_dice_coef: 0.5154  
Epoch 17/25  
43/43 [=====] - 85s 2s/step - loss: 0.2748 - dice_coef: 0.7444 - val_loss: 0.6203 - val_dice_coef: 0.4208  
Epoch 18/25  
43/43 [=====] - 84s 2s/step - loss: 0.2825 - dice_coef: 0.7386 - val_loss: 0.4412 - val_dice_coef: 0.5929  
Epoch 19/25  
43/43 [=====] - 85s 2s/step - loss: 0.2609 - dice_coef: 0.7575 - val_loss: 0.4260 - val_dice_coef: 0.6026  
Epoch 20/25  
43/43 [=====] - 84s 2s/step - loss: 0.2568 - dice_coef: 0.7608 - val_loss: 0.4798 - val_dice_coef: 0.5542  
Epoch 21/25  
43/43 [=====] - 84s 2s/step - loss: 0.2732 - dice_coef: 0.7461 - val_loss: 0.4852 - val_dice_coef: 0.5533
```

```
Epoch 22/25
43/43 [=====] - 84s 2s/step - loss: 0.2412 - dice_coef: 0.7764 - val_loss: 0.4529 - val_dice_coef: 0.5828
Epoch 23/25
43/43 [=====] - 84s 2s/step - loss: 0.2365 - dice_coef: 0.7806 - val_loss: 0.4514 - val_dice_coef: 0.5848
Epoch 24/25
43/43 [=====] - 84s 2s/step - loss: 0.2372 - dice_coef: 0.7802 - val_loss: 0.4547 - val_dice_coef: 0.5797
Epoch 25/25
43/43 [=====] - 84s 2s/step - loss: 0.2396 - dice_coef: 0.7774 - val_loss: 0.4821 - val_dice_coef: 0.5545
```

```
In [ ]: %tensorboard --logdir logs
```

```
In [13]: model=load_model('/content/drive//My Drive/Steel_Detection /segmentation_defect_2.h5',custom_objects={'bce_dice_loss':bce_dice_loss,'dice_coef':dice_coef})
```

```
In [14]: print('Training Dataset:\n')
print(model.evaluate(test_DataGenerator(train_2,preprocess=preprocess),verbose=1))
print("=*100)
print('\nValidation Dataset:\n')
print(model.evaluate(test_DataGenerator(val_2,preprocess=preprocess),verbose=1))
print("=*100)
print('\nTest Dataset:\n')
print(model.evaluate(test_DataGenerator(test_2,preprocess=preprocess),verbose=1))
```

Training Dataset:

```
174/174 [=====] - 81s 271ms/step - loss: 0.4510 - dice_coef: 0.5829
[0.451008677482605, 0.5829356908798218]
=====
```

Validation Dataset:

```
50/50 [=====] - 13s 257ms/step - loss: 0.4260 - dice_coef: 0.6026
[0.4260036051273346, 0.6026241779327393]
=====
```

Test Dataset:

```
23/23 [=====] - 5s 237ms/step - loss: 0.3944 - dice_coef: 0.6390
[0.394377201795578, 0.6390075087547302]
```

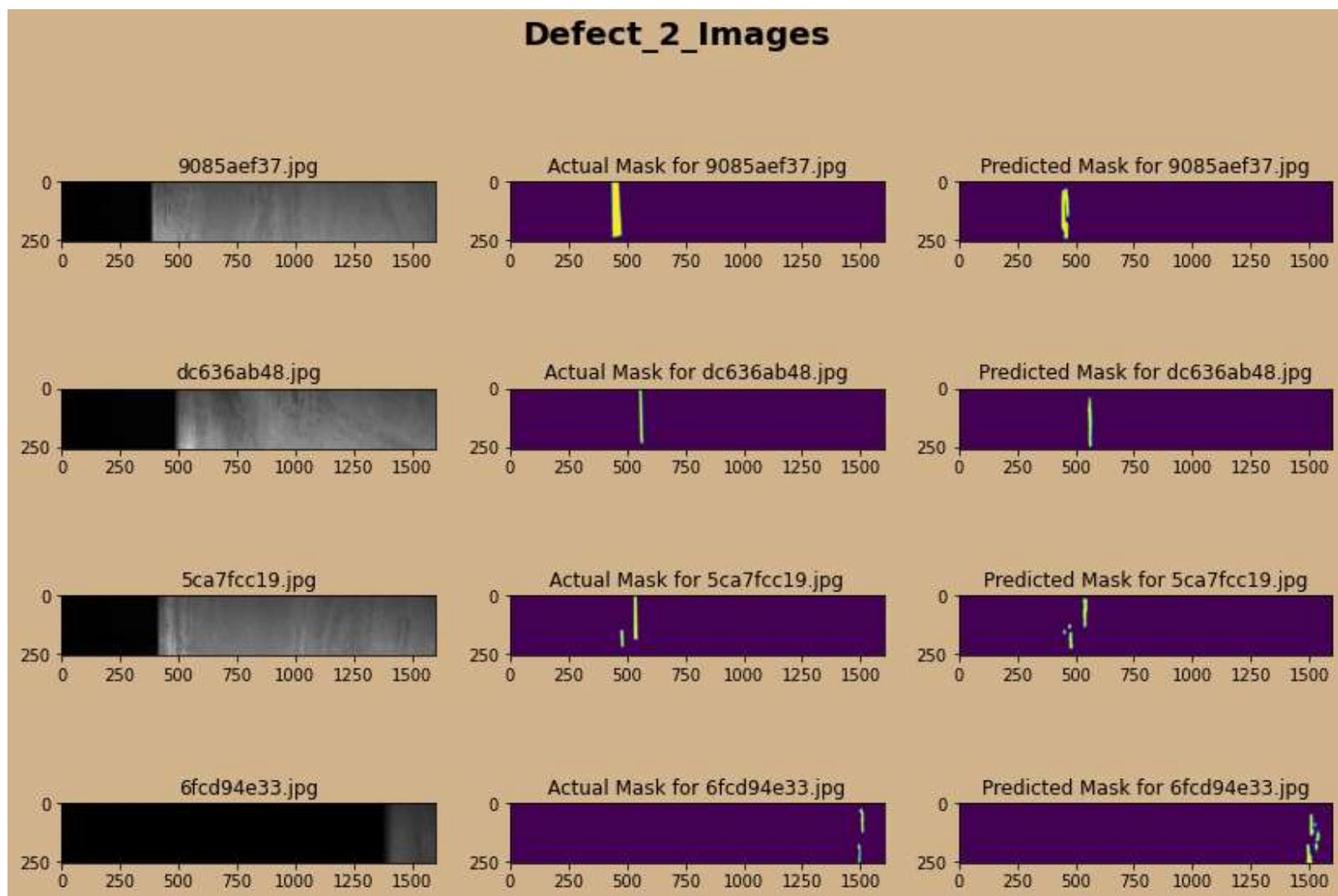
- One can observe the value of loss and metrics are similar for train, validation and test datasets thus the model is not over-fitting. On unseen data (test) dice coefficient increases and loss decreases as compared to train, validation datasets thus, model is performing really good.

## Training Dataset

```
In [ ]: train_preds=model.predict_generator(test_DataGenerator(train_2[10:14],preprocess=preprocess),verbose=1)
```

4/4 [=====] - 34s 137ms/step

```
In [ ]: plot_mask(train_2[10:14].values,2,train_preds)
```



# Validation Dataset

```
In [ ]: val_preds=model.predict_generator(test_DataGenerator(val_2[10:14],preprocess=preprocess),verbose=1  
)  
  
4/4 [=====] - 0s 122ms/step
```

```
In [ ]: plot_mask(val_2[10:14].values,2,val_preds)
```



## Test Dataset

```
In [ ]: test_preds=model.predict_generator(test_DataGenerator(test_2[10:14],preprocess=preprocess),verbose=1)
```

```
4/4 [=====] - 2s 510ms/step
```

```
In [ ]: plot_mask(test_2[10:14].values,2,test_preds)
```



## Defect 3

```
In [ ]: train_batch=train_DataGenerator(train_3,shuffle=True,preprocess=preprocess)
valid_batch=test_DataGenerator(val_3,preprocess=preprocess)

log_dir=os.path.join("logs",datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard=tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1,write_graph=True,write_grads=True)

checkpoint_filepath='/content/drive//My Drive/Steel_Detection /segmentation_defect_3.h5'
model_checkpoint_callback=tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_filepath,monitor='val_dice_coef',mode='max',save_best_only=True)
#https://keras.io/api/metrics/
#https://keras.io/api/losses/probabilistic_losses/#categorical_crossentropy-function
model.compile(optimizer='adam',loss=bce_dice_loss,metrics=[dice_coef])
callback=[model_checkpoint_callback,tensorboard]
#https://datascience.stackexchange.com/questions/34444/what-is-the-difference-between-fit-and-fit-generator-in-keras
history=model.fit_generator(train_batch,validation_data=valid_batch,epochs=6,verbose=1,callbacks=callback)
```

WARNING:tensorflow: `write\_grads` will be ignored in TensorFlow 2.0 for the `TensorBoard` Callback.  
Epoch 1/6  
928/928 [=====] - 1983s 2s/step - loss: 0.5785 - dice\_coef: 0.5818 - val\_loss: 0.5556 - val\_dice\_coef: 0.5866  
Epoch 2/6  
928/928 [=====] - 1790s 2s/step - loss: 0.4840 - dice\_coef: 0.6461 - val\_loss: 0.4853 - val\_dice\_coef: 0.6430  
Epoch 3/6  
928/928 [=====] - 1792s 2s/step - loss: 0.4603 - dice\_coef: 0.6598 - val\_loss: 0.5032 - val\_dice\_coef: 0.6305  
Epoch 4/6  
928/928 [=====] - 1792s 2s/step - loss: 0.4367 - dice\_coef: 0.6784 - val\_loss: 0.4792 - val\_dice\_coef: 0.6359  
Epoch 5/6  
928/928 [=====] - 1795s 2s/step - loss: 0.4259 - dice\_coef: 0.6861 - val\_loss: 0.4897 - val\_dice\_coef: 0.6297  
Epoch 6/6  
928/928 [=====] - 1795s 2s/step - loss: 0.4198 - dice\_coef: 0.6891 - val\_loss: 0.4793 - val\_dice\_coef: 0.6333

```
In [ ]: %tensorboard --logdir logs
```

```
In [10]: model=load_model('/content/drive//My Drive/Steel_Detection /segmentation_defect_3.h5',custom_objects={'bce_dice_loss':bce_dice_loss,'dice_coef':dice_coef})
```

```
In [13]: print('Training Dataset:\n')
print(model.evaluate(test_DataGenerator(train_3,preprocess=preprocess),verbose=1))
print("=*100)
print('\nValidation Dataset:\n')
print(model.evaluate(test_DataGenerator(val_3,preprocess=preprocess),verbose=1))
print("=*100)
print('\nTest Dataset:\n')
print(model.evaluate(test_DataGenerator(test_3,preprocess=preprocess),verbose=1))
```

Training Dataset:

```
3714/3714 [=====] - 1026s 267ms/step - loss: 0.4717 - dice_coef: 0.6475
[0.4716576039791107, 0.6474675536155701]
=====
```

Validation Dataset:

```
924/924 [=====] - 245s 266ms/step - loss: 0.4853 - dice_coef: 0.6430
[0.48533451557159424, 0.6430497765541077]
=====
```

Test Dataset:

```
512/512 [=====] - 130s 253ms/step - loss: 0.4731 - dice_coef: 0.6480
[0.47314369678497314, 0.6479683518409729]
=====
```

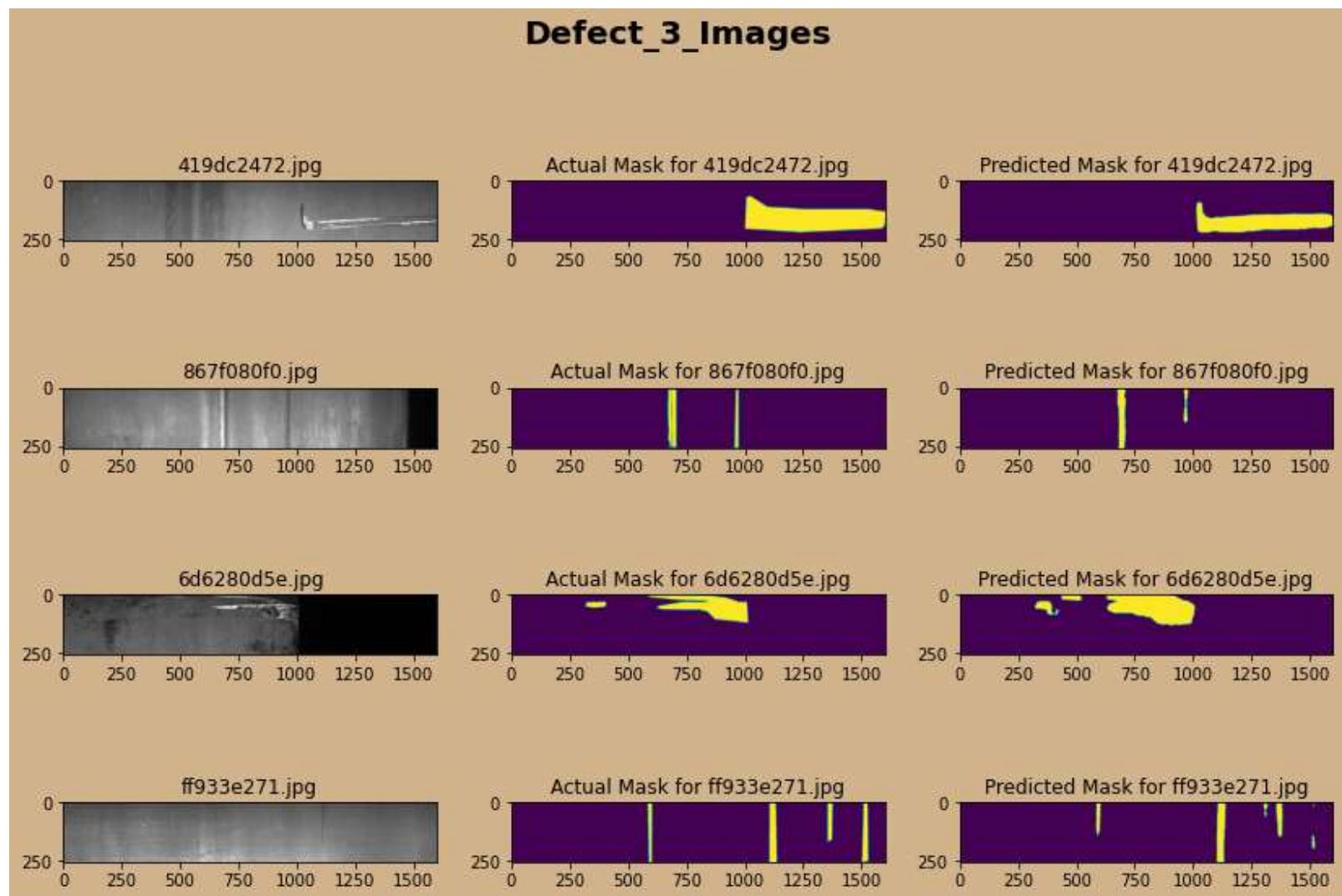
- One can observe the value of loss and metrics are similar for train, validation and test datasets thus the model is not over-fitting. On unseen data (test) dice coefficient slightly increases and loss decreases as compared to train, validation datasets thus, model is performing really good.

# Training Dataset

```
In [ ]: train_preds=model.predict_generator(test_DataGenerator(train_3[12:16],preprocess=preprocess),verbose=1)

4/4 [=====] - 1s 157ms/step
```

```
In [ ]: plot_mask(train_3[12:16].values,3,train_preds)
```

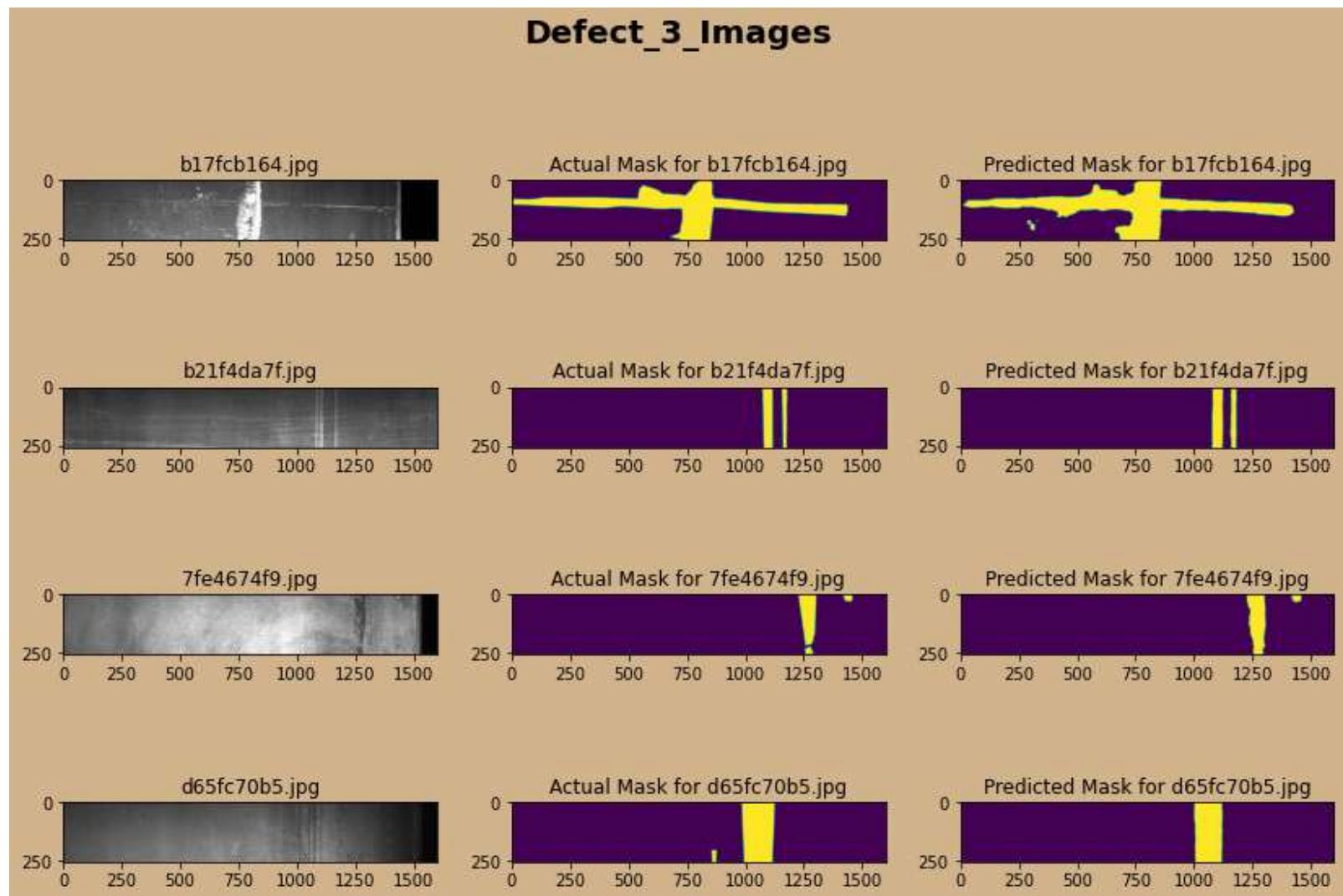


## Validation Dataset

```
In [ ]: val_preds=model.predict_generator(test_DataGenerator(val_3[12:16],preprocess=preprocess),verbose=1  
 )
```

```
4/4 [=====] - 1s 305ms/step
```

```
In [ ]: plot_mask(val_3[12:16].values,3,val_preds)
```



## Test Dataset

```
In [ ]: test_preds=model.predict_generator(test_DataGenerator(test_3[12:16],preprocess=preprocess),verbose=1)
```

```
4/4 [=====] - 1s 269ms/step
```

```
In [ ]: plot_mask(test_3[12:16].values,3,test_preds)
```



## Defect 4

```
In [ ]: train_batch=train_DataGenerator(train_4,shuffle=True,preprocess=preprocess)
valid_batch=test_DataGenerator(val_4,preprocess=preprocess)

log_dir=os.path.join("logs",datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard=tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1,write_graph=True,write_grads=True)

checkpoint_filepath='/content/drive//My Drive/Steel_Detection /segmentation_defect_4.h5'
model_checkpoint_callback=tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_filepath,monitor='val_dice_coef',mode='max',save_best_only=True)
#https://keras.io/api/metrics/
#https://keras.io/api/losses/probabilistic_losses/#categorical_crossentropy-function
model.compile(optimizer='adam',loss=bce_dice_loss,metrics=[dice_coef])
callback=[model_checkpoint_callback,tensorboard]
#https://datascience.stackexchange.com/questions/34444/what-is-the-difference-between-fit-and-fit-generator-in-keras
history=model.fit_generator(train_batch,validation_data=valid_batch,epochs=25,verbose=1,callback=callback)
```

```
WARNING:tensorflow: `write_grads` will be ignored in TensorFlow 2.0 for the `TensorBoard` Callback.  
Epoch 1/25  
145/145 [=====] - 338s 2s/step - loss: 0.5280 - dice_coef: 0.6319 - val_loss: 0.4988 - val_dice_coef: 0.6622  
Epoch 2/25  
145/145 [=====] - 277s 2s/step - loss: 0.4313 - dice_coef: 0.7002 - val_loss: 0.5453 - val_dice_coef: 0.6242  
Epoch 3/25  
145/145 [=====] - 277s 2s/step - loss: 0.4110 - dice_coef: 0.7147 - val_loss: 0.4497 - val_dice_coef: 0.6834  
Epoch 4/25  
145/145 [=====] - 277s 2s/step - loss: 0.3800 - dice_coef: 0.7364 - val_loss: 0.4400 - val_dice_coef: 0.6874  
Epoch 5/25  
145/145 [=====] - 277s 2s/step - loss: 0.3644 - dice_coef: 0.7500 - val_loss: 0.4514 - val_dice_coef: 0.6678  
Epoch 6/25  
145/145 [=====] - 277s 2s/step - loss: 0.3549 - dice_coef: 0.7582 - val_loss: 0.4386 - val_dice_coef: 0.7032  
Epoch 7/25  
145/145 [=====] - 277s 2s/step - loss: 0.3353 - dice_coef: 0.7679 - val_loss: 0.4277 - val_dice_coef: 0.6866  
Epoch 8/25  
145/145 [=====] - 277s 2s/step - loss: 0.3294 - dice_coef: 0.7742 - val_loss: 0.4577 - val_dice_coef: 0.6738  
Epoch 9/25  
145/145 [=====] - 276s 2s/step - loss: 0.3137 - dice_coef: 0.7842 - val_loss: 0.4610 - val_dice_coef: 0.6924  
Epoch 10/25  
145/145 [=====] - 277s 2s/step - loss: 0.3079 - dice_coef: 0.7865 - val_loss: 0.4030 - val_dice_coef: 0.7158  
Epoch 11/25  
145/145 [=====] - 277s 2s/step - loss: 0.2936 - dice_coef: 0.7979 - val_loss: 0.4311 - val_dice_coef: 0.7041  
Epoch 12/25  
145/145 [=====] - 277s 2s/step - loss: 0.2985 - dice_coef: 0.7918 - val_loss: 0.4219 - val_dice_coef: 0.7023  
Epoch 13/25  
145/145 [=====] - 276s 2s/step - loss: 0.2942 - dice_coef: 0.7954 - val_loss: 0.4282 - val_dice_coef: 0.7027  
Epoch 14/25  
145/145 [=====] - 277s 2s/step - loss: 0.2789 - dice_coef: 0.8079 - val_loss: 0.4295 - val_dice_coef: 0.7090  
Epoch 15/25  
145/145 [=====] - 276s 2s/step - loss: 0.2654 - dice_coef: 0.8164 - val_loss: 0.4170 - val_dice_coef: 0.7129  
Epoch 16/25  
145/145 [=====] - 276s 2s/step - loss: 0.2615 - dice_coef: 0.8205 - val_loss: 0.4289 - val_dice_coef: 0.7120  
Epoch 17/25  
145/145 [=====] - 276s 2s/step - loss: 0.2565 - dice_coef: 0.8234 - val_loss: 0.4403 - val_dice_coef: 0.6960  
Epoch 18/25  
145/145 [=====] - 276s 2s/step - loss: 0.2600 - dice_coef: 0.8199 - val_loss: 0.4720 - val_dice_coef: 0.6863  
Epoch 19/25  
145/145 [=====] - 276s 2s/step - loss: 0.2432 - dice_coef: 0.8318 - val_loss: 0.4625 - val_dice_coef: 0.7023  
Epoch 20/25  
145/145 [=====] - 277s 2s/step - loss: 0.2395 - dice_coef: 0.8353 - val_loss: 0.4342 - val_dice_coef: 0.7102  
Epoch 21/25  
145/145 [=====] - 277s 2s/step - loss: 0.2459 - dice_coef: 0.8297 - val_loss: 0.5085 - val_dice_coef: 0.6691
```

```
Epoch 22/25  
145/145 [=====] - 278s 2s/step - loss: 0.2289 - dice_coef: 0.8411 - val_loss: 0.4458 - val_dice_coef: 0.6881  
Epoch 23/25  
145/145 [=====] - 277s 2s/step - loss: 0.2354 - dice_coef: 0.8368 - val_loss: 0.4535 - val_dice_coef: 0.6974  
Epoch 24/25  
145/145 [=====] - 277s 2s/step - loss: 0.2322 - dice_coef: 0.8397 - val_loss: 0.4367 - val_dice_coef: 0.7121  
Epoch 25/25  
145/145 [=====] - 277s 2s/step - loss: 0.2297 - dice_coef: 0.8402 - val_loss: 0.4888 - val_dice_coef: 0.6799
```

```
In [ ]: %tensorboard --logdir logs
```

```
In [11]: model=load_model('/content/drive//My Drive/Steel_Detection /segmentation_defect_4.h5',custom_objects={'bce_dice_loss':bce_dice_loss,'dice_coef':dice_coef})
```

```
In [12]: print('Training Dataset:\n')
print(model.evaluate(test_DataGenerator(train_4, preprocess=preprocess), verbose=1))
print("=*100)
print('\nValidation Dataset:\n')
print(model.evaluate(test_DataGenerator(val_4, preprocess=preprocess), verbose=1))
print("=*100)
print('\nTest Dataset:\n')
print(model.evaluate(test_DataGenerator(test_4, preprocess=preprocess), verbose=1))
```

Training Dataset:

```
581/581 [=====] - 183s 256ms/step - loss: 0.4008 - dice_coef: 0.7202
[0.400820791721344, 0.7201958894729614]
=====
```

Validation Dataset:

```
142/142 [=====] - 36s 252ms/step - loss: 0.4030 - dice_coef: 0.7158
[0.40297946333885193, 0.7157671451568604]
=====
```

Test Dataset:

```
78/78 [=====] - 19s 248ms/step - loss: 0.4231 - dice_coef: 0.7077
[0.42307525873184204, 0.7077347636222839]
```

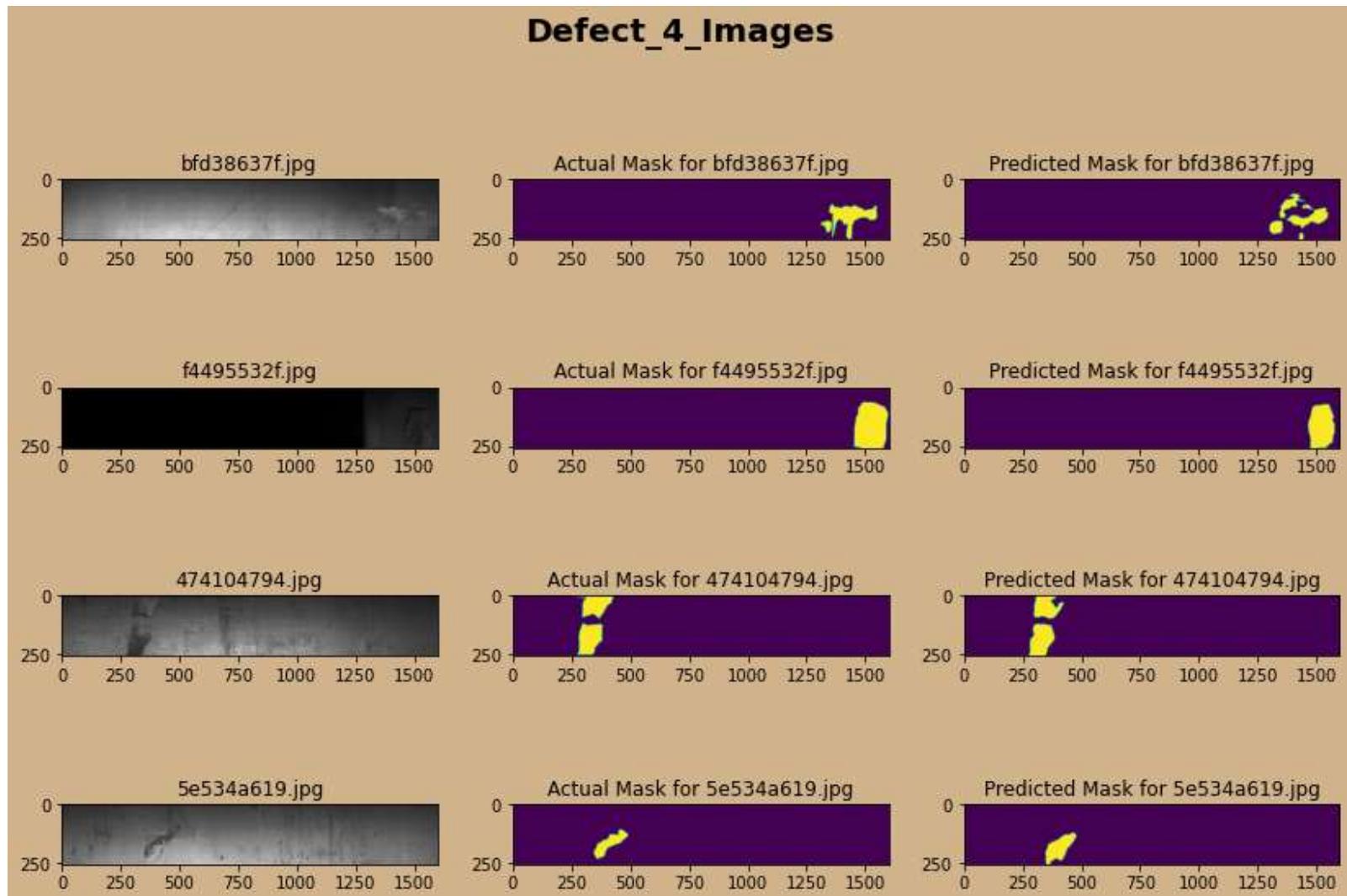
- For validation,test datasets loss slightly increases and metrics slightly decreases as compared with train data but overall values are similar thus model is not over-fitting. For better results on unseen data train model for more epochs (e.g. epoch =100) based on the available resources (memory).

## Training Dataset

```
In [ ]: train_preds=model.predict_generator(test_DataGenerator(train_4[14:18],preprocess=preprocess),verbose=1)
```

4/4 [=====] - 6s 1s/step

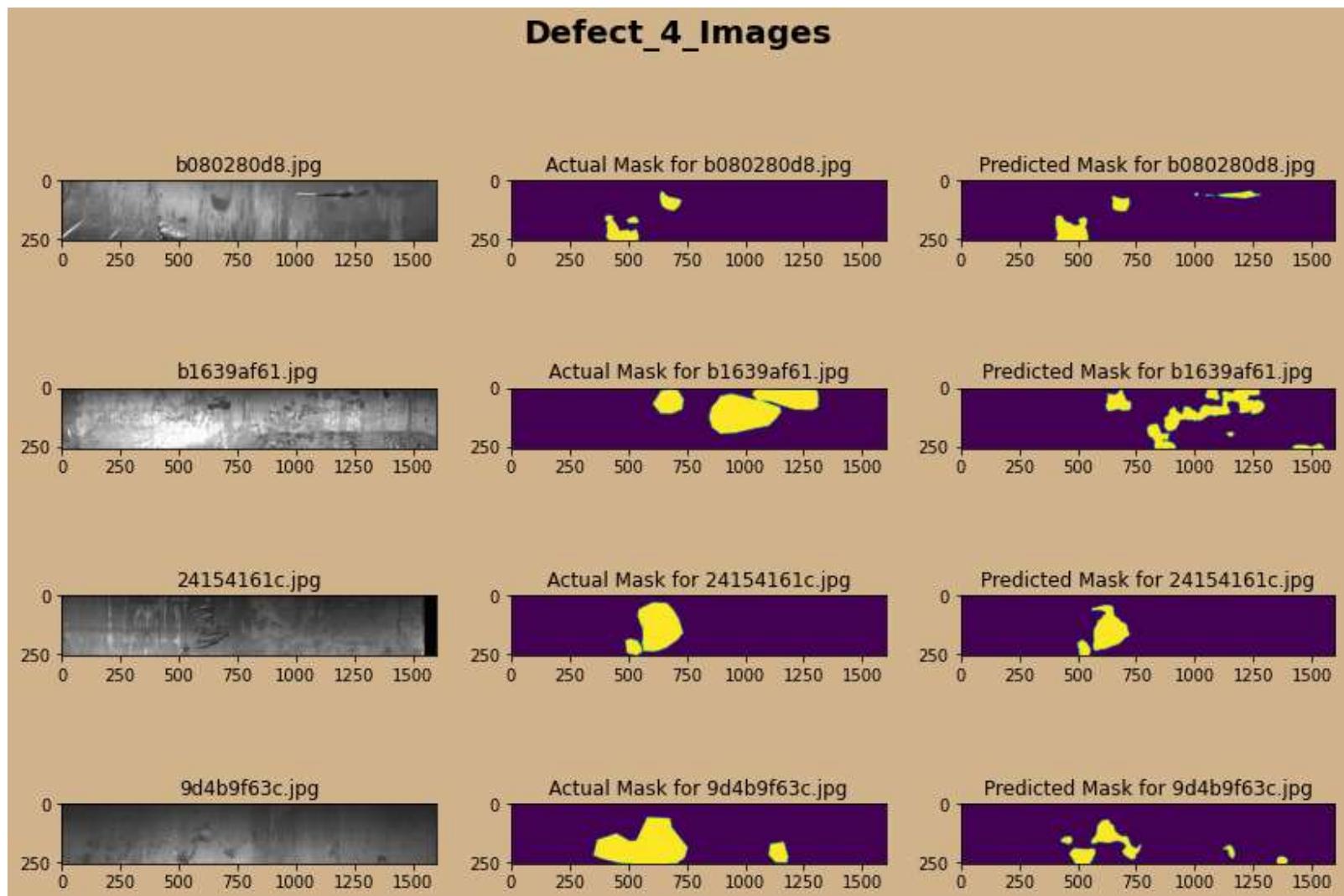
```
In [ ]: plot_mask(train_4[14:18].values,4,train_preds)
```



# Validation Dataset

```
In [ ]: val_preds=model.predict_generator(test_DataGenerator(val_4[14:18],preprocess=preprocess),verbose=1)
)
4/4 [=====] - 6s 1s/step
```

```
In [ ]: plot_mask(val_4[14:18].values,4,val_preds)
```

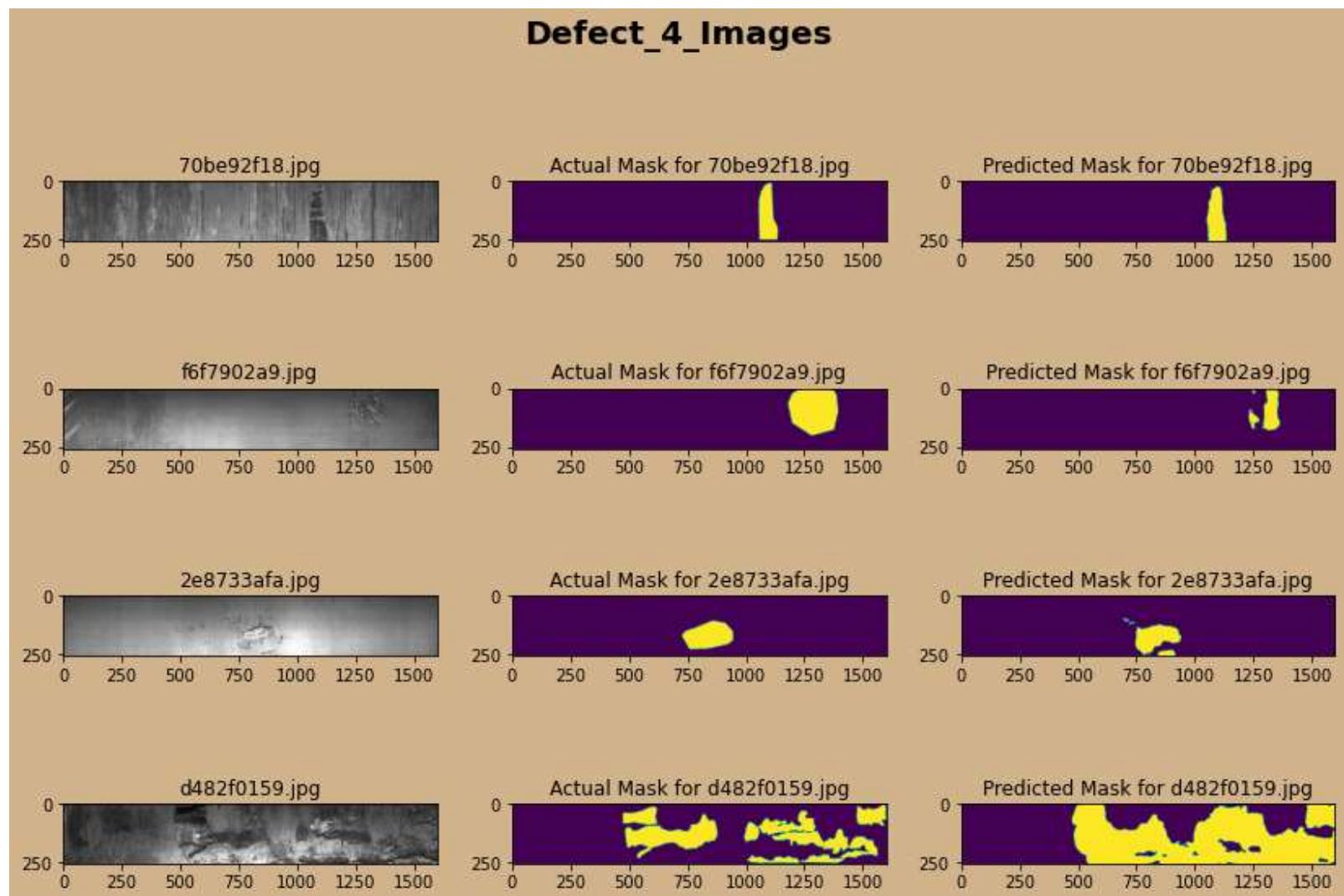


## Test Dataset

```
In [ ]: test_preds=model.predict_generator(test_DataGenerator(test_4[14:18],preprocess=preprocess),verbose=1)
```

```
4/4 [=====] - 6s 1s/step
```

```
In [ ]: plot_mask(test_4[14:18].values,4,test_preds)
```



```
In [ ]:
```

```
In [ ]:
```