For this problen we use Image Segmentation An image is a collection or set of different pixels. We group together the pixels that have similar attributes using image segmentation.. Thus, the task of image segmentation is to train a neural network to output a pixel-wise mask of the image. This helps in understanding the image at a much lower level.

for this problem we are going to use Semantic Segmentation U-Net model

https://scikit-image.org/docs/stable/user_guide/tutorial_segmentation.html

```
import numpy as np
import pandas as pd
import tensorflow as tf
from zipfile import ZipFile
import keras.backend as K
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
import os
```

```
train_zip = "/content/drive/MyDrive/DUTS-TR-Image.zip"
with ZipFile(train_zip, 'r') as zip_:
    zip_.extractall('content')
```

```
train_mask_zip = "/content/drive/MyDrive/DUTS-TR-Mask.zip"
with ZipFile(train_mask_zip, 'r') as zip_:
    zip_.extractall('content')
```

```
print("Image:  ", len(os.listdir("/content/content/DUTS-TR-Image")))
print("Masks:", len(os.listdir("/content/content/DUTS-TR-Mask")))
```

```
Image:   10553
Masks: 10553
```

```
from IPython.core.display import Image
image = []
paths = []
for dirname, _, filenames in os.walk('/content/content/DUTS-TR-Image'):
    for filename in filenames:
        path = os.path.join(dirname, filename)
        paths.append(path)

        image_id = filename.split(".")[0]
        image.append(image_id)

d = {"id": image, "image_path": paths}
```

```
df = pd.DataFrame(data = d)
df = df.set_index('id')
df.head()
```

	image_path
id	
ILSVRC2013_test_00008612	/content/content/DUTS-TR-Image/ILSVRC2013_test...
ILSVRC2014_train_00019927	/content/content/DUTS-TR-Image/ILSVRC2014_trai...
n07714571_1565	/content/content/DUTS-TR-Image/n07714571_1565.jpg
sun_acswpgpfdacoxzay	/content/content/DUTS-TR-Image/sun_acswpgpfdac...
n02701002_4128	/content/content/DUTS-TR-Image/n02701002_4128.jpg

```
from IPython.core.display import Image
image = []
mask_path = []
for dirname, _, filenames in os.walk('/content/content/DUTS-TR-Mask'):
    for filename in filenames:
        path = os.path.join(dirname, filename)
        mask_path.append(path)

        image_id = filename.split(".")[0]
        image_id = image_id.split("-Mask")[0]
        image.append(image_id)

d = {"id": image, "mask_path": mask_path}
mask_df = pd.DataFrame(data = d)
mask_df = mask_df.set_index('id')
mask_df.head()
```

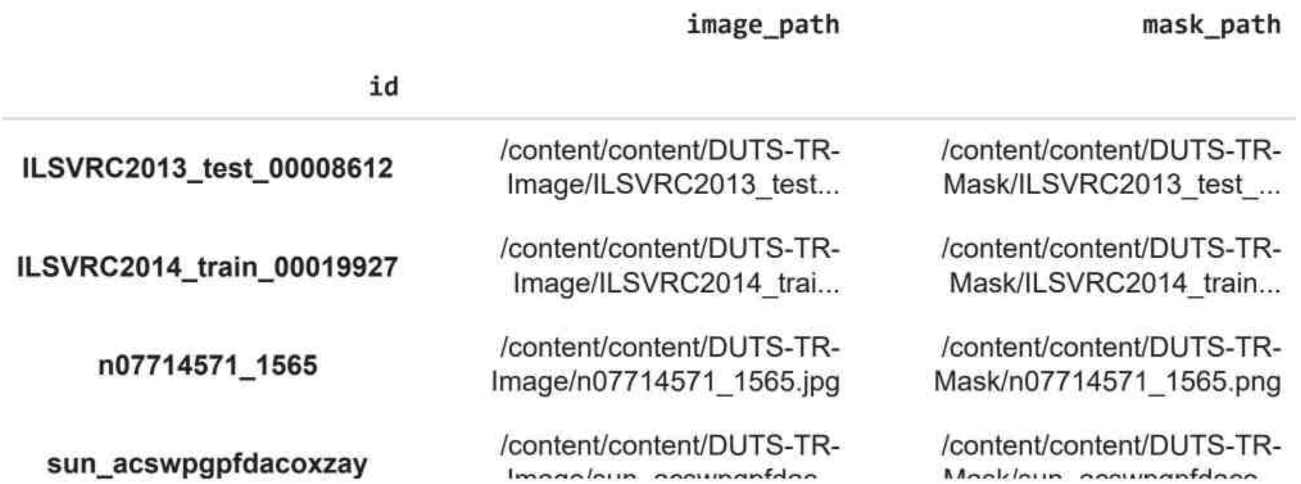
	mask_path
id	
n03775546_8657	/content/content/DUTS-TR-Mask/n03775546_8657.png
ILSVRC2012_test_00020037	/content/content/DUTS-TR-Mask/ILSVRC2012_test_...
ILSVRC2013_test_00007910	/content/content/DUTS-TR-Mask/ILSVRC2013_test_...
n07714571_17316	/content/content/DUTS-TR-Mask/n07714571_17316.png
n03710721_2131	/content/content/DUTS-TR-Mask/n03710721_2131.png

```
df["mask_path"] = mask_df["mask_path"]
df.head()
```

	image_path	mask_path
id		
ILSVRC2013_test_00008612	/content/content/DUTS-TR-Image/ILSVRC2013_test...	/content/content/DUTS-TR-Mask/ILSVRC2013_test_...
ILSVRC2014_train_00019927	/content/content/DUTS-TR-Image/ILSVRC2014_trai...	/content/content/DUTS-TR-Mask/ILSVRC2014_train...
n07714571_1565	/content/content/DUTS-TR-Image/n07714571_1565.jpg	/content/content/DUTS-TR-Mask/n07714571_1565.png
	Image/sun_acswpgpiuuc...	Mask/sun_acswpgpiuuc...

Now we usenormalize the image pixel in between 0 and 1.

```
img_size = [256,256]

def data_augmentation(img, mask_img):

    if tf.random.uniform(()) > 0.5:
        img = tf.image.flip_left_right(img)
        mask_img = tf.image.flip_left_right(mask_img)

    return img, mask_img

def preprocessing(image_path, mask_path):
    img = tf.io.read_file(image_path)
    img = tf.image.decode_jpeg(img, channels=3)
    img = tf.image.resize(img, img_size)
    img = tf.cast(img, tf.float32) / 255.0

    mask_img = tf.io.read_file(mask_path)
    mask_img = tf.image.decode_jpeg(mask_img, channels=3)
    mask_img = tf.image.resize(mask_img, img_size)
    mask_img = mask_img[:,:,:1]
    mask_img = tf.math.sign(mask_img)


    return img, mask_img

def create_dataset(df, train = False):
    if not train:
        ds = tf.data.Dataset.from_tensor_slices((df["image_path"].values, df["mask_path"].
        ds = ds.map(preprocessing, tf.data.AUTOTUNE)
    else:
        ds = tf.data.Dataset.from_tensor_slices((df["image_path"].values, df["mask_path"].
        ds = ds.map(preprocessing, tf.data.AUTOTUNE)
        ds = ds.map(data_augmentation, tf.data.AUTOTUNE)

    return ds


df.head()
```

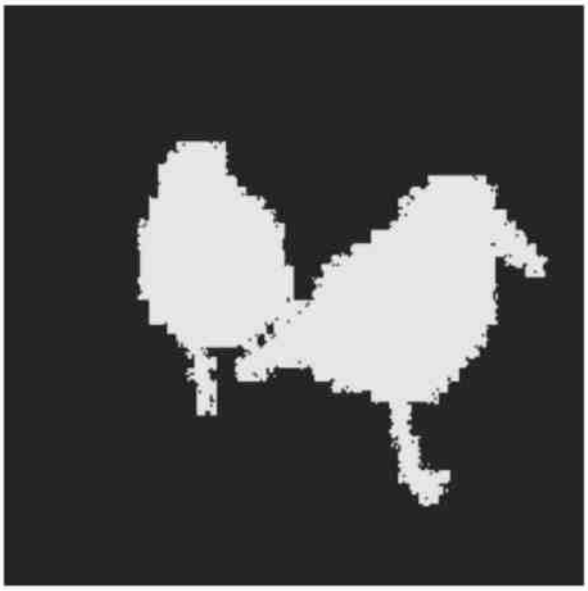


	image_path	mask_path
id		
ILSVRC2013_test_00008612	/content/content/DUTS-TR-Image/ILSVRC2013_test...	/content/content/DUTS-TR-Mask/ILSVRC2013_test_...
ILSVRC2014_train_00019927	/content/content/DUTS-TR-Image/ILSVRC2014_trai...	/content/content/DUTS-TR-Mask/ILSVRC2014_train...
n07714571_1565	/content/content/DUTS-TR-Image/n07714571_1565.jpg	/content/content/DUTS-TR-Mask/n07714571_1565.png
sun_acswpgpfdacoxzay	/content/content/DUTS-TR-	/content/content/DUTS-TR-

```
#Spliting dataset into train and test
train_df, valid_df = train_test_split(df, random_state=42, test_size=.25)
train = create_dataset(train_df, train = True)
valid = create_dataset(valid_df)


print(train_df.shape)
print(valid_df.shape)

    (7914, 2)
    (2639, 2)


TRAIN_LENGTH = len(train_df)
BATCH_SIZE = 16
BUFFER_SIZE = 1000


train_dataset = train.cache().shuffle(BUFFER_SIZE).batch(BATCH_SIZE).repeat()
train_dataset = train_dataset.prefetch(buffer_size=tf.data.AUTOTUNE)
valid_dataset = valid.batch(BATCH_SIZE)


def display(display_list):
    plt.figure(figsize=(15, 15))

    title = ['Input Image', 'True Mask', 'Predicted Mask']

    for i in range(len(display_list)):
        plt.subplot(1, len(display_list), i+1)
        plt.title(title[i])
        plt.imshow(tf.keras.preprocessing.image.array_to_img(display_list[i]))
        plt.axis('off')
    plt.show()


#show image corresponding to the mask
for i in range(5):
   for image, mask in train.take(i):
        sample_image, sample_mask = image, mask
        display([sample_image, sample_mask])
```

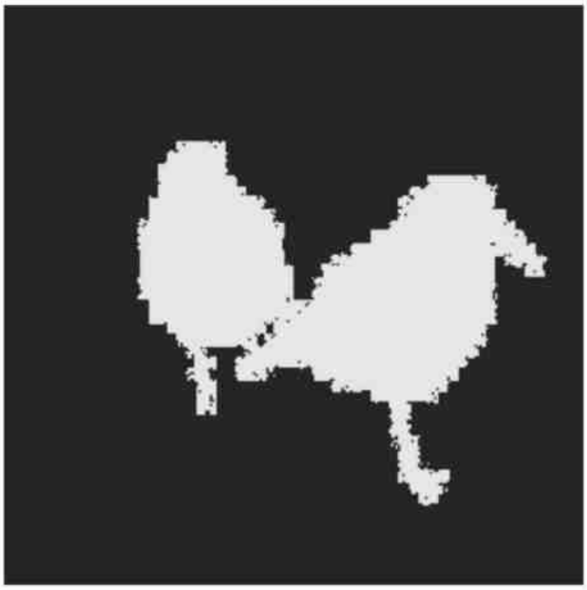
Input Image

True Mask



Input Image

True Mask



Input Image

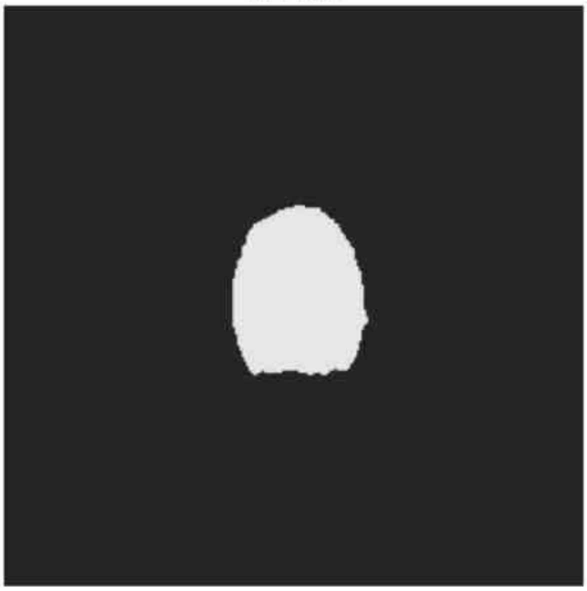
True Mask

Input Image

True Mask

Input Image

True Mask



Input Image

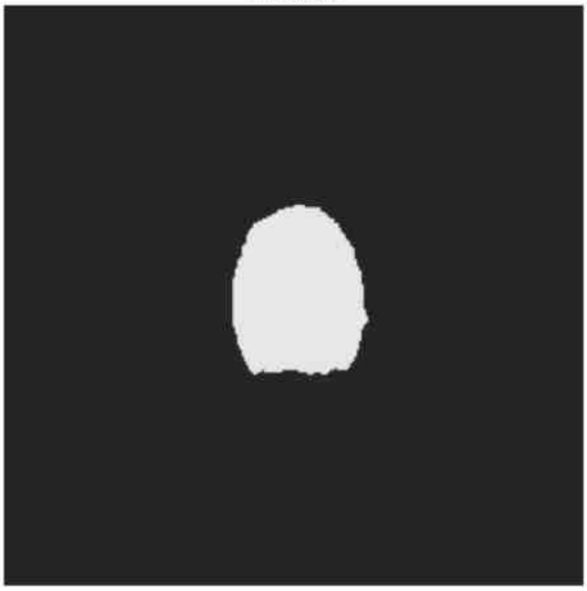
True Mask

Input Image

True Mask

Input Image

True Mask

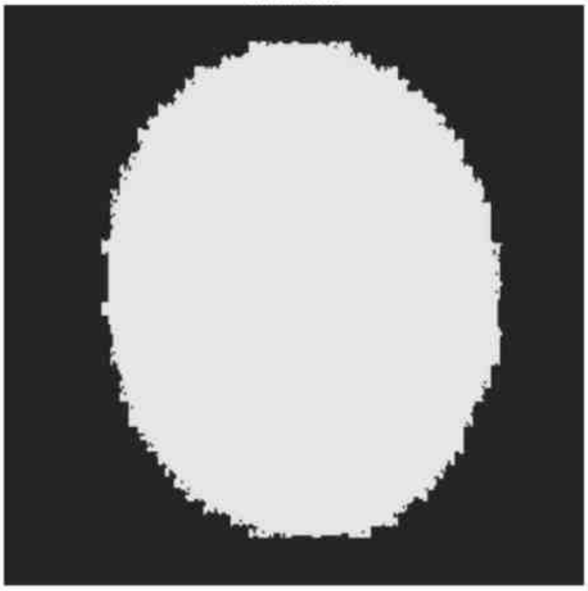


Input Image

True Mask

Input Image

True Mask



Paper:-https://blog.paperspace.com/unet-architecture-image-segmentation/

Explanation of U-net:-https://www.youtube.com/watch?v=yG6GbEtGUrU

Model--we are going to use U-Net model

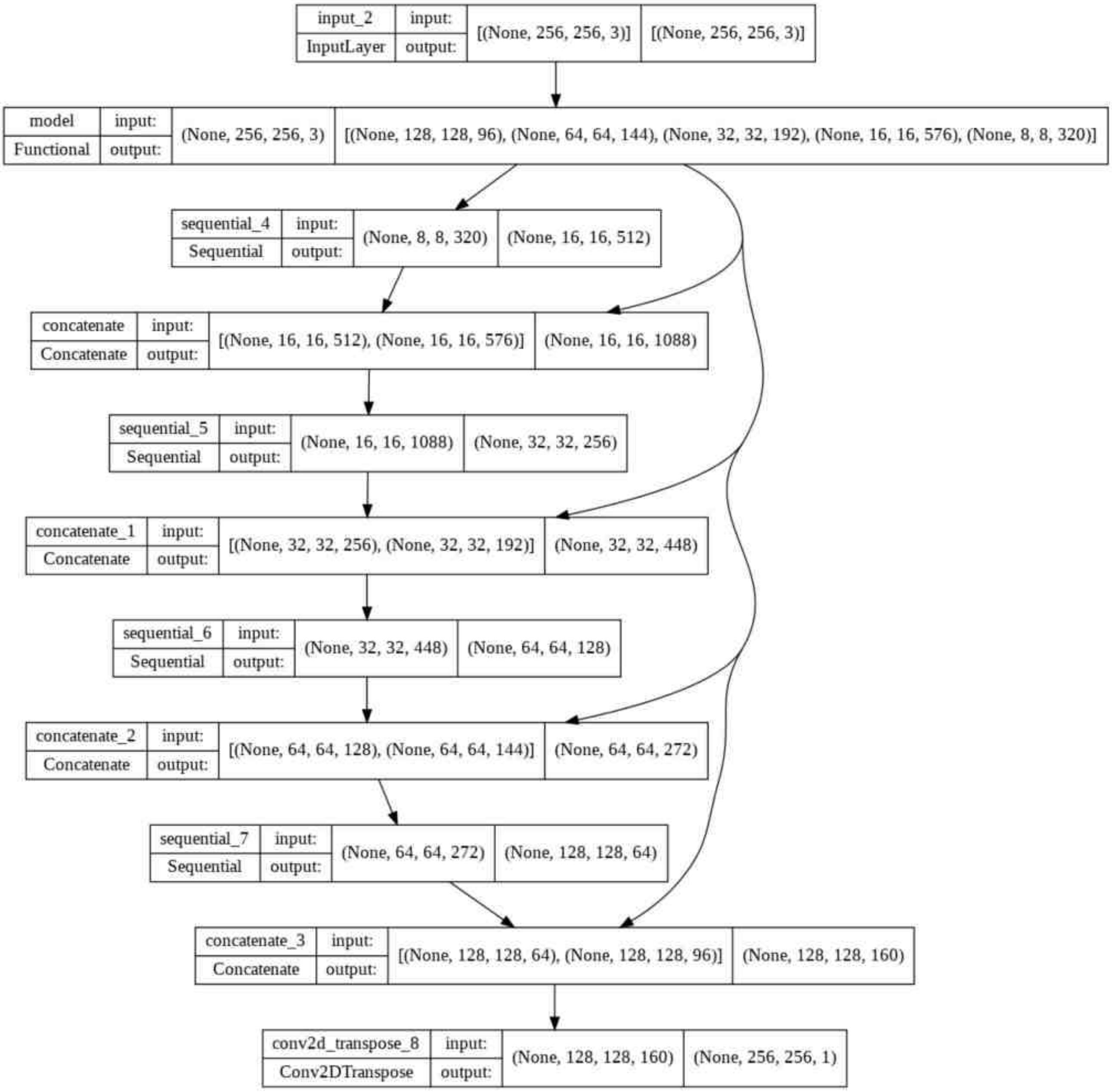
```
base_model = tf.keras.applications.MobileNetV2(input_shape=[256, 256, 3], include_top=Fals

# Use the activations of these layers
layer_names = [
    'block_1_expand_relu',   # 64x64
    'block_3_expand_relu',   # 32x32
    'block_6_expand_relu',   # 16x16
    'block_13_expand_relu',  # 8x8
    'block_16_project',      # 4x4
]
base_model_outputs = [base_model.get_layer(name).output for name in layer_names]

# Create the feature extraction model
down_stack = tf.keras.Model(inputs=base_model.input, outputs=base_model_outputs)
down_stack.trainable = False
```

```
WARNING:tensorflow:`input_shape` is undefined or non-square, or `rows` is not in [96
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/m
9412608/9406464 [==============================] - 0s 0us/step
9420800/9406464 [==============================] - 0s 0us/step
```

```
#use residual connection
def upsample(filters, size, norm_type='batchnorm', apply_dropout=False):
    initializer = tf.random_normal_initializer(0., 0.02)

    result = tf.keras.Sequential()
    result.add(
      tf.keras.layers.Conv2DTranspose(filters, size, strides=2,
                                      padding='same',
                                      kernel_initializer=initializer,
                                      use_bias=False))

    if norm_type.lower() == 'batchnorm':
        result.add(tf.keras.layers.BatchNormalization())
    elif norm_type.lower() == 'instancenorm':
        result.add(InstanceNormalization())

    if apply_dropout:
        result.add(tf.keras.layers.Dropout(0.5))

        result.add(tf.keras.layers.ReLU())
    return result

up_stack = [
    upsample(512, 3),  # 4x4 -> 8x8
    upsample(256, 3),  # 8x8 -> 16x16
    upsample(128, 3),  # 16x16 -> 32x32
    upsample(64, 3),   # 32x32 -> 64x64
]


#adding layerouts
def unet_model(output_channels):
    inputs = tf.keras.layers.Input(shape=[256, 256, 3])

    # Downsampling through the model
    skips = down_stack(inputs)
    x = skips[-1]
    skips = reversed(skips[:-1])

  # Upsampling and establishing the skip connections
    for up, skip in zip(up_stack, skips):
        x = up(x)
        concat = tf.keras.layers.Concatenate()
        x = concat([x, skip])

  # This is the last layer of the model
    last = tf.keras.layers.Conv2DTranspose(
      output_channels, 3, strides=2, activation='sigmoid',
      padding='same')  #64x64 -> 128x128

    x = last(x)

    return tf.keras.Model(inputs=inputs, outputs=x)
```

Now We are Train the Model

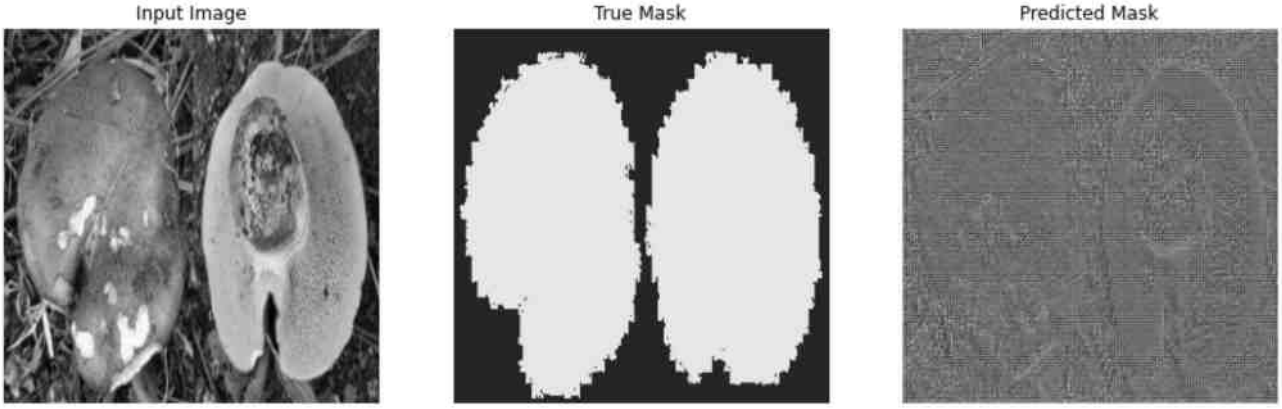
```
def dice_coef(y_true, y_pred, smooth=1):
    intersection = K.sum(y_true * y_pred, axis=[1,2,3])
    union = K.sum(y_true, axis=[1,2,3]) + K.sum(y_pred, axis=[1,2,3])
    return K.mean( (2. * intersection + smooth) / (union + smooth), axis=0)

def dice_loss(in_gt, in_pred):
    return 1-dice_coef(in_gt, in_pred)

model = unet_model(1)

model.compile(optimizer='adam',
              loss = dice_loss,
              metrics=[dice_coef,'binary_accuracy'])

tf.keras.utils.plot_model(model, show_shapes=True)
```


input_2 | InputLayer | input: | output: | [(None, 256, 256, 3)] | [(None, 256, 256, 3)]
model | Functional | input: | output: | (None, 256, 256, 3) | [(None, 128, 128, 96), (None, 64, 64, 144), (None, 32, 32, 192), (None, 16, 16, 576), (None, 8, 8, 320)]
sequential_4 | Sequential | input: | output: | (None, 8, 8, 320) | (None, 16, 16, 512)
concatenate | Concatenate | input: | output: | [(None, 16, 16, 512), (None, 16, 16, 576)] | (None, 16, 16, 1088)
sequential_5 | Sequential | input: | output: | (None, 16, 16, 1088) | (None, 32, 32, 256)
concatenate_1 | Concatenate | input: | output: | [(None, 32, 32, 256), (None, 32, 32, 192)] | (None, 32, 32, 448)
sequential_6 | Sequential | input: | output: | (None, 32, 32, 448) | (None, 64, 64, 128)
concatenate_2 | Concatenate | input: | output: | [(None, 64, 64, 128), (None, 64, 64, 144)] | (None, 64, 64, 272)
sequential_7 | Sequential | input: | output: | (None, 64, 64, 272) | (None, 128, 128, 64)
concatenate_3 | Concatenate | input: | output: | [(None, 128, 128, 64), (None, 128, 128, 96)] | (None, 128, 128, 160)
conv2d_transpose_8 | Conv2DTranspose | input: | output: | (None, 128, 128, 160) | (None, 256, 256, 1)

Let's try out the model to see what it predicts before training.

```
for images, masks in train_dataset.take(1):
    for img, mask in zip(images, masks):
```

```
for img, mask in zip(images, masks):
        sample_image = img
        sample_mask = mask
        break
def visualize(display_list):
    plt.figure(figsize=(15, 15))
    title = ['Input Image', 'True Mask', 'Predicted Mask']
    for i in range(len(display_list)):
        plt.subplot(1, len(display_list), i+1)
        plt.title(title[i])
        plt.imshow(tf.keras.preprocessing.image.array_to_img(display_list[i]))
        plt.axis('off')
    plt.show()

def show_predictions(sample_image, sample_mask):
    pred_mask = model.predict(sample_image[tf.newaxis, ...])
    pred_mask = pred_mask.reshape(img_size[0],img_size[1],1)
    visualize([sample_image, sample_mask, pred_mask])

show_predictions(sample_image, sample_mask)
```



```
model.summary()
```

```
 Model: "model_1"
 __________________________________________________________________________________________________
  Layer (type)                   Output Shape         Param #     Connected to
 ==================================================================================================
  input_2 (InputLayer)           [(None, 256, 256, 3  0           []
                                 )]

  model (Functional)             [(None, 128, 128, 9  1841984     ['input_2[0][0]']
                                 6),
                                  (None, 64, 64, 144
                                 ),
                                  (None, 32, 32, 192
                                 ),
                                  (None, 16, 16, 576
                                 ),
                                  (None, 8, 8, 320)]

  sequential_4 (Sequential)      (None, 16, 16, 512)  1476608     ['model[0][4]']
```