```
#I have done this assignment 4 on my own as I was not able to find a team partner for the prc
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#Roll No =200070051


import cv2
import pywt
from matplotlib import pyplot as plt
import numpy as np
from google.colab.patches import cv2_imshow
from skimage import exposure
from math import log10, sqrt
from scipy.ndimage.filters import gaussian_filter
#importing all the libraries required for different parts of questions
import os
import sys
import random
import tensorflow as tf
from tensorflow import keras


#code for question 1
from google.colab import drive
drive.mount('/content/drive')
```
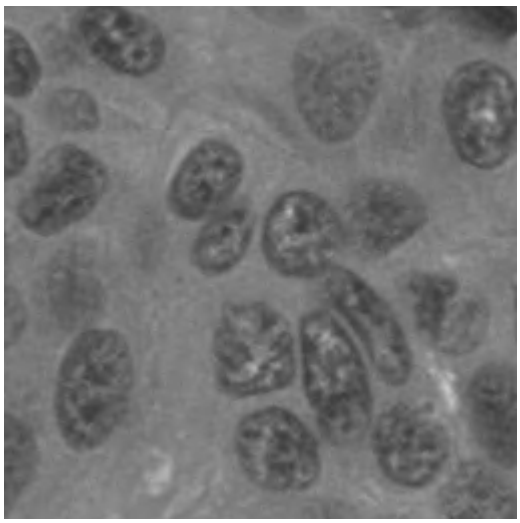

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mou
```

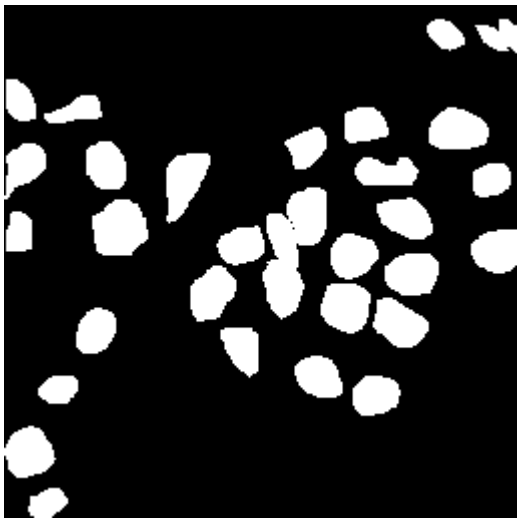
```
#code for question 1
import glob
path = "/content/drive/MyDrive/610_assignment_4/MoNuSeg-Training-Data/Binary-Mask/*.*"
y_bin_train=[]
for file in glob.glob(path):
   #print(file)
   a= cv2.imread(file,0)
   a=a[:256,:256]
   a.astype(np.float32)
   y_bin_train.append(a)
   #print(a)
y_bin_train=np.array(y_bin_train)
y_bin_train=np.expand_dims(y_bin_train,axis=3)
#refrence : https://stackoverflow.com/questions/51857468/google-colab-how-to-loop-through-ima


#code for question 1
path = "/content/drive/MyDrive/610_assignment_4/MoNuSeg-Test-Data/Binary-Mask/*.*"
y_bin_test=[]
for file in glob.glob(path):
   #print(file)
```

```
    a= cv2.imread(file,0)
    a=a[:256,:256]
    a.astype(np.float32)
    y_bin_test.append(a)
    #print(a)
y_bin_test=np.array(y_bin_test)
y_bin_test=np.expand_dims(y_bin_test,axis=3)


#code for question 1
path = "/content/drive/MyDrive/610_assignment_4/MoNuSeg-Training-Data/Tissue-Images/*.*"
x_tis_train=[]
for file in glob.glob(path):
    #print(file)
    a= cv2.imread(file,0)
    a=a[:256,:256]
    a.astype(np.float32)
    x_tis_train.append(a)
    #print(a)
x_tis_train=np.expand_dims(x_tis_train,axis=3)


#code for question 1
path = "/content/drive/MyDrive/610_assignment_4/MoNuSeg-Test-Data/Tissue-Images/*.*"
x_tis_test=[]
for file in glob.glob(path):
    #print(file)
    a= cv2.imread(file,0)
    a=a[:256,:256]
    a.astype(np.float32)
    x_tis_test.append(a)
    #print(a)
x_tis_test=np.array(x_tis_test)
x_tis_test=np.expand_dims(x_tis_test,axis=3)



cv2_imshow(y_bin_train[1])
```

```
#code for question 1
cv2_imshow(x_tis_train[0])
```



```
#code for question 1
cv2_imshow(y_bin_test[0])
```



```
#code for question 1
cv2_imshow(x_tis_test[0])
```

```
#code for question 2
def down_block(x, filters, kernel_size=(3, 3), padding="same", strides=1):
    c = keras.layers.Conv2D(filters, kernel_size, padding=padding, strides=strides, activatic
    c = keras.layers.Conv2D(filters, kernel_size, padding=padding, strides=strides, activatic
    p = keras.layers.MaxPool2D((2, 2), (2, 2))(c)
    return c, p

def up_block(x, skip, filters, kernel_size=(3, 3), padding="same", strides=1):
    us = keras.layers.UpSampling2D((2, 2))(x)
    concat = keras.layers.Concatenate()([us, skip])
    c = keras.layers.Conv2D(filters, kernel_size, padding=padding, strides=strides, activatic
    c = keras.layers.Conv2D(filters, kernel_size, padding=padding, strides=strides, activatic
    return c

def bottleneck(x, filters, kernel_size=(3, 3), padding="same", strides=1):
    c = keras.layers.Conv2D(filters, kernel_size, padding=padding, strides=strides, activatic
    c = keras.layers.Conv2D(filters, kernel_size, padding=padding, strides=strides, activatic
    return c
def UNet():
    f = [16, 32, 64, 128, 256]
    inputs = keras.layers.Input((256,256, 1))

    p0 = inputs
    c1, p1 = down_block(p0, f[0]) #128 -> 64
    c2, p2 = down_block(p1, f[1]) #64 -> 32
    c3, p3 = down_block(p2, f[2]) #32 -> 16
    c4, p4 = down_block(p3, f[3]) #16->8

    bn = bottleneck(p4, f[4])

    u1 = up_block(bn, c4, f[3]) #8 -> 16
    u2 = up_block(u1, c3, f[2]) #16 -> 32
    u3 = up_block(u2, c2, f[1]) #32 -> 64
    u4 = up_block(u3, c1, f[0]) #64 -> 128

    outputs = keras.layers.Conv2D(1, (1, 1), padding="same", activation="sigmoid")(u4)
    model = keras.models.Model(inputs, outputs)
    return model
#refrence·:·https://github.com/nikhilroxtomar/UNet-Segmentation-in-Keras-TensorFlow
#the github link was given in the description of the youtube video provided in ms teams for r


#code for question 2
print(x_tis_train.max())
print(x_tis_test.max())
print(np.unique(y_bin_train))
```

```
print(np.unique(y_bin_test))
#getting maximum size
```

```
255
249
[  0 255]
[  0 255]
```

```
#code for question 2
x_tis_train= x_tis_train/255
x_tis_test= x_tis_test/249
# Scaling the masks from 0 to 1
y_bin_train= y_bin_train/255
y_bin_test= y_bin_test/255
# for normalization


#code for question 2
model = UNet()
model.compile(optimizer="adam", loss="binary_crossentropy", metrics=["acc"])
model.summary()
#refrence : https://github.com/nikhilroxtomar/UNet-Segmentation-in-Keras-TensorFlow
```

```
conv2d_179 (Conv2D)            (None, 16, 16, 256)  295168      ['max_pooling2d_39[

conv2d_180 (Conv2D)            (None, 16, 16, 256)  590080      ['conv2d_179[0][0]'

up_sampling2d_36 (UpSampling2D  (None, 32, 32, 256)  0          ['conv2d_180[0][0]'
)

concatenate_36 (Concatenate)   (None, 32, 32, 384)  0          ['up_sampling2d_36[
                                                                 'conv2d_178[0][0]'

conv2d_181 (Conv2D)            (None, 32, 32, 128)  442496      ['concatenate_36[0]

conv2d_182 (Conv2D)            (None, 32, 32, 128)  147584      ['conv2d_181[0][0]'

up_sampling2d_37 (UpSampling2D  (None, 64, 64, 128)  0          ['conv2d_182[0][0]'
)

concatenate_37 (Concatenate)   (None, 64, 64, 192)  0          ['up_sampling2d_37[
                                                                 'conv2d_176[0][0]'

conv2d_183 (Conv2D)            (None, 64, 64, 64)   110656      ['concatenate_37[0]

conv2d_184 (Conv2D)            (None, 64, 64, 64)   36928       ['conv2d_183[0][0]'

up_sampling2d_38 (UpSampling2D  (None, 128, 128, 64  0          ['conv2d_184[0][0]'
)                               )

concatenate_38 (Concatenate)   (None, 128, 128, 96  0          ['up_sampling2d_38[
                               )                                 'conv2d_174[0][0]'

conv2d_185 (Conv2D)            (None, 128, 128, 32  27680       ['concatenate_38[0]
                               )
```

```
 conv2d_186 (Conv2D)            (None, 128, 128, 32  9248        ['conv2d_185[0][0]'
                                )

 up_sampling2d_39 (UpSampling2D  (None, 256, 256, 32  0          ['conv2d_186[0][0]'
 )                              )

 concatenate_39 (Concatenate)   (None, 256, 256, 48  0           ['up_sampling2d_39[
                                )                                 'conv2d_172[0][0]'

 conv2d_187 (Conv2D)            (None, 256, 256, 16  6928        ['concatenate_39[0]
                                )

 conv2d_188 (Conv2D)            (None, 256, 256, 16  2320        ['conv2d_187[0][0]'
                                )

 conv2d_189 (Conv2D)            (None, 256, 256, 1)  17          ['conv2d_188[0][0]'

==================================================================================
Total params: 1,962,337
Trainable params: 1,962,337
Non-trainable params: 0
__________________________________________________________________________________
```

```
print(np.shape(x_tis_train))
```

```
(24, 256, 256, 1)
```

```
print(np.shape(y_bin_train))
```

```
(24, 256, 256, 1)
```

```
#code for question 3
from sklearn.model_selection import train_test_split
x_tis_train, x_tis_valid, y_bin_train, y_bin_valid = train_test_split(x_tis_train,y_bin_trair


#code for question 3
def dice_score(y_bin_test,y_predict,smooth=1e-5):
  #y_predict=y_predict.astype(np.unit8)
  intersection=tf.reduce_sum(y_bin_test*y_predict)
  return (2.*intersection+smooth)/(tf.reduce_sum(tf.square(y_bin_test))+tf.reduce_sum(tf.squa
def dice_loss(y_bin_test,y_predict):
  return 1-dice_score(y_bin_test,y_predict)
model.compile(optimizer=tf.keras.optimizers.SGD(learning_rate=0.01),loss=dice_loss,metrics=['
#refrence https://github.com/keras-team/keras/issues/3611


#code for question 3
#fitting the model
a=model.fit(x_tis_train,y_bin_train,batch_size=1,verbose=1,epochs=30,validation_data=(x_tis_v
```

```
Epoch 1/30
19/19 [==============================] - 22s 1s/step - loss: 0.4770 - accuracy: 0.58
Epoch 2/30
19/19 [==============================] - 17s 917ms/step - loss: 0.4767 - accuracy: 0
Epoch 3/30
19/19 [==============================] - 17s 918ms/step - loss: 0.4765 - accuracy: 0
Epoch 4/30
19/19 [==============================] - 19s 1s/step - loss: 0.4764 - accuracy: 0.60
Epoch 5/30
19/19 [==============================] - 17s 922ms/step - loss: 0.4762 - accuracy: 0
Epoch 6/30
19/19 [==============================] - 17s 912ms/step - loss: 0.4761 - accuracy: 0
Epoch 7/30
19/19 [==============================] - 17s 919ms/step - loss: 0.4760 - accuracy: 0
Epoch 8/30
19/19 [==============================] - 20s 1s/step - loss: 0.4759 - accuracy: 0.60
Epoch 9/30
19/19 [==============================] - 17s 917ms/step - loss: 0.4758 - accuracy: 0
Epoch 10/30
19/19 [==============================] - 17s 910ms/step - loss: 0.4757 - accuracy: 0
Epoch 11/30
19/19 [==============================] - 20s 1s/step - loss: 0.4756 - accuracy: 0.60
Epoch 12/30
19/19 [==============================] - 17s 910ms/step - loss: 0.4755 - accuracy: 0
Epoch 13/30
19/19 [==============================] - 17s 907ms/step - loss: 0.4754 - accuracy: 0
Epoch 14/30
19/19 [==============================] - 18s 928ms/step - loss: 0.4753 - accuracy: 0
Epoch 15/30
19/19 [==============================] - 19s 1s/step - loss: 0.4752 - accuracy: 0.60
Epoch 16/30
19/19 [==============================] - 17s 910ms/step - loss: 0.4751 - accuracy: 0
Epoch 17/30
19/19 [==============================] - 17s 912ms/step - loss: 0.4750 - accuracy: 0
Epoch 18/30
19/19 [==============================] - 19s 1s/step - loss: 0.4749 - accuracy: 0.60
Epoch 19/30
19/19 [==============================] - 17s 911ms/step - loss: 0.4748 - accuracy: 0
Epoch 20/30
19/19 [==============================] - 20s 1s/step - loss: 0.4747 - accuracy: 0.60
Epoch 21/30
19/19 [==============================] - 34s 2s/step - loss: 0.4746 - accuracy: 0.60
Epoch 22/30
19/19 [==============================] - 17s 920ms/step - loss: 0.4746 - accuracy: 0
Epoch 23/30
19/19 [==============================] - 19s 1s/step - loss: 0.4745 - accuracy: 0.60
Epoch 24/30
19/19 [==============================] - 18s 936ms/step - loss: 0.4744 - accuracy: 0
Epoch 25/30
19/19 [==============================] - 19s 972ms/step - loss: 0.4744 - accuracy: 0
Epoch 26/30
19/19 [==============================] - 19s 984ms/step - loss: 0.4743 - accuracy: 0
Epoch 27/30
19/19 [==============================] - 17s 904ms/step - loss: 0.4742 - accuracy: 0
Epoch 28/30
```

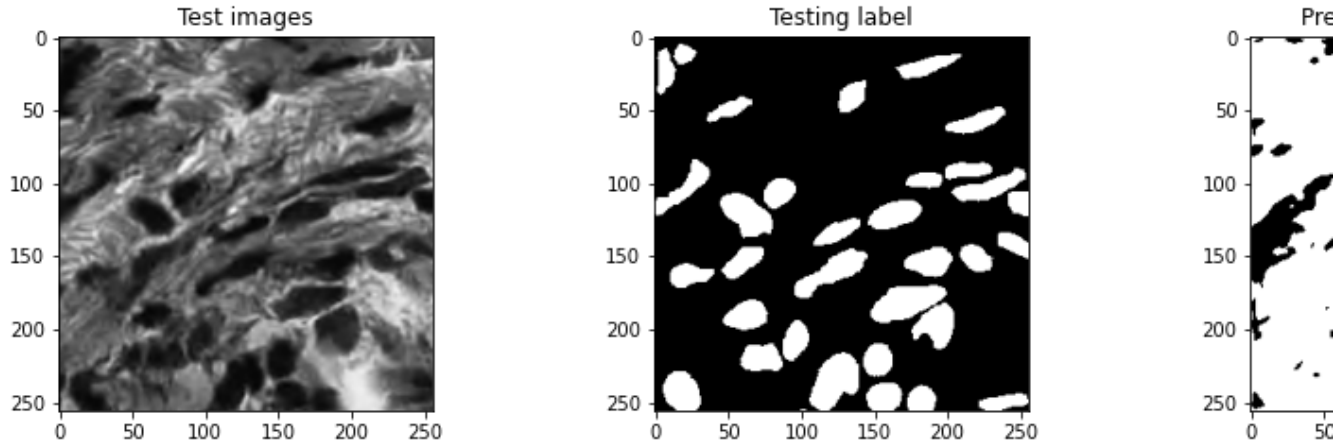
```
19/19 [==============================] - 19s 1s/step - loss: 0.4741 - accuracy: 0.60
Epoch 29/30
```

```
#code for question 4
threshold=0.5
test_number=np.random.randint(0,13) #genrates random no
test_img=x_tis_test[test_number] #gets test image at serial no = that random no
original=y_bin_test[test_number] #oringal y image mask
input_img_test=np.expand_dims(test_img,0)
print(input_img_test.shape)
predict=(model.predict(input_img_test)[0,:,:,0]>threshold).astype(np.uint8) #predicted mask a
print(predict.shape)

plt.figure(figsize=(16,8)) #figure size
plt.subplot(231)
plt.title('Test images')
plt.imshow(test_img[:,:,0],cmap='gray')
plt.subplot(232)
plt.title('Testing label')
plt.imshow(original[:,:,0],cmap='gray')
plt.subplot(233)
plt.title('Prediction of test image')
plt.imshow(predict,cmap='gray')
plt.show()

threshold=0.5
test_number=np.random.randint(0,13)
test_img=x_tis_test[test_number]
original=y_bin_test[test_number]
input_img_test=np.expand_dims(test_img,0)
print(input_img_test.shape)
predict=(model.predict(input_img_test)[0,:,:,0]>threshold).astype(np.uint8)
print(predict.shape)

plt.figure(figsize=(16,8))
plt.subplot(231)
plt.title('Test images')
plt.imshow(test_img[:,:,0],cmap='gray')
plt.subplot(232)
plt.title('Testing label')
plt.imshow(original[:,:,0],cmap='gray')
plt.subplot(233)
plt.title('Prediction of test image')
plt.imshow(predict,cmap='gray')
plt.show()

threshold=0.5
test_number=np.random.randint(0,13)
test_img=x_tis_test[test_number]
original=y_bin_test[test_number]
input_img_test=np.expand_dims(test_img,0)
```

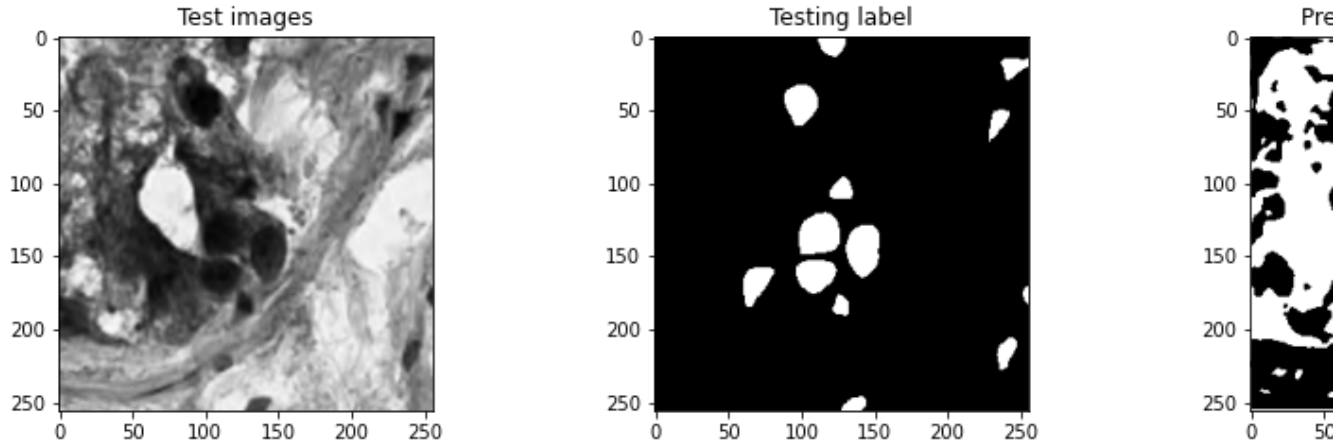
```
input_img_test=np.expand_dims(test_img,0)
print(input_img_test.shape)
predict=(model.predict(input_img_test)[0,:,:,0]>threshold).astype(np.uint8)
print(predict.shape)

plt.figure(figsize=(16,8)) #figure size
plt.subplot(231)
plt.title('Test images')
plt.imshow(test_img[:,:,0],cmap='gray')
plt.subplot(232)
plt.title('Testing label')
plt.imshow(original[:,:,0],cmap='gray')
plt.subplot(233)
plt.title('Prediction of test image')
plt.imshow(predict,cmap='gray')
plt.show()

threshold=0.5
test_number=np.random.randint(0,13)
test_img=x_tis_test[test_number]
original=y_bin_test[test_number]
input_img_test=np.expand_dims(test_img,0)
print(input_img_test.shape)
predict=(model.predict(input_img_test)[0,:,:,0]>threshold).astype(np.uint8)
print(predict.shape)

plt.figure(figsize=(16,8))
plt.subplot(231)
plt.title('Test images')
plt.imshow(test_img[:,:,0],cmap='gray')
plt.subplot(232)
plt.title('Testing label')
plt.imshow(original[:,:,0],cmap='gray')
plt.subplot(233)
plt.title('Prediction of test image')
plt.imshow(predict,cmap='gray')
plt.show()

threshold=0.5
test_number=np.random.randint(0,13)
test_img=x_tis_test[test_number]
original=y_bin_test[test_number]
input_img_test=np.expand_dims(test_img,0)
print(input_img_test.shape)
predict=(model.predict(input_img_test)[0,:,:,0]>threshold).astype(np.uint8)
print(predict.shape)

plt.figure(figsize=(16,8))
plt.subplot(231)
plt.title('Test images')
plt.imshow(test_img[:,:,0],cmap='gray')
plt.subplot(232)
```

```
    plt.title('Testing label')
    plt.imshow(original[:,:,0],cmap='gray')
    plt.subplot(233)
    plt.title('Prediction of test image')
    plt.imshow(predict,cmap='gray')
    plt.show()
```

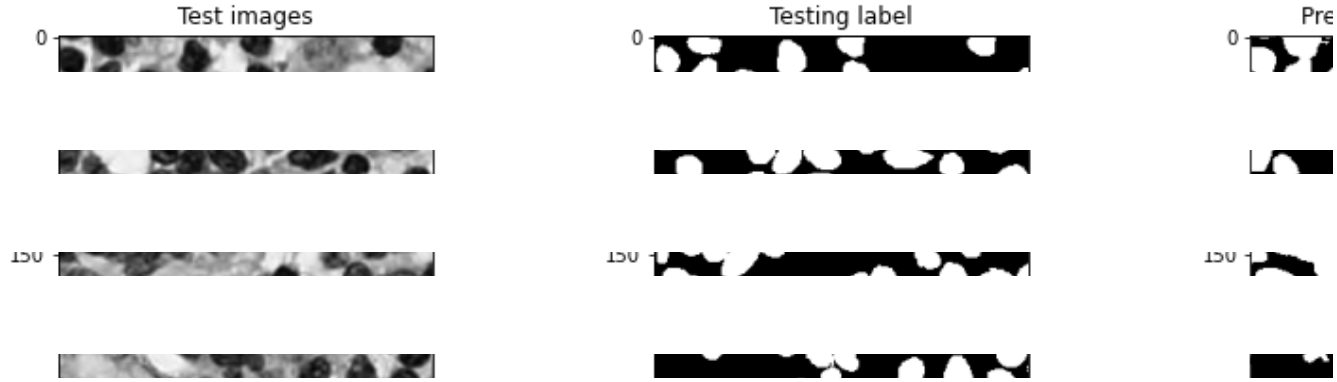
```
(1, 256, 256, 1)
1/1 [==============================] - 1s 806ms/step
(256, 256)
```



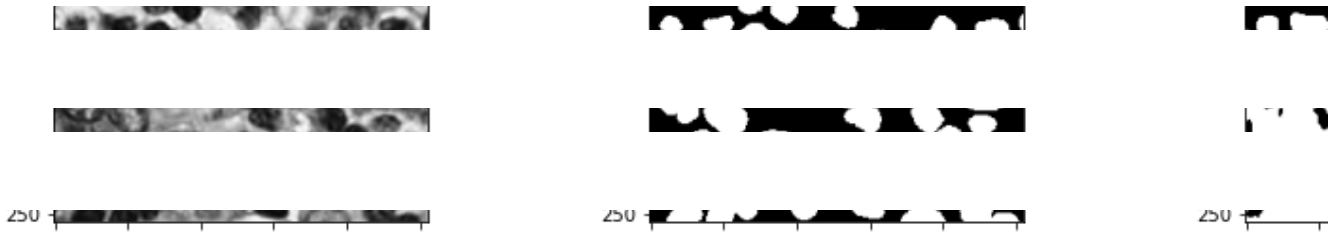

```
(1, 256, 256, 1)
1/1 [==============================] - 0s 291ms/step
(256, 256)
```



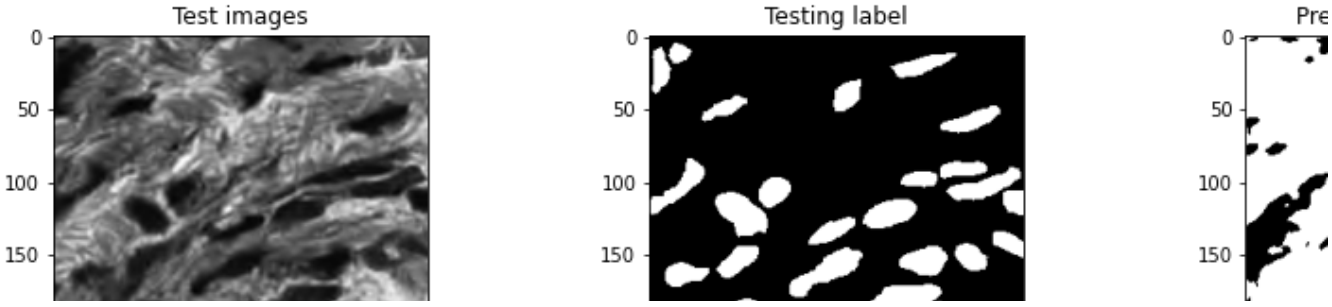

```
(1, 256, 256, 1)
1/1 [==============================] - 0s 220ms/step
(256, 256)
```




```
(1, 256, 256, 1)
```



```
1/1 [==============================] - 0s 224ms/step
(256, 256)
```



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✓ 0s completed at 22:56