Doing quantization and getting overall metric for all the models

```
import tensorflow as tf
import pydicom
import numpy as np
import matplotlib.pyplot as plt
import os
import pandas as pd
import glob
from tqdm import tqdm
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")
import gc
gc.collect()
import cv2
import tensorflow as tf
import keras
from PIL import Image, ImageDraw
from PIL import ImagePath
import imgaug.augmenters as iaa
from skimage import exposure
from tensorflow import keras
from tensorflow.keras.layers import *
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import Model, load_model
from tensorflow.keras.layers import UpSampling2D
from tensorflow.keras.layers import MaxPooling2D, GlobalAveragePooling2D
from tensorflow.keras.layers import concatenate
from tensorflow.keras.layers import Multiply
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoint
from tensorflow.keras import backend as K
from tensorflow.keras.layers import Input, Add, Dense, Activation, ZeroPadding2D, BatchNormal
from tensorflow.keras.models import Model, load_model
from tensorflow.keras.utils import plot_model
from tensorflow.keras.initializers import glorot_uniform, he_normal
from tensorflow.keras.losses import binary_crossentropy
import pathlib
K.set_image_data_format('channels_last')


import numpy as np

def mask2rle(img, width, height):
    rle = []
    lastColor = 0;
    currentPixel = 0;
    runStart = -1;
    runLength = 0;
```

```
        runLength = 0;

        for x in range(width):
            for y in range(height):
                currentColor = img[x][y]
                if currentColor != lastColor:
                    if currentColor == 255:
                        runStart = currentPixel;
                        runLength = 1;
                    else:
                        rle.append(str(runStart));
                        rle.append(str(runLength));
                        runStart = -1;
                        runLength = 0;
                        currentPixel = 0;
                elif runStart > -1:
                    runLength += 1
                lastColor = currentColor;
                currentPixel+=1;

        return " ".join(rle)

    def rle2mask(rle, width, height):
        mask= np.zeros(width* height)
        array = np.asarray([int(x) for x in rle.split()])
        starts = array[0::2]
        lengths = array[1::2]

        current_position = 0
        for index, start in enumerate(starts):
            current_position += start
            mask[current_position:current_position+lengths[index]] = 255
            current_position += lengths[index]

        return mask.reshape(width, height)



    #https://www.kaggle.com/jesperdramsch/intro-chest-xray-dicom-viz-u-nets-full-data
    def getInfoDICOM(path, data_rle_train, toPrint = False, train = True):

        info = {}

        path = os.path.join(path)
        #reading the data using methods of pydicom
        data = pydicom.dcmread(path)
        info['path'] = path
        info['age'] = data.PatientAge
        info['sex']= data.PatientSex
        info['ImageId'] = data.SOPInstanceUID

        if train: #test doesn't have encoded pixels data, we have to predict them
            #SOPInstanceUID contains the storage type which resembles the image ids given in trai
```

```
            #SOPInstanceUID contains the storage type which resembles the image ids given in trai
            encodedPixels = data_rle_train[data_rle_train['ImageId'] == data.SOPInstanceUID]["Enc
            info['encodedPixels'] = encodedPixels

            info['lenOfEncodedPixels'] = len(encodedPixels)

            #this is for visualization purpose
            if '-1' in encodedPixels or len(encodedPixels) == 0:
                info['has_pneumothorax'] = 0
            else:
                info['has_pneumothorax'] = 1

        if toPrint:
            print("Path..............:", path)
            print("Patient's Name.....:", data.PatientName)
            print("Patient's Id.......:", data.PatientID)
            print("Patient's Age......:", data.PatientAge)
            print("Patient's Sex......:", data.PatientSex)

            print("Original X Ray")
            plt.figure(figsize=(10,10))
            plt.imshow(data.pixel_array, cmap=plt.cm.bone)
            plt.show()


        return info


    def computeMasks(train, path):
        mask_paths = []
        for index, row in train.iterrows():
            pixels = row['encodedPixels']
            mask = np.zeros((1024, 1024))
            if row['has_pneumothorax'] == 1:
                for pix in pixels:
                    mask = mask + rle2mask(pix, 1024, 1024).T
            img = Image.fromarray(mask).convert('L')
            path2save = path + str(index+1) + ".jpg"
            img.save(path2save)
            mask_paths.append(path2save)
        train["mask"] = mask_paths
        return train


    def convertImagesToJpeg(train, path):
        images_paths = []
        for index, row in train.iterrows():
            path2dicom = row['path']
            ds = pydicom.read_file(path2dicom) # read dicom image
            img = ds.pixel_array # get image array
            img_mem = Image.fromarray(img) # Creates an image memory from an object exporting the
            path2save = path + str(index + 1)  + ".jpg"
            img_mem.save(path2save)
```

```
            img_mem.save(path2save)
            images_paths.append(path2save)
        train["images_paths"] = images_paths
        return train


    img_size = 256


    def load_data():
        print("Loading Data ...")
        data_rle_train = pd.read_csv("./siim/train-rle.csv")
        #The second column contains a space infront of it so manually rewriting it
        data_rle_train.columns = ['ImageId', 'EncodedPixels']

        print("Extracting info from dicom")
        filesList = glob.glob('./siim/dicom-images-train/*/*/*.dcm')
        train = pd.DataFrame()
        train_list = []
        for file in filesList:
            info = getInfoDICOM(file, data_rle_train, False, True)
            if info['has_pneumothorax'] == 1:
                train_list.append(info)
        train = pd.DataFrame(train_list)
        train.loc[train.lenOfEncodedPixels == 0 , 'encodedPixels'] = np.array(-1)
        print("Extracted info from dicom")

        print("Computing Masks")
        path = "siim/dicom-mask-train/"
        try:
            os.makedirs(path)
        except:
            pass
        train = computeMasks(train, path)
        print("Computed Masks")

        print("Converting Images to Jpg")
        path = "siim/dicom-images-train-jpg/"
        try:
            os.makedirs(path)
        except:
            pass
        train = convertImagesToJpeg(train, path)
        print("Converted Images to Jpg")

        return train


    threshold = 0.38 #learned from previous model
    train = load_data()

         Loading Data ...
         Extracting info from dicom
```

```
Extracted info from dicom
Computing Masks
Computed Masks
Converting Images to Jpg
Converted Images to Jpg
```

```
train.head()
```

	path	age	sex	ImageId	enco
0	./siim/dicom-images-train/1.2.276.0.7230010.3....	26	M	1.2.276.0.7230010.3.1.4.8323329.1051.151787516...	[120 37 9 62 9
1	./siim/dicom-images-train/1.2.276.0.7230010.3....	16	M	1.2.276.0.7230010.3.1.4.8323329.4168.151787518...	[166 1(9(
2	./siim/dicom-images-train/1.2.276.0.7230010.3....	63	F	1.2.276.0.7230010.3.1.4.8323329.5057.151787518...	[672 8 10
3	./siim/dicom-images-train/1.2.276.0.7230010.3....	13	F	1.2.276.0.7230010.3.1.4.8323329.3444.151787517...	10 23 9
4	./siim/dicom-images-	51	F	1.2.276.0.7230010.3.1.4.8323329.1478.151787516	[26 45 9

```
smooth = 1e-5
def dice_coef(y_true, y_pred):
    y_true_f = tf.keras.layers.Flatten()(y_true)
    y_pred_f = tf.keras.layers.Flatten()(y_pred)
    intersection = tf.reduce_sum(y_true_f * y_pred_f)
    return (2. * intersection + smooth) / (tf.reduce_sum(y_true_f) + tf.reduce_sum(y_pred_f)


def combined_loss(y_true, y_pred):
    return 1.0 - dice_coef(y_true, y_pred) + binary_crossentropy(y_true, y_pred)


!unzip pneumothorax_predictor.zip
```

```
Archive:  pneumothorax_predictor.zip
   creating: pneumothorax_predictor/pneumothorax_predictor/
   creating: pneumothorax_predictor/pneumothorax_predictor/assets/
  inflating: pneumothorax_predictor/pneumothorax_predictor/saved_model.pb
   creating: pneumothorax_predictor/pneumothorax_predictor/variables/
  inflating: pneumothorax_predictor/pneumothorax_predictor/variables/variables.data-0000
  inflating: pneumothorax_predictor/pneumothorax_predictor/variables/variables.index
```

```
pneumothorax_predictor = tf.keras.models.load_model("pneumothorax_predictor/pneumothorax_pred


#Predictor
converter_pred = tf.lite.TFLiteConverter.from_keras_model(pneumothorax_predictor)
tflite_models_dir = pathlib.Path("/content/pneumothorax/")
tflite_models_dir.mkdir(exist_ok=True, parents=True)
converter_pred.optimizations = [tf.lite.Optimize.DEFAULT]
tflite_predict_model = converter_pred.convert()
tflite_model_quant_file = tflite_models_dir/"predictor.tflite"
tflite_model_quant_file.write_bytes(tflite_predict_model)
```

```
WARNING:absl:Found untraced functions such as conv2d_layer_call_fn, conv2d_layer_call_ar
WARNING:absl:Found untraced functions such as conv2d_layer_call_fn, conv2d_layer_call_ar
INFO:tensorflow:Assets written to: /tmp/tmpvjcj690u/assets
INFO:tensorflow:Assets written to: /tmp/tmpvjcj690u/assets
7588272
```

```
interpreter_predictor = tf.lite.Interpreter(model_path=str(tflite_model_quant_file))
interpreter_predictor.allocate_tensors()


!unzip pneumothorax_classifier.zip
```

```
Archive:  pneumothorax_classifier.zip
   creating: pneumothorax_classifier/assets/
  inflating: pneumothorax_classifier/saved_model.pb
   creating: pneumothorax_classifier/variables/
  inflating: pneumothorax_classifier/variables/variables.data-00000-of-00001
  inflating: pneumothorax_classifier/variables/variables.index
```

```
pneumothorax_classifier = tf.keras.models.load_model("pneumothorax_classifier")


#Classifer
converter_class = tf.lite.TFLiteConverter.from_keras_model(pneumothorax_classifier)
tflite_models_dir = pathlib.Path("/content/pneumothorax/")
tflite_models_dir.mkdir(exist_ok=True, parents=True)
converter_class.optimizations = [tf.lite.Optimize.DEFAULT]
tflite_classifier_model = converter_class.convert()
tflite_model_quant_file = tflite_models_dir/"classifier.tflite"
tflite_model_quant_file.write_bytes(tflite_classifier_model)
```

```
WARNING:absl:Found untraced functions such as conv2d_36_layer_call_fn, conv2d_36_layer_c
WARNING:absl:Found untraced functions such as conv2d_36_layer_call_fn, conv2d_36_layer_c
INFO:tensorflow:Assets written to: /tmp/tmp1_l3891a/assets
INFO:tensorflow:Assets written to: /tmp/tmp1_l3891a/assets
6796272
```

```
interpreter_classifer = tf.lite.Interpreter(model_path=str(tflite_model_quant_file))
```

```
interpreter_classifer = tf.lite.Interpreter(model_path=str(tflite_model_quant_file))
interpreter_classifer.allocate_tensors()
```

```
!unzip pneumothorax_classifier_oversampling.zip
```

```
Archive:  pneumothorax_classifier_oversampling.zip
   creating: pneumothorax_classifier_oversampling/assets/
  inflating: pneumothorax_classifier_oversampling/saved_model.pb
   creating: pneumothorax_classifier_oversampling/variables/
  inflating: pneumothorax_classifier_oversampling/variables/variables.data-00000-of-0000
  inflating: pneumothorax_classifier_oversampling/variables/variables.index
```

```
pneumothorax_classifier_oversampling = tf.keras.models.load_model("pneumothorax_classifier_ov
```

```
#Classifer_Oversampled
converter_class_oversampled = tf.lite.TFLiteConverter.from_keras_model(pneumothorax_classifie
tflite_models_dir = pathlib.Path("/content/pneumothorax/")
tflite_models_dir.mkdir(exist_ok=True, parents=True)
converter_class.optimizations = [tf.lite.Optimize.DEFAULT]
tflite_classifier_model = converter_class_oversampled.convert()
tflite_model_quant_file = tflite_models_dir/"classifier_over.tflite"
tflite_model_quant_file.write_bytes(tflite_classifier_model)
```

```
WARNING:absl:Found untraced functions such as conv2d_36_layer_call_fn, conv2d_36_layer_c
WARNING:absl:Found untraced functions such as conv2d_36_layer_call_fn, conv2d_36_layer_c
INFO:tensorflow:Assets written to: /tmp/tmpghslbavs/assets
INFO:tensorflow:Assets written to: /tmp/tmpghslbavs/assets
26403360
```

```
interpreter_classifer_oversampled = tf.lite.Interpreter(model_path=str(tflite_model_quant_fil
interpreter_classifer_oversampled.allocate_tensors()
```

```
#Sampling 200 images because of resource constraints
train_sampled = train.sample(200)
```

```
#Getting the overall metric of model non - oversampled
dice_coef_avg = 0
for index in tqdm(range(len(train_sampled))):
    image = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['images_paths'])
    image = tf.keras.preprocessing.image.img_to_array(image, dtype='float32')
    image = tf.image.resize(image, [img_size, img_size])
    image = image / 255.0
    image = exposure.equalize_adapthist(image)     # contrast correction

    mask = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['mask'], color_mod
    mask = tf.keras.preprocessing.image.img_to_array(mask, dtype = 'float32')
    mask = tf.image.resize(mask, [img_size, img_size])
    mask = mask / 255.0
```

```
        mask = mask / 255.0

        image = tf.expand_dims(image, axis = 0)

        is_pneumothorax = pneumothorax_classifier.predict(image)
        is_pneumothorax = is_pneumothorax[0]

        if is_pneumothorax >= threshold :
            pred_masks = pneumothorax_predictor.predict(image)
            pred_masks = pred_masks[0]
        else :
            pred_masks = np.zeros((256,256,1))

        dice_coef_avg  = dice_coef_avg +  dice_coef(mask, pred_masks)

         100%|██████████| 200/200 [01:28<00:00,  2.25it/s]


    print("Average dice coef for non - oversampled model is:", dice_coef_avg.numpy()/200)

         Average dice coef for non - oversampled model is: 0.11101271629333496


    #Getting the overall metric of quantized model non - oversampled
    dice_coef_avg = 0
    for index in tqdm(range(len(train_sampled))):
        image = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['images_paths'])
        image = tf.keras.preprocessing.image.img_to_array(image, dtype='float32')
        image = tf.image.resize(image, [img_size, img_size])
        image = image / 255.0
        image = exposure.equalize_adapthist(image)     # contrast correction

        mask = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['mask'], color_mod
        mask = tf.keras.preprocessing.image.img_to_array(mask, dtype = 'float32')
        mask = tf.image.resize(mask, [img_size, img_size])
        mask = mask / 255.0

        image = tf.expand_dims(image, axis = 0)

        input_index = interpreter_classifer.get_input_details()[0]["index"]
        output_index = interpreter_classifer.get_output_details()[0]["index"]
        interpreter_classifer.set_tensor(input_index, image)
        interpreter_classifer.invoke()
        is_pneumothorax = interpreter_classifer.get_tensor(output_index)
        is_pneumothorax = is_pneumothorax[0]

        if is_pneumothorax >= threshold :
            input_index = interpreter_predictor.get_input_details()[0]["index"]
            output_index = interpreter_predictor.get_output_details()[0]["index"]
            interpreter_predictor.set_tensor(input_index, image)
            interpreter_predictor.invoke()
            pred_masks = tf.reshape(interpreter_predictor.get_tensor(output_index), [256, 256, 1]
```

```
        else :
            pred_masks = np.zeros((256,256,1))

        dice_coef_avg  = dice_coef_avg +  dice_coef(mask, pred_masks)
```

```
 100%|██████████| 200/200 [44:39<00:00, 13.40s/it]
```

```
print("Average dice coef for quantized non - oversampled model is:", dice_coef_avg.numpy()/20
```

```
 Average dice coef for quantized non - oversampled model is: 0.07591805458068848
```

```
#Getting the overall metric of model oversampled
dice_coef_avg = 0
for index in tqdm(range(len(train_sampled))):
    image = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['images_paths'])
    image = tf.keras.preprocessing.image.img_to_array(image, dtype='float32')
    image = tf.image.resize(image, [img_size, img_size])
    image = image / 255.0
    image = exposure.equalize_adapthist(image)     # contrast correction

    mask = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['mask'], color_mod
    mask = tf.keras.preprocessing.image.img_to_array(mask, dtype = 'float32')
    mask = tf.image.resize(mask, [img_size, img_size])
    mask = mask / 255.0

    image = tf.expand_dims(image, axis = 0)

    is_pneumothorax = pneumothorax_classifier_oversampling.predict(image)
    is_pneumothorax = is_pneumothorax[0]

    if is_pneumothorax >= threshold :
        pred_masks = pneumothorax_predictor.predict(image)
        pred_masks = pred_masks[0]
    else :
        pred_masks = np.zeros((256,256,1))

    dice_coef_avg  = dice_coef_avg +  dice_coef(mask, pred_masks)
```

```
 100%|██████████| 200/200 [01:48<00:00,  1.84it/s]
```

```
print("Average dice coef for oversampled model is:", dice_coef_avg.numpy()/200)
```

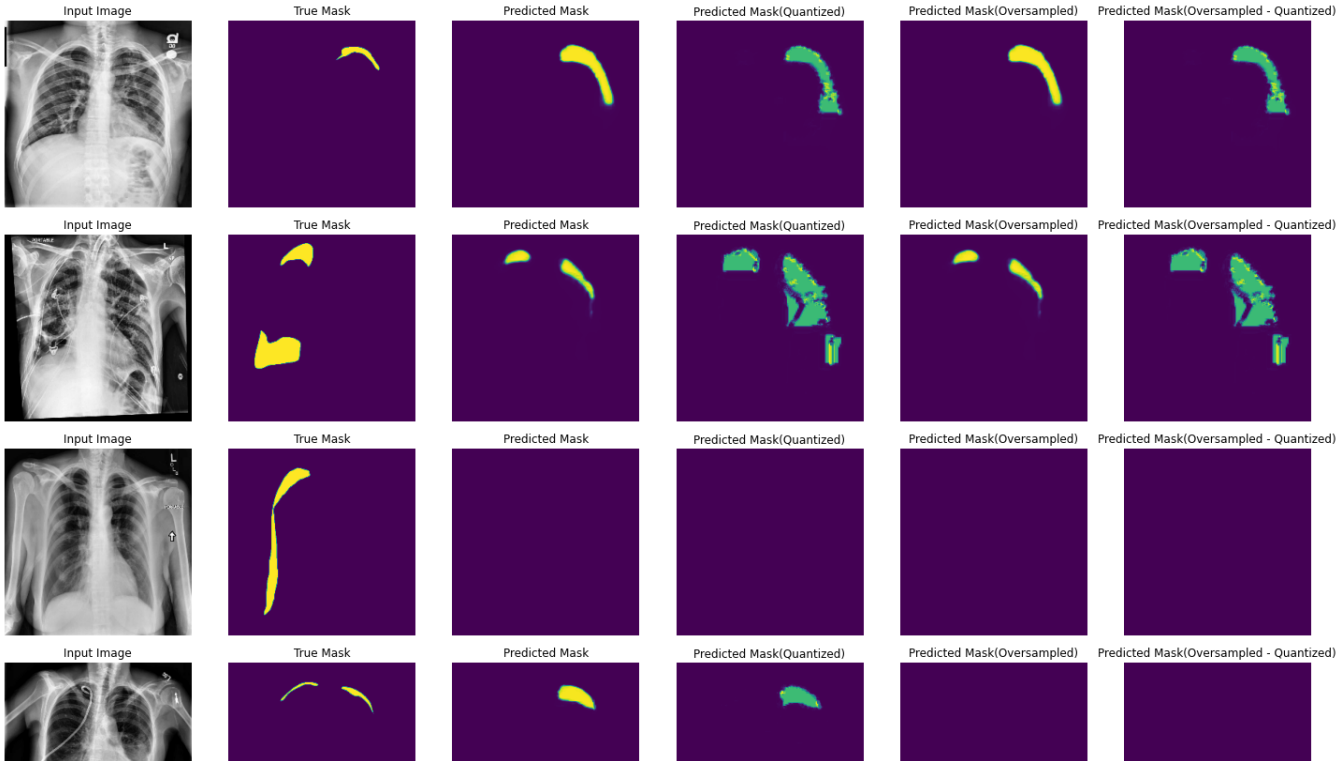
```
 Average dice coef for oversampled model is: 0.142722749710083
```

```
#Getting the overall metric of quantized model oversampled
dice_coef_avg = 0
for index in tqdm(range(len(train_sampled))):
    image = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['images_paths'])
    image = tf.keras.preprocessing.image.img_to_array(image, dtype='float32')
    image = tf.image.resize(image, [img_size, img_size])
```

```
    image = tf.image.resize(image, [img_size, img_size])
    image = image / 255.0
    image = exposure.equalize_adapthist(image)     # contrast correction

    mask = tf.keras.preprocessing.image.load_img(train_sampled.iloc[index]['mask'], color_mod
    mask = tf.keras.preprocessing.image.img_to_array(mask, dtype = 'float32')
    mask = tf.image.resize(mask, [img_size, img_size])
    mask = mask / 255.0

    image = tf.expand_dims(image, axis = 0)

    input_index = interpreter_classifer_oversampled.get_input_details()[0]["index"]
    output_index = interpreter_classifer_oversampled.get_output_details()[0]["index"]
    interpreter_classifer_oversampled.set_tensor(input_index, image)
    interpreter_classifer_oversampled.invoke()
    is_pneumothorax = interpreter_classifer_oversampled.get_tensor(output_index)
    is_pneumothorax = is_pneumothorax[0]

    if is_pneumothorax >= threshold :
        input_index = interpreter_predictor.get_input_details()[0]["index"]
        output_index = interpreter_predictor.get_output_details()[0]["index"]
        interpreter_predictor.set_tensor(input_index, image)
        interpreter_predictor.invoke()
        pred_masks = tf.reshape(interpreter_predictor.get_tensor(output_index), [256, 256, 1]

    else :
        pred_masks = np.zeros((256,256,1))

    dice_coef_avg  = dice_coef_avg +  dice_coef(mask, pred_masks)

 100%|██████████| 200/200 [43:23<00:00, 13.02s/it]


print("Average dice coef for quantized oversampled model is:", dice_coef_avg.numpy()/200)

 Average dice coef for quantized oversampled model is: 0.09985686302185058


def display(display_list):
    plt.figure(figsize=(25, 25))

    title = ['Input Image', 'True Mask', 'Predicted Mask', 'Predicted Mask(Quantized)', 'Pred

    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()


train_display = train.sample(5)
```

```
    for index in range(len(train_display)):
        image = tf.keras.preprocessing.image.load_img(train_display.iloc[index]['images_paths'])
        image = tf.keras.preprocessing.image.img_to_array(image, dtype='float32')
        image = tf.image.resize(image, [img_size, img_size])
        image = image / 255.0
        image = exposure.equalize_adapthist(image)     # contrast correction

        mask = tf.keras.preprocessing.image.load_img(train_display.iloc[index]['mask'], color_mod
        mask = tf.keras.preprocessing.image.img_to_array(mask, dtype = 'float32')
        mask = tf.image.resize(mask, [img_size, img_size])
        mask = mask / 255.0

        image = tf.expand_dims(image, axis = 0)

        #Non - Oversampled
        is_pneumothorax = pneumothorax_classifier(image)
        is_pneumothorax = is_pneumothorax[0]

        if is_pneumothorax >= threshold :
            pred_masks = pneumothorax_predictor.predict(image)
            pred_masks = pred_masks[0]
        else :
            pred_masks = np.zeros((256,256,1))

        #Quantized
        input_index = interpreter_classifer.get_input_details()[0]["index"]
        output_index = interpreter_classifer.get_output_details()[0]["index"]
        interpreter_classifer.set_tensor(input_index, image)
        interpreter_classifer.invoke()
        is_pneumothorax = interpreter_classifer.get_tensor(output_index)
        is_pneumothorax = is_pneumothorax[0]

        if is_pneumothorax >= threshold :
            input_index = interpreter_predictor.get_input_details()[0]["index"]
            output_index = interpreter_predictor.get_output_details()[0]["index"]
            interpreter_predictor.set_tensor(input_index, image)
            interpreter_predictor.invoke()
            pred_masks_quant = tf.reshape(interpreter_predictor.get_tensor(output_index), [256, 2
        else :
            pred_masks_quant = np.zeros((256,256,1))

        #Oversampled
        is_pneumothorax = pneumothorax_classifier_oversampling(image)
        is_pneumothorax = is_pneumothorax[0]

        if is_pneumothorax >= threshold :
            pred_masks_over = pneumothorax_predictor.predict(image)
            pred_masks_over = pred_masks_over[0]
        else :
            pred_masks_over = np.zeros((256,256,1))
```

```
#Quantized Oversampled
input_index = interpreter_classifer_oversampled.get_input_details()[0]["index"]
output_index = interpreter_classifer_oversampled.get_output_details()[0]["index"]
interpreter_classifer_oversampled.set_tensor(input_index, image)
interpreter_classifer_oversampled.invoke()
is_pneumothorax = interpreter_classifer_oversampled.get_tensor(output_index)
is_pneumothorax = is_pneumothorax[0]

if is_pneumothorax >= threshold :
    input_index = interpreter_predictor.get_input_details()[0]["index"]
    output_index = interpreter_predictor.get_output_details()[0]["index"]
    interpreter_predictor.set_tensor(input_index, image)
    interpreter_predictor.invoke()
    pred_masks_quant_over = tf.reshape(interpreter_predictor.get_tensor(output_index), [2
else :
    pred_masks_quant_over = np.zeros((256,256,1))

display([image[0], mask, pred_masks, pred_masks_quant, pred_masks_over , pred_masks_quant
```



-- Quantized models have reduced quality